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Contents

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Response of safflower to foliar spray of nano urea

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ABSTRACT

The objective of the present study was to investigate the effect of different rates of soil applied nitrogen (100% N, 75% N and 50% N) and foliar spray of nano urea and 2% urea (at flowering and seed filling stages) on growth and yield of safflower. The results showed that the effect of soil applied urea at vegetative stage and foliar applied urea at reproductive stage had significant effect on seed and biological yield (1581, 4249 kg/ha) of safflower and recorded maximum biological yield among given treatments.

Keywords: Growth attributes, Nano urea, Safflower, Seed yield, yield attributes

Safflower is an important oilseed crop and is grown in dry and semi-arid areas characterised by its strong tap root system thus considered drought tolerant. Its seed contains 24-36% oil and 71–75% linoleic acid, but, oleic safflower oil is highly preferred for various industry purposes (Yesilyurt *et al*., 2020; Nogales-Delgado *et al*., 2021).

Nitrogen is considered as one of the most important nutrient for crop production as it is required for the synthesis of several growth-promoting enzymes, proteins and thus plays an important role in plant growth regulation, particularly during the vegetative phase (Iqbal, 2019). It has been reported by several researcher workers that seed yield is primarily influenced by the effect of nitrogen on number of heads/plant. So, optimum fertilizer management and application timing can be a suitable strategy to improve crop growth and yield (Barlo'g and Grzebisz, 2004; Corbellini *et al*., 2006) and also increase fertilizer use efficiency. Some studies have reported that, compared to single application, split application of nitrogen depending on initial soil status is beneficial for improving crop growth and yield. It is also reported recently that Nano urea when applied to foliage, easily enters through stomata and distributed through phloem. Unutilized nitrogen is stored in plant vacuole and is slowly released for proper growth and development of plant (Baboo, 2021).

MATERIALS AND METHODS

The experiment was carried out at the research farm of All India Coordinated Research Project (AICRP) on Safflower, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani ($190^0$16' north latitude and 26^0 47' east longitudes), Maharashtra during *rabi* season of 2021-22 on medium black soil. This semi-arid region experiences hot dry summer (March-May) and cold dry winter (Oct-Feb), wet humidity with medium rainfall. The experiment was conducted on PBNS 86 variety of safflower in a split plot design with 3 replications.

The treatments in the three main plots included F1 with 100% N, F2 with 75% N and F3 with 50% N application, while, the five sub plots included N0 with no spray of nano urea, N1 with nano urea spray at flowering stage, N2 with nano urea spray at flowering and seed filling stages, N3 with 2% urea spray at flowering stage and N4 with 2% urea spray at flowering and seed filling stages.

RESULTS AND DISCUSSION

Application of 100% N (F1) at vegetative stage and foliar spray of nano urea at flowering and seed filling stages (N2) recorded significantly higher plant height, number of capitula /plant, seed weight/plant, seed yield and biological yield of the crop as compared to other treatments (Table 1). Application of 100% N at vegetative stage is beneficial for crop in improving its vegetative growth, yield attributes and yield of crop.

Among the given treatments, foliar spray of nano urea twice at flowering and seed filling stages (N2) recorded maximum plant hight, number of capitula /plant, seed weight/plant, seed yield and biological yield of the crop. Nano urea will enhance the nutrient use efficiency of the plant because of its slow release of nutrients and it also reduces the soil and water pollution due to draining off of the applied chemical fertilizers into water bodies

The study suggests the use of nano urea as foliar spray along with the basal application of 100% N would be beneficial for farmers in getting good returns and also can reduce the environment pollution to some extent.

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Table 1 Growth attributes, yield attributes, seed yield and Oil yield of safflower as influenced by application of urea and foliar spry of Nano urea

Treatments	Plant height (cm)	Capitula No./plant	No. of seed/capitula	Seed yield (kg/ha)	Biological yield (kg/ha)	Oil yield (kg/ha)
Fertilizer N Application						
F_1: 100 % N	85.93	59.33	27.66	1467	4434	478
F_2: 75 % N	85.26	57.06	26.60	1043	3753	343
F_3:50 % N	81.46	53.46	23.80	992	3516	324
S.Em±	0.76	0.63	0.41	62	52.28	24
C.D (p≤0.05)	2.98	2.47	1.63	243	205	93
Foliar spray of Nano urea /urea						
N_0 : No spray of Nano urea	80.88	48.55	20.88	951	3695	309
N_1 : Nano urea spray at flowering stage	84.00	50.77	28.11	1212	4039	397
N_2 : Nano urea spray at flowering and seed filling stage	88.88	65.33	30.88	1581	4249	520
N_3 : Urea spray at 2% at flowering stage	86.11	58.00	26.88	1052	3786	344
N_4 : Urea spray at 2% at flowering and seed filling stage	81.22	60.44	23.33	1042	3737	339
S.Em±	1.15	1.38	0.60	47	51	16
C.D (p≤0.05)	3.38	4.02	1.75	136	148	45
F x N Interaction						
S.Em±	2.00	2.39	1.04	80	88	27
C.D (p≤0.05)	5.85	NS	NS	NS	257	NS
C.V (%)	4.13	7.31	6.93	12	4	12

Genetic enhancement for grain yield and mungbean yellow mosaic India virus (MYMIV) resistance through introgressions from *Glycine soja*

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ABSTRACT

The current study aimed at development of early maturing, mungbean yellow mosaic India virus (MYMIV) resistant and higher yield soybean genotypes. Through a series of backcrosses (BC_4 generation) MYMIV resistance gene has been introgressed from *G. soja* in to a widely adaptable cultivar JS 335. Introgression lines, viz., YMV1, YMV2, YMV 11 and YMV 16 having MYMIV resistance and higher yield performance over recurrent parent and other check varieties were identified and characterized. GGE biplots analysis revealed YMV 16 as ideal genotype with respect to 100-seed weight and grain yield whereas YMV 11 was promising under sugarcane-soybean intercropping system in spring season. Further, study also reports the development of an extra-early maturing (72 days) genetic stock NRC 252, which can be a potential parent in breeding for early maturing soybean varieties. In conclusion, alleles from wild type soybean could improve yield and MYMIV resistance in cultivated soybean. The genotypes developed in the present study will help in reducing the damage caused by MYMIV disease and area expansion of the soybean crop through intercropping with sugarcane.

Keywords: *Glycine soja*, Grain yield, Introgression, Mungbean yellow mosaic India virus (MYMIV) resistance, Soybean

Breeding for early maturity and higher yield is the principal objective in genetic improvement of soybean. Yellow Mosaic Disease (YMD) caused by Mungbean Yellow Mosaic India Virus (MYMIV) causes upto 80% yield loss. *Glycine soja*, the wild species of soybean, possess QTLs for yield and attributing traits like 100-seed weight, seed yield and MYMIV resistance (Kumawat *et al* 2019b). Soybean crop in India is mainly grown under rainfed condition where short growing season and high cropping intensity desires development of extra early (80-85 days) and early maturing genotypes (85-90 days) (Maranna *et al* 2021). Considering losses caused by disease and availability of resistance sources, it is imperative to generate elite soybean varieties with durable resistance to yellow mosaic disease and high yield, either through molecular breeding or conventional plant breeding approach.

MATERIALS AND METHODS

G. soja (PI393551) was used as donor parent for introgression of MYMIV resistant gene into popular variety JS 335. By backcrossing at ICAR-IISR, Indore followed by screening for MYMIV resistance at PAU Ludhiana, two BC_2F_4 lines were identified as MYMIV resistant during 2014. These BC_2F_4 lines were again backcrossed to recurrent parent JS 335 to develop BC_3 and BC_4F_1population. Tightly linked markers viz., BARCSOYSSR_08_0867 on chromosome 8, and BARCSOYSSR_14_1416 and BARCSOYSSR_14_1417 on chromosome 14 were identified for MYMIV resistance (Anita et al 2018). Two SSR markers satt063 and BARCSOYSSR_14_1382 present on genomic region associated with MYMIV resistance were polymorphic between donor and recurrent parents. Foreground selection was carried out in BC_4 population using satt063 and BARCSOYSSR_14_1382 to identify MYMIV resistant plants. Corresponding BC_4F_2 progenies were again tested using linked markers satt063 and BARCSOYSSR_14_1382. Subsequently, four MYMIV resistant and agronomically superior introgressions lines viz., YMV1, 2, 11, and 16 were identified which were evaluated for grain yield and attributing traits over Indore and Ludhiana locations. Further, genotype YMV 11 was also tested for its suitability in sugarcane intercropping.

RESULTS AND DISCUSSION

Interestingly, *G. soja* gene pool is indisputably more diverse than *G. max* and potential donor for early maturity, MYMIV resistance, grain yield, 100-seed weight and several other key traits (Kumawat et al 2019b). For conversion of JS 335 into its MYMIV resistant version, *G. soja* was crossed with JS 335 and through series of backcrossing and phenotyping. Current study developed four promising genotypes YMV 1, YMV 2, YMV 11 and YMV 16 with higher yield, MYMIV resistance, and high 100-seed weight. Further these genotypes found superior to recurrent variety JS 335 and other check varieties. Two SSR markers satt063 and BARCSOYSSR_14_1382, have been found to be associated with MYMIV resistance in the four identified genotypes. Background analysis using >350 polymormhic SSR markers revealed that >84 % of recurrent parent genome in the four high yielding, MYMIV resistant genotypes. Breeding for early maturity is one of the major requirement by the farmers who cultivate three different crops per year particularly soybean-potato-wheat in central zone (Malwa region) of India. The present study developed earliest maturing genotype NRC 252 (71 days) as against check variety JS 20-34 (92 days) and it produced significantly higher yield than early maturing check variety JS 20-34. GGE biplots analysis revealed YMV 16 as an ideal genotype for grain yield. Further, present study has identified YMV 11 suitable for intercropping with sugarcane in spring season.

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Genome-wide association studies on charcoal rot resistance in soybean (*Glycine max*, L.)

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ABSTRACT

A genome-wide association study (GWAS) was conducted for Charcoal rot resistance by using 267 soybean germplasm lines. GWAS analysis revealed two most significant SNPs at chromosome 3 (*S3_8215775* and *S3_8309181*) for multiple traits associated with adult plant resistance. Candidate genes related to calcium ion signaling, response to nematode infestation, abscisic acid stimulus and defense response to bacteria were identified within the flanking regions of the significant SNP positions. Among all, one most important gene (Glyma.03G057100) involved in jasmonic acid biosynthesis was identified. Two SNPs each on chromosome 8 (*S8_22467783* and *S8_22467802*) and chromosome 9 (*S9_2923863* and *S9_2935518*), associated with seedling resistance have also been identified.

Keywords: Charcoal rot resistance, Disease resistance, GWAS, soybean

Charcoal rot disease caused by *Macrophomiba phaseolina* is one of the most devastating diseases in soybean. Employing genetic resistance is the most economical and eco-friendly to manage this disease. Breeding for charcoal rot resistance has been impeded owing to the complexity of the trait. Understanding the genetic architecture of the resistance mechanism can aid in success of the breeding programs and in developing resistant varieties. With this background, the current study was conducted to identify loci/genes governing charcoal rot resistance in soybean.

MATERIALS AND METHODS

A collection of 267 diverse germplasm lines were used in the current study. These 267 germplasm lines were genotyped with the help of GBS platform. Imputations were performed to fill missing data and finally a total of 66300 SNPs distributed all over 20 chromosomes were used for association analysis**.** Field screening was carried out in a sick plot at J.N.K.V.V, Jabalpur. Disease assessment was based on Percent Disease Incidence, Area Under Disease Progress Curve (AUDPC) and Root Stem Severity (RSS) index (Mengistu *et al* 2007). Artificial screening was carried out at V_2 growth stage using cut-stem inoculation technique (Twizeyimana *et al* 2012). Disease assessment was based on AUDPC calculated based on necrosis length 5, 10 and 15 days after inoculation.

RESULTS AND DISCUSSION

A total of eight SNPs were identified to be associated with charcoal rot resistance. Four SNPs associated with charcoal rot adult plant resistance have been identified on chromosome 3. Among them, two SNPs *S3_8215775* and *S3_8309181* were found to be associated with AUDPC, PDI and RSS, while one SNP *S3_8199156* was found to be associated with AUDPC and PDI. SNP *S3_8537736* was found to be associated with RSS. Through gene annotation within the significant SNP region (postion 8199156 to 8537736) on chromosome 3, candidate genes related to calcium ion signaling, response to nematode infestation, abscisic acid stimulus and defense response to bacteria were identified near the flanking regions of the significant SNP positions. Among all, one most important gene (Glyma.03G057100) involved in jasmonic acid biosynthesis was identified. In case of seedling resistance, four SNPs, two each on chromosome 8 (*S8_22467783* and *S8_22467802*) and chromosome 9 (*S9_2923863* and *S9_2935518*) were found to be associated with AUDPC. Non-overlapping of genes/loci between seedling and adult plant resistance indicates the complexity of the charcoal rot resistance mechanism in soybean. Further, genes/loci identified have to be validated through marker-trait association in bi-parental mapping populations the identified candidate genes are to be validated through gene expression and gene silencing studies.

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Impact of conservation tillage and agronomic biofortification strategies on soil health and grain quality aspects under soybean–wheat cropping system

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ABSTRACT

A field experiment was initiated in 2018 at ICAR-IISR Indore (MP), to study the effect of crop establishment techniques and agronomic biofortification methods on grain yield, crop and soil quality aspects under long-term conservation agriculture (CA) based soybean-wheat cropping system. The experiment was laid out in split plot design with two crop establishment techniques and eight agronomic biofortification methods. The results revealed that significantly higher grain yield, lowest soil pH, highest available nutrients (DTPA-Zn and DTPA-Fe), increased soil enzyme (Dehydrogenase) of soybean and wheat under conservation tillage. Among different agronomic biofortification methods soil application of Zn+Fe (DTPA-Zn and DTPA-Fe) reported significantly higher grain yield, compared to control. However, seed inoculation of microbial strains MDSR 14 + MDSR 34 reported significantly lowest soil pH, highest soil enzyme. Soybean and wheat grain phytic acid/Zn (<15) and phytic acid/Fe (<10) molar ratio was found significantly lower under conservation tillage and foliar application of Zn+Fe. Thus, in long term, adaptation of conservation tillage along with soil or foliar application of Zn+Fe and seed inoculation of MDSR 14 + MDSR 34 could be prominent options to improve yield, soil and crop quality parameters under CA based soybean-wheat cropping system.

Keywords: Conservation agriculture, Soil biofortification, Soybean-wheat cropping system

In India >70% of soybean is grown in central India, where, Vertisols are predominately poor available micronutrients (Zn &Fe) and soil organic carbon status. Further, >98% of soybean area is under rainfed and severely affected by low rainfall at the time of sowing and extremely high rainfall towards crop maturity (Agarwal *et al*., 2013). Around 92 million tons of crop residue is burned and cause environment pollution. So, sustainable agriculture management practices like Permanent broad bed furrow (PBBF), residue retention and FYM application can boost soybean productivity, soil health and crop quality by reducing environmental pollution. Central India, commonly called durum wheat bowl of India, the productivity of succeeding wheat crop after soybean will be enhanced due to legume and residual effect of CR and FYM under PBBF with positive impact on soil and crop quality aspects. Further, in vertisols, micronutrients are present abundantly but their availability is hindered due to solubilization and mobilization (Marschner *et al*. 2011). Under such condition employing microbial strains (MDSR 14 + MDSR 34) can enhance micronutrients availability in soil and edible part of crops. Therefore, increasing density of Zn and Fe concentration through conservation tillage and microbial strains could be environment sustainable methods to decrease PA/Zn and PA/Fe molar ratio to enhance micronutrients bioavailability in seeds to reduce malnutrition of Zn and Fe.

MATERIALS AND METHODS

The experiment was laid out in split plot design with two tillage practices as main plots (M_1-conservation, CA-T, Permanent broad bed furrow and M_2-conventional, Con-T, farmer practices) and eight agronomic biofortification methods (S_1-control, S_2-Zn-soil application, S_3-Zn-foliar application, S_4-Fe-soil application, S_5-Fe-foliar application, S_6-Zn+Fe-soil application, S_7-Zn+Fe-foliar application and S_8-MDSR14+ MDSR34) in sub plots with three replications. Sun dried chopped residues of the wheat to soybean retained @ 4 t/ha, soybean residue @ 2 t/ha to wheat + 5 t/ha FYM applied before sowing, in CA-T plots. Soybean cultivar (JS 20-29) was sown at 45 x 10 cm with seed rate 65 kg/ha. Recommended dose of fertilizer (25:60:40 kg N, P_2O_5 and K_2O/ha) and soil application of Zn ($ZnSO_4$ @ 25 kg/ha) and Fe through FeSO4 @ 50 kg/ha were placed below the seed zone at sowing as per the treatment. Seeds of soybean and wheat treated with microbial strains (MDSR14+MDSR34) @ 10 g/kg seed. The foliar application of Zn (@ 0.5%) and Fe (@ 1.0 %) done at three stages - before flowering, maximum flowering and grain filling stage as per the treatment. Samples of grain yield, soil and crops quality parameters were assessed by employing recommended standard procedures. The data was analyzed by using SAS statistical software (ver. 9.2; SAS Institute, Cary, NC enterprise guide 4.2).

RESULT AND DISCUSSION

The data pertaining to soil health, grain yield and quality aspects of soybean and wheat presented in Table 1. Significantly lowest soil pH, highest DTPA-Zn, DTPA-Fe and increased dehydrogenase activity were recorded with conservation tillage and seed inoculation of microbial strains MDSR 14 + MDSR 34. The combined soil application of Zn+Fe increased DTPA-Zn (55.5-67.9%) and DTPA-Fe (37.9-50.0%) in soybean and wheat as compared to control. Soybean seed (14.79%) and wheat grain (7.13%) yield were significantly increased under conservation tillage over conventional tillage practices. Among different agronomic biofortification methods soil application of Zn+Fe, foliar application of Zn+Fe and seed inoculation of microbial strains (MDSR 14 + MDSR 34) reported significantly higher seed yield of soybean (20.17-21.63%) and grain yield of wheat (14.89-16.36%) as compared to control. The phytic acid/Zn (PA/Zn) and phytic acid/Fe (PA/Fe) molar ratio in soybean (11.02%) and wheat (7.69%) grains were found significantly lower under conservation tillage as compared to conventional tillage. Among agronomic biofortification methods significantly lowest PA/Zn and PA/Fe molar ratio of soybean (72.07%) and wheat (62.20%) grains were found with foliar application of Zn+Fe as compared to control. This concurs with the findings of Ramesh *et al*. (2014).

CONCLUSION

Permanent broad bed furrow (PBBF) with FYM (5 t/ha) and residue retention (4 t/ha wheat residue to soybean and 2 t/ha soybean residue to wheat) and agronomic biofortification methods such as soil application of $ZnSO_4$ + $FeSO_4$ @ 25 + 50 kg/ha as basal, foliar application of $ZnSO_4$ + $FeSO_4$ (0.50% + 1.0%) at stages - before flowering, maximum flowering and seed filling, and seed inoculation with microbial stains (MDSR 14+ MDSR 34) @ 10g/kg seed enhanced grain yield of soybean and wheat, improved crop and soil quality parameters under soybean-wheat cropping system..

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Table 1 Effect of tillage practices and agronomic biofortification methods on soil health, grain yield and quality aspects of soybean and wheat under CA based soybean-wheat cropping system (Data at the end of 4 years cropping cycle)

Treatments	Soybean							Wheat						
	Soil pH	Dehydrogenase activity (µg triphenyl formazon/g soil/24h)	Grain yield (kg/ha)	Phytic acid/Zn molar ratio	Phytic acid/Fe molar ratio	DTPA-Zn (mg/kg)	DTPA-Fe (mg/kg)	Soil pH	Dehydrogenase activity (µg triphenyl formazon/g soil/24h)	Grain yield (kg/ha)	Phytic acid/Zn molar ratio	Phytic acid/Fe molar ratio	DTPA-Zn (mg/kg)	DTPA-Fe (mg/kg)
Crop establishment techniques (CET)														
M1-CA-T	7.52B	89.6A	2459A	13.6B	9.17B	0.79A	2.61A	7.50B	86.8A	7189A	15.6B	9.88B	0.85A	2.75A
M2-Con-T	7.54A	85.9B	2142B	15.1A	9.95A	0.72B	2.49B	7.53A	83.5B	6710B	16.8A	10.9A	0.76B	2.60B
Agronomic biofortification methods (ABM)														
S1-Control	7.64A	62.4E	2057E	19.1A	12.44A	0.54E	2.03E	7.63A	71.6E	6378D	20.6A	13.9A	0.53D	2.00E
S2-Soil application of Zn	7.61A	69.3D	2185CD	14.4C	11.08B	0.83AB	2.45D	7.60A	79.3D	6713C	16.6C	12.3B	0.87A	2.51D
S3-Foliar application of Zn	7.54B	91.4C	2143DE	12.1EF	9.67C	0.78BC	2.41D	7.53B	85.8BC	6599C	14.0D	11.0C	0.86AB	2.45D
S4-Soil application of Fe	7.60A	72.7D	2316B	16.3B	9.31CD	0.74CD	2.76AB	7.59A	82.5CD	6952B	17.9B	10.0D	0.81BC	2.97A
S5-Foliar application of Fe	7.51BC	93.1C	2239BC	15.0BC	8.09E	0.72D	2.58C	7.50BC	88.5ABC	6841B	16.3C	8.45E	0.78C	2.76C
S6-Soil application of Zn and Fe	7.48CD	101.1B	2502A	12.8DE	8.89D	0.84A	2.80A	7.46CD	89.9ABC	7422A	14.7D	9.28D	0.89A	3.00A
S7-Foliar application of Zn and Fe	7.45DE	104.6AB	2489A	11.1F	7.57E	0.80AB	2.66BC	7.44D	91.4ABC	7363A	12.7E	8.07E	0.84AB	2.83B
S8-MDSR14+ MDSR34	7.43E	107.3A	2472A	13.7CD	9.46CD	0.81AB	2.72AB	7.41D	92.2A	7328A	16.6C	9.93D	0.87A	2.89B
ANOVA														
ABM	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CET x ABM	0.8371	0.9833	0.2531	0.8624	0.8826	0.6727	0.2925	0.2520	0.9647	0.0001	0.3921	0.5329	0.1008	0.0301

Data are mean values of three replicates; Values followed by same capital letters are not significantly different among tillage practices and agronomic biofortification methods at P=0.05. Tukey's range test was used to separate the treatment means. Values under ANOVA are the probabilities (P values) of the source of variation. Initial soil DTPA-Zn content (0.6 mg kg^{-1}) and DTPA-Fe content (2.15 mg/kg).

PBNS 184- A New Safflower High Oil Yield Variety for Zone I

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ABSTRACT

A new safflower variety PBNS-184 evaluated in coordinated trials at twenty locations under rainfed and irrigated conditions during 2018-2021 for seed and oil yield as well as reaction to biotic stresses *viz;* Alternaria leaf spot, *Fusarium* wilt and aphid pest in comparison with the national checks A-1 and PBNS-12 AICRP testing programme has recorded 11.26 and 14.39% higher oil yield over checks and was found moderately resistant to *Fusarium* wilt and tolerant to *Alternaria* leaf spot disease reaction. It was also moderately tolerant to aphid pest as compared with all other qualifying varieties and checks. Hence, the variety PBNS -184 was released for cultivation in Zone-I i.e. Maharashtra, Karnataka, Telangana and Andhra Pradesh by project.

Keywords: PBNS-184, Rainfed, Tolerant

Safflower is a major *rabi* oilseeds crop mainly cultivated on residual moisture condition. The average productivity of the country is very low i.e. 637 kg/ha during 2020-21. The area under this crop is declining due to several reasons including the non-availability of seed of high yielding with high oil content varieties. Therefore, a variety having more oil content, tolerant to *Fusarium* wilt, alternaria leaf spot diseases and aphid, a major pest of safflower is the need for ranifed as well as irrigated conditions. Accordingly, efforts have been made at All India Coordinated Safflower Research Project, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani for development of a new variety.

The spiny variety PBNS- 184 was developed by pedigree method from the cross (PBNS-F4-3-1 x SSF-691). It was tested at 20 different location in the coordinated trials *viz.*, IVT, AVT-I and AVT-II during *rabi* 2018-19, 2019-20 and 2020-21 under irrigated and rainfed conditions. The observations were recorded for seed yield, oil yield, oil content and ancillary data and comparison was made with spiny checks A1 and PBNS-12. The recommended packages of practices were followed while conducting the trial. The variety was also screened for its agronomic adaptability for different cropping situations, disease and pest reactions under artificial and natural conditions at different coordinated centres across India.

The seed yield performance of PBNS -184 is presented in Table 1. It recorded higher seed yield (1531 kg/ha) compared to the checks A1 (1512 kg/ha) and PBNS-12 (1453 kg). The PBNS -184 variety had high oil content i.e. 31.3%, It recorded higher oil yield (480 kg/ha) compared to the checks A1 (434 kg/ha) and PBNS-12 (422 kg), which was 10.6 % and 13.7 % higher over the checks A1 and PBNS 12 respectively. The variety, PBNS-184 was found moderately resistant to *Fusarium* wilt and tolerant to *Alternaria* leaf spot disease reaction under protected and unprotected conditions. PBNS-184 was also moderately tolerant to aphid pest as compared with all other qualifying varieties and checks in agronomic trials, the spacing of 45 x 20 cm was found optimum. The recommended fertilizer dose and recommended sowing time recorded higher seed yield in agronomical trials indicating better response to recommended fertilizer application and sowing time. The plant achieved 50% flowering in about 78-81 days and matures in 120-124 days. The plant grows to the height of 80-85 cm with 24-25 capitula/plant. The capitulum is of medium size with 28-33 seeds/capitulum. The capitula remain in closed condition and are non shattering type. The seed is without papus and is white in colour having test weight 5.3-5.5g. Considering the higher oil yield and oil content the entry PBNS-184 is released and notified for cultivation in Zone-I (Maharashtra, Karnataka and Telegana state) of safflower growing areas of the country.

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Table 1. Mean Seed yield, oil Yield and oil % data of Coordinated Varietal Trials

Year of testing	No. of trials/locations	PBNS-184	A-1 (NC)	PBNS-12 (ZC)	% increase over	
					A-1	PBNS-12
Seed yield (Kg/ha)						
2018-2019	6	1657	1472	1375	12.5	20.5
2019-2020	8	1505	1564	1536	--	--
2020-2021	6	1441	1483	1421	2.83	1.41
Weighted Mean	20	1531	1512	1453	1.28	5.38
Oil yield (kg/ha)						
2018-2019	6	500	394	392	26.9	27.5
2019-2020	8	479	467	464	2.5	3.2
2020-2021	6	461	430	397	7.2	16.1
Weighted Mean	20	480	434	422	10.6	13.7
Oil %						
2018-2019	6	30.2	26.7	28.5	--	--
2019-2020	8	31.7	29.6	30.0	--	--
2020-2021	6	31.9	27.5	29.6	--	--
Weighted Mean	20	31.3	28.1	29.4	--	--

Effect of foliar spray of nano urea and 2% urea on growth parameters which contribute to yield of safflower

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ABSTRACT

The results from the present investigation showed that application of 100% nitrogen in the form of urea top dressing at vegetative stage and foliar spray of nano urea and 2% urea at reproductive stage improved the physiological parameters and yield of safflower. The growth parameters *viz.* leaf area index, relative growth rate, crop growth rate and net assimilation rate and seed yield recorded maximum values with 100% N application, while they reduced when the nitrogen dose was halved.

Keywords: Growth parameters, Nano urea, Safflower, Seed yield

Safflower is a strongly tap rooted, thistle like herb, highly branched important oil seed crop belonging to the family Asteraceae. Safflower seed contains 24-36% oil content. Safflower oil is traditionally a linoleic type with 71–75% linoleic acid and is a polyunsaturated edible oil.

Plant nutrition is vital for agricultural production and crop quality and fertilizer application accounts for 40% to 60% of global food production. Fertilizing with nitrogen is one of the most important factors that affects yield due to its multi-dimensional effects on the growth, development and improving the productivity of safflower (Grant, 2006). Nitrogen is required for the synthesis of several growth-promoting enzymes, proteins and so plays an important role in plant growth regulation, particularly during the vegetative phase (Iqbal, 2019). Agricultural use of inorganic fertilizers in 2019 was about 190 million tonnes of nutrients, of which 57% was nitrogen (FAO, 2021). So, optimum fertilizer management and application timing based on the crop need or when water is available to enhance nutrient uptake, can be a suitable strategy to improve crop growth and yield (Corbellini *et al*., 2006). Some studies have reported that, compared to single application, split application of nitrogen depending on initial soil status is beneficial for improving crop growth and yield as well as improving the efficiency of nitrogen utilization. The controlled release of nutrients provided by nanostructured fertilizers will allow for a longer effective duration of nutrient supply to the plant ensuring without any negative environmental consequences (Kopittke *et al*., 2019).

Nano urea when applied to foliage, easily enters through stomata and gets distributed through phloem. Unutilized nitrogen is stored in plant vacuole and is slowly released for proper growth and development of plant.

MATERIAL AND METHODS

The experiment was carried out at the research farm of All India Coordinated Research Project (AICRP) on Safflower, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra during *rabi* season of 2021-22 on medium black soil. The experiment was conducted on PBNS 86 variety of safflower in a split plot design with 3 replications.

The treatments in the three main plots include F1 with 100% N, F2 with 75% N and F3 with 50% N application while, the five sub plots include N0 with No spray of nano urea, N1 with nano urea spray at flowering stage, N2 with nano urea spray at flowering and seed filling stages, N3 with 2% urea spray at flowering stage and N4 with 2% urea spray at flowering and seed filling stages.

RESULTS AND DISCUSSION

Application of 100% N (F1) as urea topdressing at three stages of the crop increased the growth and dry matter accumulation of safflower and thereby improved the growth parameters *i.e.*, leaf area index, relative growth rate, crop growth rate and net assimilation rate of safflower. Table 1

Table 1: - Growth parameters and seed yield of safflower as influenced by application of urea and foliar spray of Nano urea.

Treatments	Crop growth rate ($g/cm^2/day$)		Relative Growth rate (g/g/day)		Net Assimilation Rate ($g/cm^2/day$)		Leaf Area Index			Seed yield (kg/plot)
Fertilizer	30-60	60-90	30-60	60-90	30-60	60-90	0-30	30-60	60-90	
F1	0.0066	0.0026	0.1271	0.0272	0.0066	0.0026	0.44	1.12	2.05	4.76
F2	0.0060	0.0020	0.1141	0.0213	0.0060	0.0020	0.40	1.08	1.88	3.39
F3	0.0057	0.0016	0.1102	0.0190	0.0057	0.0016	0.36	1.00	1.75	3.22
Mean	0.0061	0.0021	0.1171	0.0225	0.0061	0.0021	0.40	1.07	1.89	3.79
Foliar spray										
N0	0.0068	0.0016	0.1030	0.0202	0.0068	0.0016	0.41	1.23	1.82	3.09
N1	0.0066	0.0021	0.1180	0.0214	0.0066	0.0021	0.42	0.99	1.95	3.93
N2	0.0060	0.0026	0.1370	0.0200	0.0060	0.0026	0.40	1.07	1.96	5.13
N3	0.0055	0.0019	0.1140	0.0261	0.0055	0.0019	0.40	1.01	1.90	3.34
N4	0.0056	0.0022	0.1140	0.0250	0.0056	0.0022	0.37	1.05	1.84	3.46
Mean	0.0061	0.0021	0.1172	0.0225	0.0061	0.0021	0.40	1.07	1.89	3.79

The effect of split application of urea during the vegetative stage of the crop improved the growth parameters and thereby the yield of safflower. Application of nano urea as foliar spray at flowering and seed filling stages of the crop significantly improved the seed yield of safflower.

Application of 100% N at vegetative stage and foliar spray of nano urea at reproductive stage is beneficial for crop in improving its vegetative growth and yield of crop. Foliar spray of nano urea during the reproductive stage of the crop provided the crop with required nutrients and thereby improved nutrient uptake which helped in promoting improved yield of safflower. Nano urea will enhance the nutrient use efficiency of the plant because of its slow release of nutrients and it also reduces the soil and water pollution due to draining off of the applied chemical fertilizers into water bodies. So, the use of nano urea as foliar spray along with the basal application of 100% N would be beneficial for farmers in getting good returns and also can reduce the environment pollution to some extent.

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Can molecular model crop rice become a boon towards progress of groundnut functional genomics?

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ABSTRACT

Improvement through conventional breeding is a big problem in developing diverse lines of groundnut on tackling good seed quality. A total of 25 markers targeting 13 known rice genes were evaluated with 24 groundnut genotypes and two wild groundnut genotypes *(Arachis glabrata, Arachis villosa*) and a local popular rice variety NLR34449 (Nellore Mashuri) as molecular check. It was very interesting to note that amplification of 17 (11genes) out of 25 rice gene tagged markers (GTMs) in groundnut accounted for 68% transferability. The analysis of transferability of rice GTMs at individual peanut genotype level revealed a range of 79.17% to 91.67%. This confirmed the possibility of use of the rice markers/genes in groundnut.

Keywords: Cross crop transferability, Gene tagged markers, Groundnut, Rice

Groundnut (*Arachis hypogaea* L.) is an important edible oil seed crop in the world. It is valued as a rich source of energy, contributed by 48–50% of oil and 25–28% of protein in the kernels. Seed quality is utmost important in peanut. At this juncture, apart from conventional crop improvement methods what would benefit a breeder during post genome sequencing era is, identification of trait governing genes and there by tagging of functional variants at molecular level. With the advent of comparative genomics data, it is evident that many gene families across plant kingdom are functionally conserved as proved by different research groups. Thus, the knowledge of known plant architecture, yield, flowering time, seed quality and stress tolerance governing genes from molecular model crops like rice, *Arabidopsis* etc. can be deployed to tag the orthologues in legume crops in general and peanut in particular, as till now very meagre progress has been acheived in peanut gene mapping. Thus, it would help in identification of conserved functional variations for these candidate genes and facilitates Marker Assisted Breeding with high veracity and rapidity for the targeted traits. With this premise, a study was carried out by employing known rice yield and seed quality governing gene tagged markers (GTMs) in groundnut, to assess their transferability.

MATERIALS AND METHODS

Improvement through conventional breeding is a big problem in developing diverse lines of groundnut on tackling good seed quality. However, molecular approaches would be useful in this regard. A total of 25 markers targeting 13 known rice genes viz., (i) for seed quality (size and weight): we selected 18 markers targeting 9 genes; ii) for seed filling- 2 markers targeting one gene and iii) for seed micronutrient content- 5 markers targeting 3 genes and these were evaluated with Twenty-four groundnut genotypes that were released from RARS, Tirupati and ARS, Kadiri, ANGRAU and two other popular varieties grown across India and also two wild groundnut genotypes *(Arachis glabrata, Arachis villosa*) and a local popular rice variety NLR34449 (Nellore Mashuri) as molecular check.

RESULTS AND DISCUSSION

In a search for genes from molecular model crop rice to groundnut, we are able to tackle the transferability. From the results overall transferability of markers under study and their possible utilization in peanut was assessed. It is very interesting to note that amplification of 17 (11genes) out of 25 rice GTMs in groundnut was observed which accounted to 68%. This implied highly conserved nature of functionally characterized genes between rice and peanut.

The analysis of transferability of rice GTMs at individual peanut genotype level (Fig.) revealed a range of 79.17% (for the varietiesTCGS1157- Nithya Haritha, Greeshma, Prasuna, Kalahasti, Narayani and wild genotype *A. villosa*) to 91.67% (TCGS 1073-Dheeraj). This confirmed the possibility of use of the rice markers/genes in groundnut. Sequencing of these transferable alleles would further confirm the presence of rice orthologs in peanut and would pave the way for in-depth studies.

In silico analysis of Peanut base identified 51 rice gene orthologs of *Arachis hypogaea* for seed size traits under study. Of which, a total of 28 genes for GW5 gene, 20 genes for GW2 gene, 2 genes for GS2 gene and 1 gene for GW8 gene were identified. Primer blast analysis of NCBI-peanut transcript data confirmed the expression of rice yield and seed quality gene orthologs in peanut.

Functional characterization of this repertoire of genes identified in the current study, both with forward and reverse genetic approaches would help in rapid tagging of peanut genes. Sequencing approaches are more powerful to reveal the indels and thereby the functional variants at respective genes rather analysing with conventional methods, especially in complex genomes like groundnut. Thus, utilization of the available knowledge of functionally characterized genes of molecular model crops and vast list of annotated orthologous genes present in 'Omics' databases, widens the scope to improve the crops by pyramiding of desirable genes.

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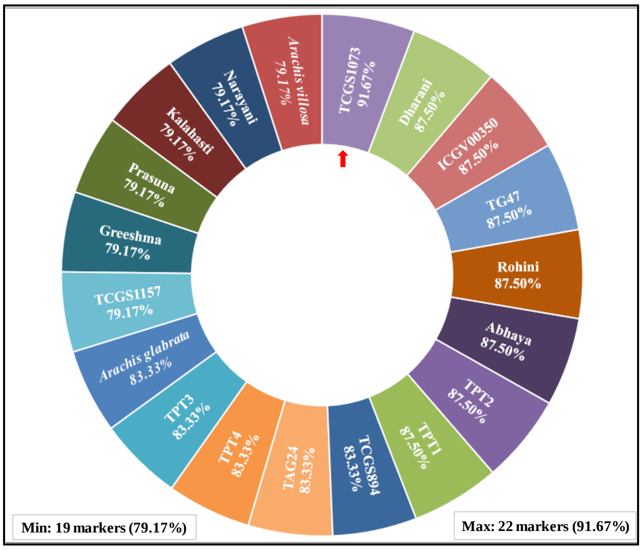

Fig.: Comparison of individual groundnut genotypes for amplification status (%) with rice yield and seed quality governing gene tagged markers

Studies on inheritance of achene colour and markings among confectionary germplasm of sunflower

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ABSTRACT

To study the genetic control of achene colour in sunflower, a cross was made between EC-734846 × EC-734849-II having white and black kernels respectively and another cross was made between EC-734863-II and EC-734846 having black striped and white achene colour. The first cross revealed typical monohybrid segregation of 3:1 for black to white seeds. The backcross with recessive parent exhibited 1:1 ratio suggesting achene colour to be single gene controlled with white seed colour controlled by recessive allele. The second cross revealed the ratios of grey seeds with white stripes, greyish black and white seeds with black stripes colour seeded plants to be 9:3:4 suggesting supplementary gene interaction among two genes controlling the seed colour and distinctive markings.

Keywords: Achene colour, Monohybrid Ratio, Sunflower, Stripe

Sunflower (*Helianthus annuus*) ranks fourth among oilseeds crops globally and significant volume of produce is consumed as snack or added into confectionery products in the form of meal. The confectionery sunflowers are different from oilseed sunflower with respect to seeds and quality characteristics (Fernandez-Cuesta *et al.*, 2012). Much acceptance is there for white or stripped sunflower kernels for table purpose, whereas, black kernels are associated with higher oil content. In order to develop inbreds with desirable seed colour it is imperative to understand the genetic control of the trait. Inheritance studies based on evaluation of parental and segregating generations (F_2 or backcross generation) has been utilized by several workers. The pigments present in different layers of sunflower seed hull give different colours like grey, brown and black while white seed colour is present due to absence of any pigmentations. Likewise the distinct stripes are also present on seeds due to variable pigmentation (Nadkarni *et al.*, 2017).

MATERIALS AND METHODS

The two cross combinations made were EC-734846 x EC-734848-II representing white seed × black seed cross while, another cross was made representing black striped kernels × white seed using inbreds EC-734863-II and EC-734846 respectively. The crosses were attempted during spring 2019 and F_1 was raised during kharif 2019. During kharif season backcrosses were also attempted. The F_2 and backcross generations were raised during spring 2020 and the observations were recorded for variation for the trait. All the data obtained was statistically analysed to test the goodness of fit using chi-square test given by Karl Pearson (1900) as per the formula:

$$\chi^2 = \sum \frac{(O-E)^2}{E} \quad \text{, with (n-1) d.f.}$$

Where,
O = observed frequencies
E = expected frequencies
n = number of classes
d.f. = degree of freedom

The significance of Chi-square was tested by comparing the calculated Chi square value with table value at 5% level of significance at appropriate degrees of freedom (n-1).

RESULTS AND DISCUSSION

In the cross EC-734846 (white seeds) × EC-734849-II (black seeds), black seeds colour with grey stripes was seen in F_1 plants. In F_2 generation, out of a total 105 plants, 87 exhibited black seed colour while, 18 plants exhibited white seed colour. Based on chi square test, goodness of fit was observed for a typical monohybrid segregation of 3:1 (χ^2 = 3.457, p value = 0.063). Furthermore, backcross generation from F_1 x white seeded parent EC-734846, consisting of 65 plants, 27 were having white seeds while remaining 38 were having black seeds (Table 1). Chi square test revealed goodness of fit for 1:1 ratio with chi-square value of 1.862 and p value of 0.172. The above observations suggested that the seed colour is controlled by a single gene with major effect. The allele controlling black seed colour (B) showed complete dominance over white seed colour (b).

Table 1. Segregation ratios of F_2 and BC_1 generation for white (EC-734846) × black (EC-734849-II) cross

Generations	Observed		Expected		Expected ratio	χ^2 values		p-value
	White	Black	White	Black		calculated	tabulated	
F_2	18	87	26.25	78.75	3:1	3.457	3.841	0.0630
	18	87	19.6875	85.3125	13:3	0.178	3.841	0.6731
BC_1	27	38	32.5	32.5	1:1	1.862	3.841	0.1724

Table 2. Segregation ratios of F_2 generation for striped × white cross (EC-734863-II × EC-734846)

Generations	Observed			Expected			Expected ratio	χ^2 values		p-value
	Grey with white stripes	Greyish black	White with black stripes	Grey with white stripes	Greyish black	White with black stripes		Observed	Table	
F_2	148	40	57	137.813	45.937	61.25	9:3:4	1.815	5.991	0.4035

In another cross the female parent having black seeds with white stripes (EC-734863-II) was crossed to male parent having white seeds (EC-734846). All the F_1 plants showed grey seeds with white stripes. In F_2 generation of 245 plants, 148 plants exhibited grey with white striped seeds, 40 plants exhibited greyish black seeds and 57 plants exhibited white with black striped seeds (Table 2). In F_2 generation, the ratios of black seeds with stripes, black seeds without stripes and white seeds with black stripes fitted well into a 9:3:4 ratio ($\chi2$ = 1.815, p value= 0.403). This suggested that two genes present in dominant form are required to produce black seeds with white strips whereas; when both genes are present in recessive form they lead to expression of white seeds with black stripes. The allele B in absence of dominant allele for second gene (A) failed to express for white stripes thus the genotypes aaB_ resulted in black seeds with no stripes. In absence of dominant allele for B, black seed colour is not formed whereas A does not produce white stripes on its own thus producing similar phenotype as that of aabb. This observation was also in concordance with results from first cross that bb results in white kernels whereas BB results in black kernels. The results obtained in this study was contradictory to Nadkarni *et al* (2017) who suggested that inheritance of seed colour is controlled by complementary gene interaction whereas dominant alleles result in phenotype

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A new safflower variety- parbhani suverna (pbns-154) resistant to biotic stress released for Maharashtra state

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ABSTRACT

A new safflower variety Parbhani Suverna (PBNS-154) was evaluated in IET and RMT at different research station of VNMKV, Parbhani under rainfed and irrigated conditions during 2016-2021 for seed and oil yield as well as reaction to biotic stresses *viz;* Alternaria leaf spot, *Fusarium* wilt and aphid pest in comparison with the checks PBNS-12 and sharada. It has recorded 23.62 and 27.69% higher seed yield over the checks PBNS-12 and sharada, respectively. This variety was found tolerant to *Fusarium* wilt and *Alternaria* leaf spot disease reaction and also moderately resistant to aphid pest as compared with all other qualifying varieties and checks. Hence, the variety PBNS -154 is released for cultivation in Safflower growing areas of Maharashtra.

Keywords: PBNS-154, Rainfed, Safflower, Tolerant, Variety

. Safflower is a major *rabi* oilseed crop of Maharashtra mainly cultivated on residual moisture condition. The area under safflower crop in the Maharashtra is 0.22 lakh ha which accounts for 42 % of the total area in the country with a production of 0.15 lakh tones, which accounts for 36% of the India's safflower production. The average productivity of state was 691 kg/ha in 2019-20 (Anonymous, 2020). The majority of area under safflower cultivation is in Marathwada region. The average productivity of the Maharashtra is very low. Therefore, a variety with high seed and oil yield having more oil content, tolerant to *Fusarium* wilt, *Alternaria* leaf spot and Aphid, a major pest of safflower is the need for breeding strategy for rainfed as well as irrigated condition of the state. Accordingly, efforts have been made at AlCRP on Safflower, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani for development of a new variety PBNS-154 which have high seed and oil yield with high (30.90%) oil content, tolerant to *Fusarium* wilt, *Alternaria* and moderately resistant to Aphid.

MATERIALS AND METHODS

The spiny variety PBNS- 154 developed by pedigree method from the cross of A-1 x SPP-70. It was tested at different locations of Vasantrao Naik Marathwada Krishi Vidyapeeth under rainfed and irrigated conditions during 2016-2021. The observations were recorded for seed yield, oil yield, oil content and ancillary data and comparison was made with spiny checks PBNS-12 and sharada. The recommended packages of practices were followed while conducting the trial. The variety was also screened for its agronomical adaptability for different cropping situations, disease and pest reactions under artificial and natural conditions.

RESULTS AND DISCUSSION

The seed yield performance of PBNS-154 was presented in Table 1. It has recorded higher seed yield (1549 kg/ha) compared to the checks PBNS-12 (1253 kg/ha) and sharada (1213 kg), which was 23.62% and 27.69% higher over the checks PBNS 12 and sharada respectively. The PBNS-154 variety had high oil content i.e. 30.90%, It recorded higher oil yield (565kg/ha) compared to the checks PBNS-12 (439 kg/ha) and sharada (368 kg). The variety, PBNS-154 was found tolerant to *Fusarium* wilt (Disease severity-17.65- tolerant to F.wilt < 20% in sick plot condition) and *Alternaria* leaf spot disease reaction (Disease severity-24.06 - tolerant to Alternaria < 25%) under protected and unprotected conditions. PBNS-154 was also found moderately resistant to aphid pest (AII- 2.2 MR) as compared with all other qualifying varieties and checks. In agronomic trials, the spacing of 45 x 20 cm was found optimum. The recommended fertilizer dose and recommended sowing time recorded higher seed yield in agronomical trials indicating better response to recommended fertilizer application and sowing time. The plant attained 50% flowering stage in about 76-85 days and maturity in 124-134 days. The plant grows to the height of 92-112 cm with 24-42 capitula/plant. The capitulum is of medium size with 25-34 seeds/capitulum. The seed is without papus and is white in colour having average test weight 5.8 g. considering the higher oil yield and oil content the entry PBNS-154 is released and notified for cultivation in Maharashtra.

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Table 1.Mean Seed yield, oil Yield and oil %data of different location/trials.

Year of testing	No. of trials/location	PBNS-154	PBNS-12	sharada	% increase over PBNS-12	% increase over sharada
			Seed yield (Kg/ha)			
2016-2017	04	1741	1272	1431	36.87	21.66
2017-2018	04	1208	995	1002	21.40	20.55
2018-2019	03	1541	1255	1092	22.78	41.11
2019-2020	04	1753	1401	1218	25.12	43.92
2020-2021	04	1504	1343	1324	11.98	13.59
Weighted Mean	**19**	**1549**	**1253**	**1213**	**23.62**	**27.69**
			Oil yield (kg/ha)			
2018-2019	03	620	503	429	23.26	44.52
2019-2020	04	510	374	307	36.36	66.12
Mean	**07**	**565**	**439**	**368**	**28.70**	**54.34**
			Oil %			
2018-2019	03	30.65	29.49	28.41	--	--
2019-2020	04	31.24	30.93	29.98	--	--
Mean	**07**	**30.90**	**30.21**	**29.20**	--	--

Vegetable oils: A brief overview on the production issues and insights to overcome them

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ABSTRACT

Vegetable oils are extracted from corn, palm, soybean, and sunflower seeds. In accordance with a study, about 250 lakh metric tonnes of vegetable oils are consumed domestically each year, but only 111.6 lakh metric tonnes are produced. More than half of the country's domestic needs are imported. The need to reduce import dependence must be addressed immediately. Research and technology dissemination, as well as institutional interventions, will contribute to the revitalization of the oil industry. It is worth noting that India has the potential to increase its oilseed production.

Keywords: Domestic production, Export, Import, Vegetable oils

This article discusses the current situation of oilseeds and issues related to the production of vegetable oil in India. Among the world's vegetable oil economies, India is the fourth largest after the United States, China, and Brazil. There is a 55 percent gap between the supply and demand of vegetable oils in India. In contrast to domestic oilseed production, which has not been keeping pace with demand, farmers prefer to grow grains such as rice and wheat, whose price is guaranteed by the government. Among the three oils that India imports palm oil, accounts for 36 percent of its edible oil consumption, soybeans and sunflower oils, which account for 22 percent and 12 percent, respectively (source: Solvent Extractors Association of India). The recent ban on palm oil exports by Indonesia, the ban on soymeal exports by Argentina, and the disruption of sunflower oil supplies by the Russia-Ukraine conflict have adversely affected India. As a result, India has once again been reminded of the importance of being self-sufficient in vegetable oils.

MATERIALS & METHODS

Multiple technologies are needed to boost oilseed cultivation - information technology, biotechnology, nuclear agriculture, drones, etc. Artificial intelligence has the potential to transform Indian agriculture generally, and oilseed farming specifically. Funds must be allocated to modernise oilseed-crushing mills as a policy measure. As a result, extraction efficiency will improve. Supply essential physical inputs (fertilizers, pesticides), financial inputs (credits, crop insurance) and technical inputs (extension services) to major agricultural zones.

RESULTS & DISCUSSION

Our focus should be on incentivizing oilseed cultivation in Punjab, Haryana and Uttar Pradesh to prevent an ecological disaster. This will result in multiple benefits, including reducing dependency on vegetable oil imports and increasing domestic processing capacity utilization. By adopting technology, yields can be increased. However, Indian demand for vegetable oil is only going to grow, so a long-term vision is needed.

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Identification of major QTLs for seed size by combining QTL-mapping and RNA-seq in an electron beam induced mutant of groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Combining QTL-mapping using SNP markers generated with genotyping by sequencing and RNA-seq identified a major QTL and candidate genes for enhanced seed size and leaf size in groundnut, respectively. Towards this, we conducted quantitative trait locus (QTL) analysis for hundred kernel weight in F_2 mapping population derived from electron beam induced large seed mutant, TG 89 and normal seed genotype, ICGV 15007. A major QTL for seed size was identified in Arahy.05 chromosome between flanking markers AhMITE470 and *SNP05_103140987*. This QTL interval harboured a groundnut ortholog of *TIFY* gene. Of the 29 *TIFY* family genes in groundnut, the gene *arahy.5M7JWE* is the identified within the QTL interval on chromosome A05 and was down regulated in the mutant, indicating its putative role for large seed phenotype in the mutant.

Keywords: Candidate gene, QTL-Mapping, RNA Seq, SNP, *TIFY* gene family

Cultivated groundnut (*Arachis hypogaea* L.) is an important oilseed crop which is also directly consumed for its high nutritional value (Settaluri *et al.*, 2012). With respect to the growing preference for large seed, hundred kernel weight (HKW) is often utilized as a selection parameter for seed size in groundnut. QTL mapping is proven efficient in detecting putative genes responsible for trait of interest for marker-assisted selection (Alyr *et al.*, 2020) thus have potential in accelerating the breeding process. In this study, an F_2 population was developed from the cross between large seed mutant TG 89 and ICGV 15007 to identify QTLs controlling HKW. Also, RNA-seq analysis for performed in the leaves for mutant and parents to identify candidate genes and mechanism of phenotypic expression of large seed trait.

MATERIALS AND METHODS

A large seed mutant TG 89 was isolated from an electron beam induced mutagenesis of popular variety TG 26 (Mondal et al. 2017). Large seed mutant TG 89 was hybridized with a distant normal seed genotype ICGV 15007 to develop a F_2 mapping population with 124 plants. These were phenotyped for seed size and genotyped with SNP generated from genotyping by sequencing (GBS), AhMITE and SSR markers. The linkage mapping and QTL identification was carried out using QTL IciMapping ver 4.1. RNA seq analysis was carried out by sequencing of DNA from fresh leaf tissues using an Illumina DNBseq platform at the Beijing Genomics Institute. This analysis generated 150 bp paired-end reads. These reads were aligned with reference genome using HISAT2, sorted with samtools, and normalized and counted using Cufflink program. Then, the differentially expressed genes (DEGs) between two samples were detected by the Cuffdiff by comparing gene expression between "mutant" vs "parent" samples. The expression patterns of candidate *TIFY* genes were investigated using quantitative real-time PCR.

RESULTS AND DISCUSSION

An electron beam induced mutant, TG 89 having 54 % increment in seed size and having 82% bigger leaf area than that of parent, was utilised to identify the QTL and the candidate genes associated with seed size in groundnut. Seed size and plant leaf are important regulators of plant productivity and growth. However, relatively little is known about these quantitative trait loci (QTLs) and associated genes in groundnut. In this study, QTL analysis with SNPs, AhMITE, and SSR markers, revealed two major QTLs on linkage group A05 and A09 explaining more than 11% phenotypic variation. The major additive QTL, mutant_qHKW_1, was located between marker *Ah*MITE470 and *SNP05_103140987* having a map interval 8.6 cM on A05 chromosome and other QTL was present in between *Ah*MITE0303 and *Ah*MITE0391 on chromosome A09 at map interval of 3 cM. Chromosome A05 is known to be associated with stable and major QTLs for pod weight and size (Luo et al 2018). QTL on A05 corresponded to 99.18 to 103.71 Mbp region that harboured a groundnut ortholog of *TIFY* gene at 102 Mbp. TIFY are plant specific transcription factors having key role in growth and stress responsive processes. Real time PCR indicated down-regulation of this gene in mutant which indicated its putative role for large seed phenotype in the mutant. Genome wide RNA seq analysis revealed downregulation of *TIFY* genes; Arahy.5M7JWE and Arahy.X6RF7Y which are negative regulators of jasmonic acid signalling. Differential gene expression analysis also revealed upregulation of genes like those for biosynthesis and transport of IAA, auxins and downregulation of genes for jasmonic acid and brassinosteroid signalling which can be attributed to the cell enlargement and plant growth in mutant**.** The markers, AhMITE333 and AhMITE470, present close to the map interval had higher efficiency for discriminating breeding lines with different seed size and it would be useful as introgression marker in marker-assisted breeding.

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Capital formation through Technology Integrated Approaches for Tribal Communities: A Pragmatic Analysis

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ABSTRACT

The present study is part of an evaluation report of the Scheduled Tribe Component (STC) implemented in the Jharkhand area. Under this project, more than 6000 tribal families were covered under the capacity building and skill development programs with forward and backward linkages during 2021-22. A preliminary survey revealed the footprints of technology dissemination among the tribal households, affordability of inputs, and infrastructural development for value addition in the oilseed sector in general and rapeseed mustard in particular. Productivity of rapeseed mustard improved in Ranchi (4.17%) and Gumla (2.63%) districts over the state of Jharkhand (1.29%) during the period of 20010-11 to 2019-20. Based upon the existing yield gaps and growth rates coupled with the synergy of apiculture, capital formation forecasting reflects the huge potential in the tribal economy of the country and would be an effective strategy to improve the vulnerability indices in aspirational areas.

Keywords: Compound Annual Growth Rates, Rapeseed & Mustard, Socio-Economic Features, Yield Gap

Tribals have been living in forests for ages and identified as *"heritage groups"* with advocacy for special care and treatment (Bhuria Report, MoTA, and GOI 2004). The strategy for integrated development led to the launching of the Tribal Sub Plan (TSP) concept in the Fifth Plan period. Three basic parameters include variations in the socio-economic and cultural milieu, demographic distribution, and primitive tribal communities living in scheduled regions. In predominant tribal regions, an area approach with a focus on the development of tribal communities has been favored, while for primitive groups community-oriented programs have been preferred. Jharkhand has immense potential for rapeseed and mustard cultivation. The present study is part of an evaluation report of the Scheduled Tribe Component (STC) implemented in the Jharkhand area.

MATERIALS AND METHODS

Both primary and secondary data were used for macro and micro-level analysis of the socio-economic features and yield variance. A review of the tribal community-oriented policy initiatives was also conducted.

RESULTS & DISCUSSION

It has been evident for some time that the lion's share of the various benefits and concessions earmarked for the SC & ST is appropriated by the numerically larger and politically well-organized communities (Lakur Committee Report 1965, Department of Social Security, GOI). The Planning Commission Report on development issues to deal with the causes of discontent, unrest, and extremism (2006) highlighted the significant differences in the accessibility to agricultural land and capital assets ranging from □0.49 lakh for Scheduled Castes (SC), □0.52 lakh for Scheduled Tribes (ST), □1.34 lakh for Other Castes (OC) and overall asset value was estimated □1.07 lakh. Mungekar Standing Committee Report (2009) of the Planning Commission on inter-sectoral issues relating to tribal development on standards of administration and governance in the scheduled areas aimed to target only nine states of India including the most recent Jharkhand, Chhattisgarh, and Madhya Pradesh in 2003.

National Advisory Committee (NAC) reported that about 15% of the landmass in various ecological and geo-climatic conditions ranging from plains to forest, hills, and inaccessible areas provide livelihood supports to tribal households. There is a significant variation of decadal growth rates in the population of rural and urban areas as well over time ranging from 21% (from 2001 to 2011) in rural areas to 147% (1971-1981) in urban areas. The sex ratio among the rural tribal population has not witnessed significant changes. According to Census 2011 only 45% of tribal households availing banking services in comparison to the national average of 59% of households. Jharkhand state ranks sixth in tribal population after
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Madhya Pradesh (14.7%), Maharashtra (10.1%), Odisha (9.2%), Rajasthan (8.9%), and Gujarat (8.6%) while it ranks third with 14% population of the Particularly Vulnerable Tribal Groups (PVTGs) after undivided Madhya Pradesh (28%) and Maharashtra (15%). Adoption of the mainstream way of life is very slow in these areas. More emphasis had given to the strategies of the XII five-year plan (2012-2017) for livelihood support, apart from the land and forest-based activities under MGNREGA imparting skills and creating employment opportunities near their habitations. Under this project, more than 6000 tribal families were covered under the capacity building and skill development programs with forward and backward linkages during 2021-22.

Among the tribal households, affordability of inputs (quality seed, farm implements, vermicompost, bio-pesticides, storage bins, *etc*.) and infrastructural development for value addition in the oilseed sector in general and rapeseed mustard in particular. Productivity of rapeseed mustard improved in Ranchi (4.17%) and Gumla (2.63%) districts over the state of Jharkhand (1.29%) during the period of 20010-11 to 2019-20. Comparative quinquennial analysis of yield levels during 2010-11 to 2014-15 and 2015-16 to 2019-20 revealed a significant variation at district level 140kg/ha (Gumla) and 100kg/ha (Ranchi), state level (54kg/ha), national (181kg/ha) and global (97kg/ha) levels. This technological intervention through policy initiative (STC) injects about □82.44 million through backward linkages and □101.08 million through forward linkages of capital formation in the economy of two districts annually.

The outreach of the most modern technological interventions may be facilitated. Based upon the existing yield gaps and growth rates coupled with the synergy of apiculture, capital formation forecasting reflects the huge potential in the tribal economy of the country and would be an effective strategy to improve the vulnerability indices in aspirational areas.

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ICT and social media digital initiatives for effective dissemination of Soybean technologies

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ABSTRACT

In India, the use of social media and ICTs has gained popularity in the last decade consequent to the digital revolution. In line with these developments, the ICAR-Indian Institute of Soybean Research has started use of social media platforms like WhatsApp, YouTube and Facebook etc. for dissemination of information related to the improved soybean production technologies developed by the Soybean R&D system and facilitating feedback mechanisms among the clients and their interaction with the research system using different ICT tools. Institute has also developed many software to use the potential of Information Communication Technologies (ICT) in best manner. These ICT tools help the farming as well as scientific community in solving different problems and improve and issues as well as for decision making in real time situations.

Keywords: ICT tools, Social media platforms, Soybean, Technology dissemination

Recent developments in the mobile, computing and networking technologies provide new ways of technology transfer. Technology dissemination is a vital part of the innovation process, through which the developed technologies are transferred to the targeted communities. Information and Communication Technologies (ICTs) have occupied a greater significance in the extension services in the present era of digital world. Social media are digitally enabled platform for communication through internet in any form where the content is created and used by the users. In India, the use of social media and ICTs has gained popularity due to the digital revolution. In line with these developments, the ICAR-Indian Institute of Soybean Research has started use of social media platformsfor dissemination of information related to the improved soybean production technologies developed by the Soybean R&D system and facilitating feedback mechanisms among the clients and their interaction with the research system using different ICT tools are discussed in detail in the following sections.

SOCIAL MEDIA INITIATIVES IN SOYBEAN

With the latest developments in the digitization of the Information and Communication media, the institute has initiated use of some digital media like WhatsApp group far farmers (IISR Soy Farmers) and Institute Facebook page, Institute Website etc which are regularly being used for disseminating the need-based and timely information like weekly advisories on soybean crop during the crop season, organization of various on and off campus extension activities by the institute etc. Accordingly, the ICAR-IISR has started using these social media tools for Transfer of Technology (TOT) purpose since last 3 years (starting from 2017). Further, the institute has launched its YouTube Channel during June 2020 containing informative videos on various topics on soybean technological recommendations.

FARMER-EXPERT WHATSAPP GROUP

Institute created a WhatsApp group viz. IISR Soy Farmers for strengthening the strong linkage between soybean growers and soybean domain experts in order to solve farmers queries and problems throughout the year particularly during the cropping season. It was created on 14th May 2017and has 149 members in the group. Farmers could easily share the images of infected fields and get timely advice by the experts within this group. The group also have representation of multi-disciplinary team of scientists especially belonging to discipline like Plant Breeding, Agronomy, Plant Pathology, Entomology, Seed Technology, Microbiology, Computer Application and Agril. Extension at present. It is proving to be a very effective platform helping farmers to connect with domain experts throughout the country. Institute has also launched its Facebook Page that can be accessible from the link viz https://www.facebook.com/ICAR-Indian-Institute-of-Soybean-Research-Indore-507415769433553/. The Institute on regular basis is engaged in posting relevant useful information about the events, technological recommendations, varietal release etc on this page. The popularity of the page can be guessed by the fact that as on date 2636 people like this and 2,141 people follow this page. Large number of internet community is getting benefitted by the information being posted on it from time to time.

YOUTUBE CHANNEL- IISR SOYBEAN INDORE

Institute is also running its YouTube Channel since June 2020 for effective dissemination of soybean technologies. The YouTube Channel is accessible from the link https://www.youtube.com/channel/UCNdY5AsfPZqs CO8IxkAuSyQ/videos. There are 45 videos on different topics uploaded on the channel till now. The videos contain short and interactive discussion/advice by the institute scientists on various package of practices, management of biotic and abiotic factors like weed, insect-pest and diseases. The comments on these videos are dealt with suitable response by the experts. All the videos are technically informative for different clientele groups. The channel is increasing its popularity with presently having 21.3 thousand subscribers. The contents are also being liked by the users as evidenced by the number of views, watch hours and comments of the viewers.

ICT INITIATIVES IN SOYBEAN

Institute has also developed many software to use the potential of ICT in best manner. These ICT tools help the farming as well as scientific community in solving different problems and improve and issues as well as for decision making in real time situations and some of these tools are briefly described here.

SOYBEAN GYAN MOBILE APP:

Developed for Soybean growers to take right decisions in the real time field conditions. It contains comprehensive knowledge on soybean crop management at one platform. The App provides information on – i) Agronomic Practices, Production technology and Crop management, ii) Insect Management, iii) Disease Management, iv) Weed Management, v) Health Benefits and Food Uses vi) Seed treatment and storage vii) Farm Machinery and vii) Important information for Soybean cultivation. This mobile App is freely downloadable from the link https://play.google.com/store/apps/details?id= com.icar.soyainfo&hl=en from the Google play store. The users of the app, found it as highly useful with the average review ratings of 4.2 on a scale of 5 and more than ten thousand downloads of the contents.. It is useful to all the stakeholders.

WEB APPLICATIONS IN SOYBEAN

Institute has developed many web based applications. These applications are accessible from institute website http://iisrindore.icar.gov.in and are briefly discussed here.

A **Web-based Soybean Insect Identification and Management** System has been developed for identification and management of Soybean insects. It provides information on different aspects of soybean insects' viz. economic losses, pre-disposing climatic condition for insect attack, seasonal incidence of soybean pests during kharif season, friendly-insects of soybean, and insect management recommended practices in Hindi language. It served as an effective ICT tool for farmers to take appropriate and timely measures to minimize field losses due to insect attack.

A **Web-based Expert System for disease diagnosis in Soybean** has been developed. It is based on fuzzy-logic Inferencing. It is developed using ASP.NET web technologies. It diagnoses the disease based on the symptoms observed by the user on the field at a particular crop age, applies the appropriate disease rules stored in disease Knowledge base and using the fuzzy-logic based inferencing method, it draws conclusion. It suggests an appropriate control measure based on the diagnosed disease.

A **Knowledge Acquisition System** has been developed as a sub-system of Disease Expert System. It provides a graphical user interface to create the disease knowledge base of any crop. At present, it has disease knowledge on 25 soybean diseases. It is developed using ASP.NET web technology. The Knowledge base is implemented using SQL Server.

An **Intelligent Disease Tutor System** has been developed as a sub-system of Disease Expert System. It acts an Audio-visual training tool to provide complete knowledge on 25 major soybean diseases.

There are many other web-based information systems developed and being used which serve the requirements of specific clientele engaged in the activities. These include
a **Web-based Soybean Germplasm Information System** (WBGIS),

Web-based Varietal Information System,

A **Farmer Advisory System, and**

Database Management System for AICRPS trials

The digital revolution experienced recently has led to the successful use of IT tools in the process of technology dissemination in agriculture. The increased use of ICT tools is offering solutions to the farming community on real time basis making the process of technology transfer a more efficient, effective, trustworthy and economically viable to the users. The ICAR-IISR Indore has also started providing technical support and guidance to its group of clients through these ICT tools which in future could make a desirable impact among the farmers for adoption of technologies developed by the institute and digital package of practices.

Influence of crop establishment method and residue management practices on productivity and economics of soybean-based cropping systems

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ABSTRACT

The field experiment was conducted during *kharif*, 2021 at ICAR-Indian Institute of Soybean Research, Indore (MP). This experiment was initiated in *kharif* season of 2017, to study the effect of different cropping systems, crop establishment method and residue management practices on productivity and soil health of soybean-based cropping systems. Significantly higher yield of soybean was registered under soybean-chickpea. Among the crop establishment techniques, permanent broad bed and furrow (PBBF) + residue retention (R) followed by PBBF + without residue retention (WR) found superior as compared to conventional tillage as per farmer practices. The increase in seed yield was 13.0 to 19.0% under PBBF technology as compared to conventional tillage as per farmers' practices (CTFP).

Keywords: Broad-bed furrow, Cropping systems, Residue management, Soybean

Loss of soil organic carbon is a common phenomenon and resorting to improving soil organic carbon content that dictates improvement in soil quality parameters and increased nutrient mobilization for crop assimilation is paramount. This can be achieved through proper management practices involving resource conservation technologies such as reduced tillage/no till, , residue management, and assessing the best cropping system. In this regard, efforts were made to identify the best land configuration, residue management under soybean-based cropping systems

MATERIALS AND METHODS

The experiment comprised of three cropping systems namely, soybean-wheat, soybean-maize and soybean-chickpea and four crop establishment methods namely, permanent broad bed furrow with residue (PBBF + R), permanent broad bed furrow without residue (PBBF + WR), conventional tillage as per farmers' practices with residue (CTFP + R) and conventional tillage as per farmers practices without residues (CTFP + WR). Residue retention practices that were followed included 50% soybean residue retained for subsequent season in the respective treatment, and 30% for wheat and maize; and 50% of chickpea residue retained before sowing of the soybean crop in the respective treatment. For all the crops standard agronomic package and practices were followed. The data was analyzed using SAS statistical software (ver. 9.2; SAS Institute, Cary, NC enterprise guide 4.2).

RESULTS AND DISCUSSION

Among the cropping systems, significantly the highest yield of soybean was registered under the soybean-chickpea (23.9 q/ha) cropping systems as compared to soybean-maize (19.3 q/ha) and soybean-wheat (20.8 q/ha). Among the different crop establishment techniques significantly the highest soybean yield was registered under PBBF + R treatment followed by PBBF + WR. The yield increased by 19.0% under PBBF + R and 12.6% under PBBF + WR as compared to CTFP +WR. The highest cost of cultivation was registered under CTFP + R followed by CTFP +WR and lowest under PBBF + WR. Among the cropping systems maximum net return and B:C ratio was registered under soybean -chickpea followed by soybean-wheat system. Similarly, among the different crop entailment techniques the highest B:C ratio was registered under PBBF + R (2.68) followed by PBBF + WR (2.53) and lowest under CTFP + WR (2.09). Agricultural practices for example tillage, crop rotation, and inorganic or organic inputs significantly affect the physical, chemical, and biochemical properties of soil (Hernández et al., 2016). Improved crop establishment technologies and residue retention/incorporation under soybean-based cropping systems might have increased the organic carbon content, microbial proliferation and diversity paving way to improvement in soil physical, chemical and microbiological characteristics thereby influencing the crop productivity (Verma et al., 2020). The higher cost of cultivation was under soybean-wheat system. On the contrary, the highest net return and B: C ratio was under soybean-maize system.

In conclusion, adoption of permanent broad bed furrow technology with residue retention can reduce the cost of cultivation and increase crop productivity under soybean-based cropping systems.

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Table 1. Effect of cropping systems, crop establishment's method/land configuration and residue management practices on yields and economics of soybean (at the end of the 5th cropping cycle)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Cost of cultivation (₹/ha)	Net income (₹/ha)	B:C ratio
			Cropping Systems (CS)			
Soybean-maize	1929	3376	5497	27656	54602	1.99
Soybean-chickpea	2391	3630	6009	27656	74739	2.80
Soybean-wheat	2082	3408	5681	27656	61380	2.30
SEm±	41.8	90.3	37.66	-	1486.	0.05
CD (P=0.05)	164.3	354.8	147.86	-	583	0.21
			Crop establishment methods/land configurations (LC)			
PBBF + R	2329	3551	5949	27178	71595	2.68
PBBF + WR	2203	3519	5814	26334	66846	2.53
CTFP + R	2046	3486	5661	28978	59700	2.20
CTFP + WR	1957	3331	5492	28134	56157	2.09
SEm±	47.63	85.34	52.53	-	1717	0.06
CD (P=0.05)	164.78	295.26	181.75	-	5944	0.21

PBBF + R= permanent broad bed furrow + residue retention; PBBF + WR= permanent broad bed furrow + without residue retention; CTFP + R= conventional tillage as per farmers practices with residue; CTFP + WR= conventional tillage as per farmers practices without residue

GWAS and transcriptome analysis reveal key loci associated with drought tolerance in soybean

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ABSTRACT

Genome-wide association and gene expression studies were conducted to identify key genes and markers associated with drought tolerance. GWAS panel consisting around 300 diverse soybean accessions were phenotyped for morpho-physiological traits under control and drought stress condition for three years during 2019-2021. Genotyping by Sequencing (GBS) of GWAS panel identified 66300 SNPs distributed over all the 20 chromosomes and were used for association analysis. GWAS analysis revealed closely located significant SNPs on chromosome 4 (50500762, 52098616 and 53008801) and chromosome 16 (32371663, 33082976 and 33283177). Key candidate genes related to MYB family, cell signaling gene (GPCR), salicylic acid synthesis, oxidative stress, auxin and ABA synthesis pathway were identified. Further few tolerant and susceptible haplotypes were also identified for real-time based expression analysis under drought stress condition.

Keywords: Drought stress, GWAS, Soybean

Drought is the most important abiotic constraint to crop production worldwide. With increasing effects of climate change the frequency and duration of droughts are increasing at an alarming rate, causing huge yield losses (Zou *et al.*, 2020). Drought, being a polygenic trait, the potential candidate genes are those contributing to tolerance are related to cellular detoxification, osmolyte accumulation, antioxidant machinery, and signaling pathways (Chamarthi *et al.*, 2021). In the present study, a GWAS and microarray analysis was conducted for drought tolerance to dissect allelic diversity and potential genes responsible for drought tolerance in soybean.

MATERIALS METHODS

A total of 300 cultivated soybean germplasm lines were evaluated in the field (control) and rain-out shelter (drought stress) in augmented design with replicated checks. Different morpho-physiological traits i.e. chlorophyll content, canopy temperature, canopy wilting trait, relative water content, specific leaf weight and different yield attributes were recorded.Genotyping was done for 269 soybean accessions with the help of GBS platform. Imputations were performed to fill missing data and finally a total of 66300 SNPs were used for association analysis.The association analysis was conducted by employing mixed linear model (MLM) in TASSEL 5.2. Microarray Analysis was also conducted for drought tolerant (JS 97-52) and susceptible genotype (JS 95-60).

RESULTS AND DISCUSSION

GWAS analysis revealed closely located significant SNPs on chromosome 6 (18611061 and 18857089) for two different years (2019 and 2021), chromosome 4 (50500762, 52098616 and 53008801) and chromosome 16 (32371663, 33082976 and 33283177) for three consecutive years (2019-2021). Some candidate genes related to Myb family, cell signaling gene (GPCR), salicylic acid synthesis, oxidative stress, auxin and ABA synthesis pathway were identified in genomic region of above significant SNPs positions. Further few tolerant and susceptible haplotypes were also identified for Real-time based expression analysis under drought stress condition. Microarray analysis showed 10 different DEGs possess higher fold change. Also identified an uncharacterized gene (LOC100306426) having crucial role in transmitting environmental signals allowing the cell to adapt to cellular stress.

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Table 1: Microarray analysis showed different DEGs with higher fold change

	Transcript ID	Gene Symbol	Chromosome	Fold Change	Description
Up-regulated	Gma.12372.1	LOC100306426	chr2	147.43	stress-activated mitogen-activated protein
	Gma.1043.1	LOC100783381	chr7	110.01	LRR; Leucine-rich repeat (LRR) protein
	GmaAffx.46010.1	LOC100527213	chr4	75.26	uncharacterized LOC100527213
	Gma.11115.1	HSP70	chr12	71.37	heat shock cognate 70 kDa protein-like
	GmaAffx.2122.2	LOC100806440	chr18	57.44	GPI transamidase component PIG-S-like
	Gma.9148.1	LOC100786461	NA	40.1	receptor-like protein kinase FERONIA-like
	GmaAffx.5579.1	LOC100776178	chr20	36.34	cyclin-D4-1-like
Down-regulated	Gma.9688.2	LOC100500679	chr14	-76.78	uncharacterized LOC100500679
	Gma.18007.1	LOC100793122	chr16	-75.73	TMV resistance protein N-like
	Gma.10658.1	LOC100500325	chr8	-69.2	Bet_v_1 domain-containing protein
	GmaAffx.460.1	LOC100798489	chr19	-39.4	cystinosin homolog
	GmaAffx.37095.2	LOC100794705	chr16	-35.39	TMV resistance protein N-like
	Gma.197.1	LOC100798318	chr11	-33.45	asparagine synthetase [glutamine-hydrolyzing] 2-like
	Gma.1840.2	LOC100787075	chr13	-31.64	chaperone protein dnaJ 10-like

Development of new high oleic Sunflower (*Helianthus annus* L.) hybrids and its genotype × environment interaction across temperature regimes

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ABSTRACT

The present investigation was undertaken to assess the stability of 30 sunflower hybrids for oleic acid content along with four commercial checks across three temperature regimes of Karnataka, India over two seasons, *rabi/*summer 2020-21 and *rabi* 2021. The phenotypic stability of sunflower hybrids was analyzed by AMMI model. The AMMI biplots delineated one promising hybrid combination which exhibited stable expression of high oleic acid content, with pooled mean of all six environments revealing 73.06 per cent of oleic content. The identification of this particular hybrid combination served the purpose of this study of deriving the stable high oleic hybrid across temperature regimes.

Keywords: AMMI analysis, G x E Interaction, Oleic acid content, Sunflower hybrids, Stability

The research work on high oleic hybrids has been rejuvenated recently in India with slow progress in public domain. However, no success has been reported regarding high yielding sunflower hybrid with high oleic acid content in both public as well as in private sector. Keeping this in view, the present study was initiated with an aim of improving sunflower oil quality with altered fatty acid composition by developing high oleic sunflower hybrids and assessing its stability across different locations and seasons, which would meet the industrial demands of the country as well as health benefits of the people.

MATERIALS AND METHODS

Planting material and test environments: The experimental material comprised of 30 promising new high oleic hybrids bearing oleic acid content of more than 70 %. The experiment was conducted under three temperature regimes of Karnataka, India *viz*., AICRP on Sunflower, Bangalore, ZAHRS, Hiriyur and AICRP on Sunflower, Raichur over two seasons *viz*., *rabi/*summer 2020-21 (December–March) and *rabi* 2021 (September-December). The experiment was laid out in randomized complete block design (RCBD) with two replications in each location. The prime objective of this study was to identify the stable high oleic hybrids across three locations and over two different seasons.

RESULTS AND DISCUSSION

Identification of promising, stable hybrids based on AMMI biplots: An attempt was made to identify the stable hybrids with high oleic content from the Fig. 1 and Fig. 2. Among the 30 hybrids evaluated along with 4 checks, two hybrids namely CMS 1103A× G-5 (G-18) and CMS 234A× K-10 (G-8) exhibited ultra-high oleic acid content of 82.92 *per cent* and 85.5 *per cent* respectively over three locations combined during *rabi/*summer season. Both the hybrids were placed with IPCA1 score very close to zero (Fig. 1) indicating the small interaction effect for oleic acid content across three different locations during *rabi/*summer season. But these hybrids failed to exhibit the same oleic content during *rabi* 2021 season. Hence these identified stable high oleic hybrids could be preferred for only *rabi/*summer season (December-March) and not for *rabi* season (September-December).

However, from Fig. 1 and Fig. 2 one stable high oleic cross combination was identified namely CMS 903A× K-11 (G-6) with pooled mean of three locations and two seasons revealing 73.06 *per cent* of oleic acid content. The identification of this particular hybrid combination served the purpose of this study of deriving the stable high oleic hybrid across temperature regimes.

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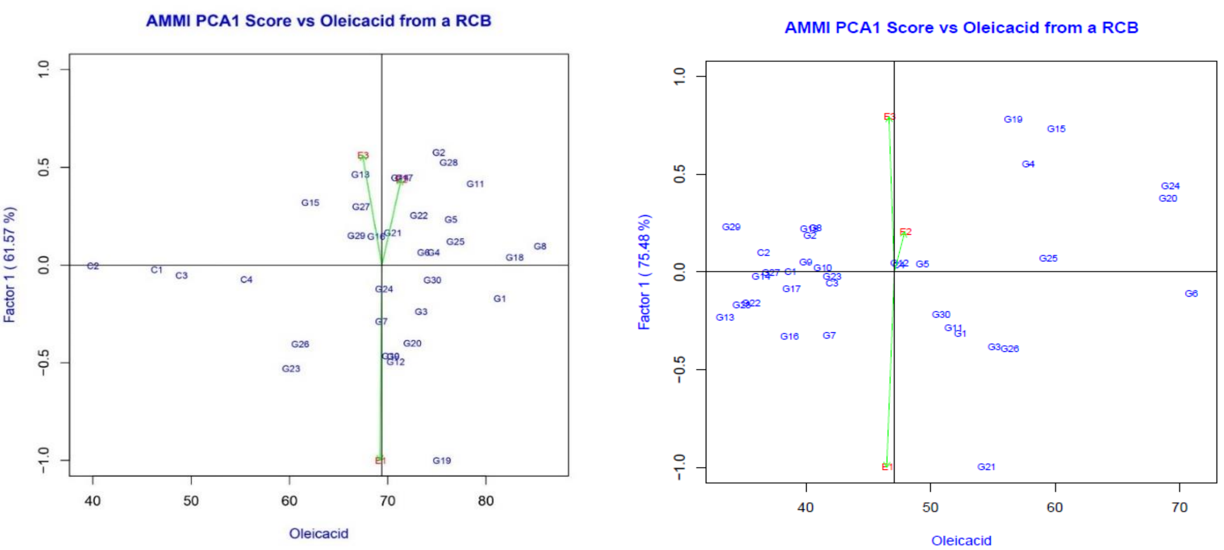
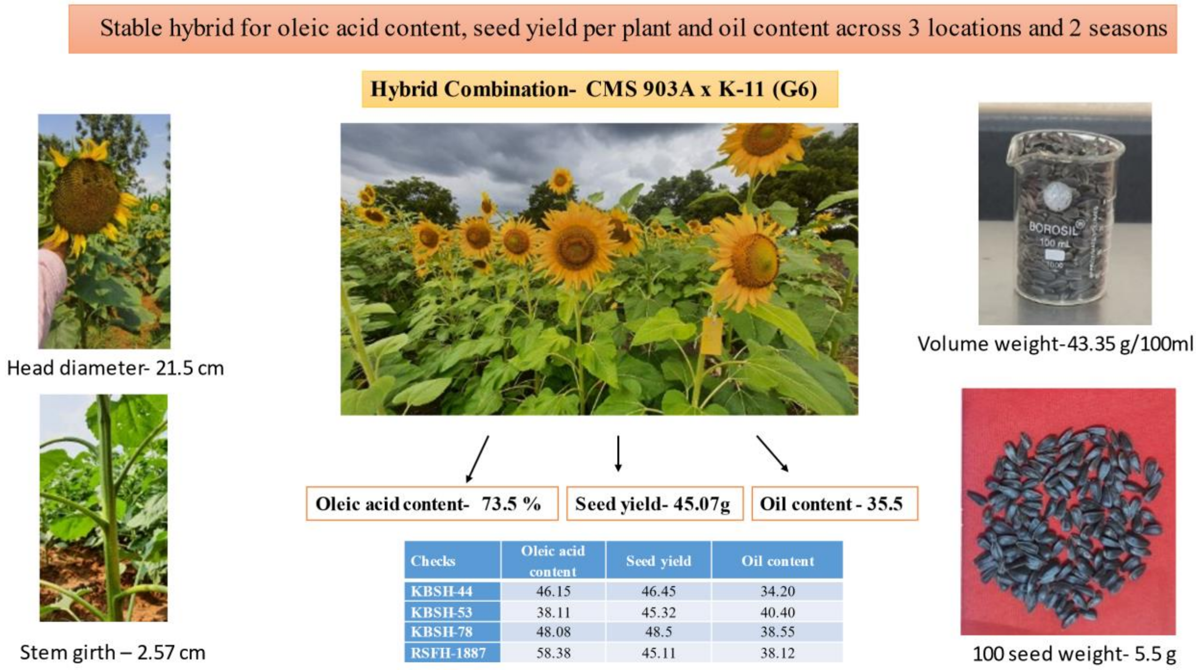


Fig. 1. Biplot of oleic acid content means (%) *v/s* IPCA1 for 30 hybrids over three locations during *rabi*/summer 2020-21 and *rabi* 2021



Checks	Oleic acid content	Seed yield	Oil content
KBSH-44	46.15	46.45	34.20
KBSH-53	38.11	45.32	40.40
KBSH-78	48.08	48.5	38.55
RSFH-1887	58.38	45.11	38.12

Genetic analysis and molecular mapping of resistance to bacterial leaf pustule disease in soybean

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ABSTRACT

Bacterial leaf pustule (BLP) caused by *Xanthomonas axonopodis* pv. *glycines* (*Xag*) is a serious disease of soybean. A resistant source 'TS 3' was identified and the inheritance studies indicated that the duplicate recessive genes govern the resistance. The genetic linkage analysis mapped the resistance locus (*rxp-2*) on chromosome 2 flanked by the SSR markers Sat_183 and BARCSOYSSR_02_1613 at a distance of 0.9cM and 2.1cM respectively. Similarly, another resistance locus (*rxp-6*) was mapped between the SSR markers BARCSOYSSR_06_0024 and BARCSOYSSR_06_0013 at a distance of 1.5cM and 2.1cM respectively.

Keywords: Bacterial leaf pustule, Mapping, Resistance locus, Soybean, SSR markers

Bacterial leaf pustule (BLP) is a foliar disease caused by *Xanthomonas axonopodis* pv. *glycines* (*Xag*) that cause subsequent yield losses in soybean. Screening of soybean genotypes for BLP resistance resulted in the identification of resistant genotype 'TS 3' and inheritance studies indicated that the duplicate recessive genes govern the resistance. Therefore, the objective of the study was to map the resistance genes conferring resistance to BLP in the Indian soybean genotype 'TS-3'.

MATERIALS AND METHODS

A segregating population derived from the cross PK472 X TS-3 and parents were phenotyped using excised leaf technique (Totade et al. 2022). For linkage mapping, a total of 310 SSR markers were screened following bulked segregant analysis. The linkage map was generated based on BLP phenotypic and SSR genotypic data using the JoinMap program, version 3.0.

RESULTS AND DISCUSSION:

In this study, the genotype 'TS-3' showed a highly resistant reaction to *Xag* compared to 'PK472' under laboratory conditions. All the F_1 plants were susceptible, indicating that the resistance to BLP in 'TS-3' was governed by a recessive gene(s). The F_2 population of the cross segregated in 15:1 ratio (χ^2 = 1.22, P= 0.268) indicating two recessive genes governing the resistance to BLP. The genetic linkage analysis mapped the five SSR markers and the BLP resistance locus (*rxp-2)* on chromosome 2 within the map distance of 5.5cM with flanking SSR markers Sat_183 and BARCSOYSSR_02_1613 tightly linked to *rxp-2* locus at a distance of 0.9 cM and 2.1 cM, respectively. Similarly, BLP resistance locus (*rxp-6*) was mapped with seven SSR markers on chromosome 6, with SSR markers BARCSOYSSR_06_0024 and BARCSOYSSR_06_0013 flanking the *rxp-6* locus at distances of 1.5 cM and 2.1 cM, respectively. Molecular mapping of BLP resistance loci (*rxp-2* and *rxp-6*) on chromosomes 2 and 6 in the current study clearly indicated that these loci are non-allelic to earlier mapped *rxp* loci on chromosomes 10 (Kim et al., 2011) and 17 (Kim et al., 2010). Using SSR markers tightly linked to *rxp-2* and *rxp-6* would help breeders identify BLP-resistant genotypes independently of the environmental conditions and even in the absence of *Xag* pathogen. The flanking SSR markers tightly linked to these resistance loci would provide an important molecular tool to expedite the soybean resistant breeding programs.

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Increasing sunflower production in Uganda through seed importation and developing local sunflower hybrids

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ABSTRACT

There is great potential for growing sunflower in Uganda. For the last decade, the farmers of Uganda have picked interest in the growing of sunflower. This is because of availability of ready market from the oil millers. However, production is constrained by limited available high yielding sunflower hybrids. Much of the seed is imported from International Seed Companies. Single cross hybrids and three-way cross hybrids were evaluated to check which types gives better yield, oil content and other desirable traits. Preliminary results showed that a number of three-way cross hybrids yielded better than the imported hybrids. We are therefore contemplating towards emphasis on scaling out three-way cross compared to single cross hybrids which is generally grown worldwide.

Keywords: Development, Seed importation, Single cross hybrids, Three-way cross hybrids

Sunflower, *Helianthus annuus* L., is the leading oilseed crop that can eliminate the importation of vegetable oil in Uganda. Presently, Uganda produces only 40% and imports up to 60% vegetable oil mainly from Argentina, South Africa and Asia. This can be reduced by growing of locally developed sunflower varieties affordable by the resource poor farmers. The area under production had been increasing from 2,000 hectares in mid 1990s up to 240,000 hectares by 2017. The production has reached 245,000 mt by 2017. It gained popularity among farmers on account of its high oil quality and fairly modest production requirements.

Uganda and most of the East African countries have basically been relying on imported seed. Although over 24 sunflower hybrids have been officially released in Uganda, most of them except two are imported from other countries.

The imported seeds are very costly and sold to farmers expensively. Also, in some cases the imported seeds fail to germinate. On many occasions, NaSARRI has been requested to fill that gap to no avail. Unfortunately, sunflower does not have an International research centre where scientists can get germplasm free like other crops. Most of the sunflower hybrids are protected in their countries and they do not allow any other country to obtain them.

MATERIALS AND METHODS

During the first rainy season of 2021 (May-July), four experiments were set: two for single-cross hybrids tested where one was evaluated at 7 multilocational sites and one only at Serere due to inadequate seed available and another experiment was for three-way cross hybrids whereby one set was at 7 multilocational sites and one only at Serere. The single cross hybrid experiment evaluated at 7 locations had twenty genotypes comprising of 15 single cross hybrids locally developed at Serere, one open-pollinated variety and 4 hybrids from Pannar Seed Company based in South Africa and used as checks while the three-way cross hybrid experiment evaluated multilocationally at 7 locations had 36 genotypes of which 29 genotypes were three way cross hybrids locally developed, 2 single cross hybrids locally developed and 4 hybrids from Pannar Seed Company used as checks.

RESULTS AND DISCUSSION

Preliminary results showed that a number of three-way cross hybrids yielded better than the imported hybrids. We are therefore contemplating towards emphasizing on scaling up three-way cross compared to single cross hybrids which is generally grown worldwide.

It is a well-known fact that the majority of sunflower hybrids grown in USA, Europe and many Asian countries are developed as single cross hybrids. The parental lines of single cross are inbred lines that are weak in growth and do not produce good yields. The advantage associated with three-way cross hybrids is the economy of seed production owing to almost double the seed yields in production plots of three-way cross hybrids compared to single cross hybrids (Jayalaxmi and Narendra, 2004, Kulkarni (2016). Since three way cross hybrids have wider genetic components, they then tend to adapt better in poor environments. Also, if the resource poor farmers are to multiply or produce the three-way cross hybrids, the first cross made in three-way cross is male sterile but very vigorous like a hybrid and produce higher seed yield and the farmer can sell this hybrid to a local seed company in the form of a three-way cross hybrid.

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A consistent 100-seed weight QTL with pleiotropy for seed number/plant in soybean (*Glycine max* L.)

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ABSTRACT

Seed weight and seed number/plant are important determinants of seed yield in soybean (*Glycine max* L.). A recombinant inbred line (RIL) population of cross EC538828 x JS97-52 was phenotyped for 100-seed weight (100-SW), seed number/plant (SNPP) and seed yield/plant (SYPP) for identifying quantitative trait loci (QTL) governing these traits. Linkage analysis using SSRs from reported QTL hotspots for 100-SW identified a consistent but pleiotropic QTL on chromosome 10. The QTL showed pleiotropy for SNPP with opposite phenotypic effect, while the pleotropic QTL doesn't affect seed yield in consistent manner.

Keywords: Pleiotropy, QTL, Seed weight, Seed number, Yield

Soybean is an important oilseed crop of India ranking *numero uno* in production. Seed weight and seed number/plant are important determinants of seed yield. In this study, three QTL hotspots for 100-SW previously reported (Ikram *et al.,* 2020; Hina et al., 2020), were analyzed in a RIL population of the cross EC538828 x JS97-52, for 100-SW, SNPP and SYPP traits.

MATERIALS AND METHODS

EC538828 is a drought tolerant, early maturing germplasm with 100-SW of 22-24 gm, while JS97-52 is also a drought tolerant variety, but having late maturity, higher SNPP and lower 100-SW (8-9 gm). A bi-parental cross was made between EC538828 and JS 97-52 in year 2011, and from F_2 onwards, population was advanced by single seed descent method till F_5. The RIL population was phenotyped for 100-SW (gm) and SYPP traits (gm) for four years (2015-2018, F_5-F_8), and SNPP for two years (2016 and 2017, F_6-F_7). SSR markers from three QTL hotspot on chromosome 02, 10 and 17 were genotyped in F_{10} RIL population. QTL analysis was conducted in QTL ICI Mapping software (Lei *et al.*, 2015).

RESULTS AND DISCUSSION

Linkage analysis for 100-SW trait identified a major QTL between BARCSOYSSR_10_1400 and

BARCSOYSSR_10_1444, explaining 13.38-56.37% of phenotypic variance, and positive allele was contributed by EC538828. QTL analysis for SNPP also identified a QTL between BARCSOYSSR_10_1400 and BARCSOYSSR_10_1444 for both the years analyzed (2016-2017), but positive allele for this trait was contributed by JS97-52. The phenotypic variance explained by this QTL for SNPP trait ranged from 18.57-42.19%. QTL analysis for SYPP also identified a QTL at the same position on Chr.10 for three years' data, but 2017. Results showed that the pleotropic QTL did not affect seed yield in consistent manner. These results suggested that the QTL identified on Chr.10, is a consistent QTL for 100-SW but also control SNPP with opposite effect on trait value. Apparently the gene controlling 100-SW and SNPP at this locus keeps a balance between the two traits, a similar negative trade-off between two traits was reported in Japanese cultivars (Kumagai et al. 2022). In our earlier study, the QTL for seed weight at BARCSOYSSR_10_1400, was identified in a bi-parental mapping population of Type 49 x EC538838, for phenotyping data of 100-SW at three locations. The major QTL for 100-SW identified on Chr.10 in EC538828 is consistent across population, locations and years, therefore can be used for improving 100-SW in soybean cultivars having low seed weight.

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Analysis of physio-biochemical indices for growth and yield of groundnut (*Arachis hypogaea* L.)

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ABSTRACT

The present study on the topic was performed at AICRP on groundnut, M.P.K.V., Rahuri, (M.S.) during summer 2021.The experiment was laid out in Randomized Block Design with three replication including sixteen genotypes. The groundnut genotypes with highest rate of photosynthesis and transpiration processes are higher in yielding. Correlation studies revealed that number of mature pods/plant and 100 kernels weight (g), showed maximum influence on dry pod yield (g/plant). The genotypes Phule Unnati, ICGV-15311 and ICGV-15303 showed higher yielding ability and HI (%).

Keywords: Biochemical studies, Groundnut, Physiological parameters, Yield and yield attributes

Groundnut has been dubbed "Nature's Masterpiece of Food Value" as it contains 36 to 54 percent oil, 24 to 26 percent protein and has an energy value 2,363 KJ per 100g Vitamin A, B1, B2, nicotinic acid, E and K are rich in kernels (Woodroof, 1983).

Past improvements in yield potential in most crop species including groundnut appear to have been derived primarily from increases in harvest index, when genetic enhancement is absent in photosynthesis and growth (Zhu *et al.*, 2010). Any morphological trait linked to higher seed yield or that contributes significantly to yielding ability could be beneficial in increasing grain yield. Basic research on the basis of morpho-physiological traits is required in order to overcome yield barriers within genotypes

It is critical to identify plant characters that govern productivity in a breeding programme to improve pod yield in groundnut. For achieving genotype with desirable traits, it was necessary to investigate the interrelationships between different characters. Therefore, the present study was undertaken to assess the physiological and biochemical parameters of groundnut genotypes as well as yield and yield attributes with a focus on pod yield.

MATERIALS AND METHODS

The field experiment was carried out in the summer of 2021 at the farm of AICRP on Groundnut, M.P.K.V., Rahuri. The sixteenth genotypes of groundnut were sown on 20 February, 2021 with three replications by dibbling method and maintaining 30 cm × 10 cm spacing under irrigated condition. FYM @ 10 cartloads/ha was applied during land preparation and incorporated well with harrowing. The recommended dose of chemical fertilizer was 25 kg N and 50 kg P_2O_5/ha in the form of urea and SSP was applied at the time of sowing. The observations were recorded as per the standard procedures. The chlorophyll content (a, b and total) of leaves was estimated at 10 days after flowering by spectrophotometer method described by Arnon,D.I. (1949) on fresh weight basis and calculated by using formula suggested by Sadasivam S. and A. Manickam(1992).

RESULTS AND DISCUSSION

The vegetative phase is responsible for the plant's overall phenotypic expression and prepares it for the reproductive phase. The data on groundnut genotypes in respect of photosynthetic rate, stomatal conductance and transpiration rate at 50 per cent flowering measured using Infra-red Gas Analyzer (IRGA; Model Portable Photosynthetic System LI 6400) presented in Table 1, revealed that the genotype ICGV-15311 (26.20 µ mol $CO_2/m^{2./}s$) recorded highest photosynthetic rate, which was at par with genotypes ICGV-15303 (26.16 µ mol $CO_2/m^{2\ /}s$) and ICGV-10007 (25.81 µ mol CO_2 $_/m$ $^/s$); ICGV-15311 (0.39 m mol CO_2/m^2 /s), ICGV-15303 (0.38 m mol CO_2 $/m^2$ $/s^1$) and ICGV-10007 (0.37 m mol CO_2 $/m^2$ $/s^1$) recorded highest stomatal conductance and ICGV-15303 (3.16 m mol CO_2 $/m^2$ $/s^1$), ICGV-15311 (3.07 m mol CO_2 $/m^2$ /s) and ICGV-10007 (3.04 m mol CO_2 $/m^2$ $/s^1$) recorded highest transpiration rate. The adaxial stomatal frequency was higher in ICGV-15303 (19.05) and ICGV-15311 (18.87) whereas, abaxial frequency was higher for ICGV-15311 (11.24), ICGV-10007 (10.87), ICGV-15303 (10.87) and Phule Unnati (10.85). The genotype ICGV-15311 and ICGV-15303 recorded higher rate of stomatal conductance, photosynthetic and transpiration rate produced higher grain yield. These findings support the results reported by Bhattacharya and Singh (1999), Kalpana *et al.* (2003) and Borkar and Dharanguttikar (2014).

In present investigation, genotypic variations were statistically significant for all variables, indicating a large level of difference in yield and yield attributes between genotypes. The maximum number of total pods/ plant was produced by Phule Unnati (47.90), ICGV-15311 (47.60), ICGV-10007 (47.47) and ICGV-15287 (47.40). The number of pods per plant is genetically controlled and one of the main yield contributing characters , Rasheed *et al.* (2015) reported the similar result.The genotypes ICGV-15303 (37.94 g/100 kernels), ICGV-10004 (34.38 g/100 kernels) and Phule Unnati (33.97g/100 kernels) were found bold seeded. The significantly highest dry pod yield (g) plant^{-1} was recorded by Phule Unnati (28.69 g) followed by ICGV-15311 (26.94 g). The harvest index gives better understanding of assimilates translocation efficiency of the genotype. The highest harvest index was maintained by genotype Phule Unnati (66.58 %) followed by ICGV-15311 (63.69 %) and ICGV-15303 (63.03%) indicating the better translocation efficiency. It is measure of grain yield potential of genotype and considered as an important criteria for selection of high yielding genotypes. These results are similar with the findings of Bhargavi *et al.* (2015) and Kamshette *et al.* (2015). The genotypes ICGV-15311 (3599.88 kg), ICGV-15303 (2909.38 kg) and Phule Unnati (2852.50 kg) recorded higher kernel yield (kg) per hectare (Table 2).

The chlorophyll pigment is critically important components in photosynthesis process as it convert light energy to chemical energy and influence photosynthesis rate. The genotype ICGV-15303 (0.76 mg/g) content significantly highest amount of chlorophyll-a followed by genotypes TAG-24 (0.67 mg/g) and ICGV-10007 (0.65 mg/g). The maximum chlorophyll-b content was recorded by genotype ICGV-13086 (0.59 mg/g) at par with genotypes ICGV-15303 (0.56 mg/g) and Phule Unnati (0.56 mg/g). The total chlorophyll content was highest in the genotype ICGV-15303 (1.32 mg/g) followed by the genotypes Phule Unnati (1.20 mg/g) and ICGV-10007 (1.17 mg/g). The higher chlorophyll content is one of the most important factors responsible for better yield. These findings support the results reported by Kathirvelan and Kalaiselvan (2006) and Mane *et al.* (2017). Groundnut contains 36 to 54 percent oil, 24 to 26 percent protein and Vitamin A, B1, B2, nicotinic acid; E and K are rich in kernels (Woodroof, 1983). In the present investigation, protein content amongst the genotypes ranged between 22.24 to 25.06 per cent, while of oil content ranged from 44.54 to 51.33 %. The genotype TAG-24 (25.06 %) and Phule Unnati (24.63 %), found superior in respect of protein content. whereas, Phule Unnati (51.33 %), TAG-24 (50.83 %) and ICGV-15303 (49.40 %) were superior for oil content (Table 3).

Correlation studies indicate that 100 kernels weight (0.914**), kernel yield (kg/ha) (0.899**), primary branches per plant (0.839**), secondary branches per plant (0.808**), total pods per plant (0.753**), mature pods per plant (0.753**), dry haulm yield (kg/ plot) (0.752**), leaf area (dm^2/plant) (0.533*) and oil content (0.452**) showed maximum influence on dry pod yield (g/plant).

CONCLUSION

In the present study, that genotypes, ICGV-15311 and ICGV-15303 showed better performance in all parameters after Phule unnati therefore, these may employed for heterosis in further breeding programme

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Table 1:- Physiological parameters influenced by groundnut genotypes

Sr. No.	Genotypes	Photosynthesis rate (μ molm^{-2}s^{-1})	Stomatal conductance (m molm^{-2}s^{-1})	Transpiration rate (m molm^{-2}s^{-1})	Stomatal frequency (mm^2/leaf area)	
					Adaxial	Abaxial
1	ICGV-10001	24.70	0.31	2.39	16.58	10.25
2	ICGV-10004	23.99	0.27	1.93	15.67	10.27
3	ICGV-10005	24.37	0.30	2.26	17.08	10.21
4	ICGV-10007	25.81	0.37	3.04	18.53	10.87
5	ICGV-10008	24.84	0.31	2.49	17.08	10.27
6	ICGV-10016	25.06	0.32	2.75	17.37	10.65
7	ICGV-10021	25.36	0.35	2.81	17.55	10.82
8	ICGV-13027	25.32	0.33	2.82	17.88	10.77
9	ICGV-13086	24.36	0.28	2.14	16.01	10.11
10	ICGV-15284	24.61	0.31	2.40	18.53	10.23
11	ICGV-15287	25.02	0.32	2.44	16.98	10.54
12	ICGV-15290	23.88	0.25	2.08	14.24	09.42
13	ICGV-15303	26.16	0.38	3.16	19.05	10.87
14	ICGV-15311	26.20	0.39	3.07	18.87	11.24
15	TAG-24 (C)	25.05	0.31	2.54	17.24	10.64
16	Phule Unnati (C)	25.76	0.36	2.44	18.11	10.85
	Mean	**25.03**	**0.32**	**2.55**	**17.30**	**10.50**
	S.E.±	0.146	0.010	0.056	0.178	0.140
	C.D. at 5 %	0.423	0.029	0.162	0.514	0.406

Table 2:- Yield and yield contributing attributes as influenced by groundnut genotypes

Sr. No.	Genotypes	Total Pods/plant	Mature Pods/plant	100 kernels Weight (g) (HKW)	Kernel yield (kg/ha)	Dry pod yield (g/plant)	Harvest index (%)
1	ICGV-10001	30.00	27.47	22.47	1437.06	12.78	39.81
2	ICGV-10004	45.15	37.53	34.38	2423.38	17.00	57.50
3	ICGV-10005	42.73	36.73	24.43	2449.77	17.88	55.49
4	ICGV-10007	47.47	41.47	33.94	2533.33	19.55	51.04
5	ICGV-10008	38.53	35.33	33.81	1625.12	16.51	51.72
6	ICGV-10016	32.67	28.47	29.73	1737.27	16.30	47.50
7	ICGV-10021	34.40	29.80	26.04	1900.00	14.06	39.27
8	ICGV-13027	41.13	37.33	27.72	2256.25	15.51	47.09
9	ICGV-13086	40.80	36.33	32.63	1627.31	14.29	45.62
10	ICGV-15284	26.20	22.93	20.28	1040.16	8.62	39.54
11	ICGV-15287	47.40	40.53	30.04	2295.83	17.89	50.07
12	ICGV-15290	32.73	27.53	25.44	1748.26	12.58	40.06
13	ICGV-15303	36.87	30.80	37.94	2909.38	21.90	63.03
14	ICGV-15311	47.60	42.20	31.19	3599.88	26.94	63.69
15	TAG-24 (C)	33.87	28.73	28.10	1825.23	14.41	46.72
16	Phule Unnati (C)	47.90	42.57	33.97	2852.20	28.69	66.58
	Mean	**39.09**	**34.11**	**29.51**	**2141.28**	**17.18**	**50.30**
	S.E.±	2.057	2.024	0.870	144.850	1.021	3.008
	C.D. at 5 %	5.940	5.846	2.513	418.357	2.948	8.686

Table 3. Chlorophyll content and protein and oil percentage as influenced by groundnut genotypes

Sr. No.	**Genotypes**	**Chl 'a' (mg/g)**	**Chl 'b' (mg/g)**	**Total Chl (mg/g)**	**Protein content (%)**	**Oil content (%)**
1	ICGV-10001	0.38	0.46	0.84	22.24	44.54
2	ICGV-10004	0.64	0.50	1.14	22.97	47.99
3	ICGV-10005	0.49	0.53	1.03	23.28	46.73
4	ICGV-10007	0.65	0.52	1.17	23.84	48.81
5	ICGV-10008	0.48	0.51	0.99	24.02	45.73
6	ICGV-10016	0.53	0.49	1.02	23.70	47.77
7	ICGV-10021	0.38	0.42	0.80	23.41	47.56
8	ICGV-13027	0.49	0.50	0.99	22.67	45.42
9	ICGV-13086	0.41	0.59	1.00	24.06	47.15
10	ICGV-15284	0.27	0.37	0.64	23.20	44.97
11	ICGV-15287	0.63	0.52	1.15	23.37	46.49
12	ICGV-15290	0.40	0.43	0.82	24.17	46.95
13	ICGV-15303	0.76	0.56	1.32	23.68	49.40
14	ICGV-15311	0.57	0.48	1.05	23.75	45.61
15	TAG-24 (C)	0.67	0.40	1.07	25.06	50.83
16	Phule Unnati (C)	0.64	0.56	1.20	24.63	51.33
	Mean	**0.52**	**0.49**	**1.01**	**23.63**	**47.33**
	S.E.±	0.015	0.017	0.024	0.155	0.170
	C.D. at 5 %	0.042	0.048	0.070	0.449	0.490

Leafhopper, *Amrasca biguttula biguttula* (ishida): An Emerging insect pest on sunflower

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ABSTRACT

The present experiment was conducted to know the seasonal incidence of leafhopper, *A. biguttula biguttula* on sunflower. The significant and negative correlation was observed between nymphal population and minimum temperature, while bright sunshine hours showed a significant and positive correlation. However, there was no significant and positive correlation between leafhopper population and Rainfall. Whereas, the relation was negative and non-significant with maximum temperature, morning relative humidity and evening relative humidity.

Keywords: Dynamics, Leafhopper, Sunflower

Among sucking pests, leafhopper appears on the crop round the year but it becomes a serious pest during certain months at different places. It is distributed in almost all sunflower growing regions of the country, but economically important in Maharashtra, Tamil Nadu and Karnataka. Summer crops are likely to suffer more with this pest than in kharif. Cotton, sunflower, castor, brinjal, potato, Hibiscus and cucurbits are the alternate hosts of this pest (Basappa and Prasad, 2005). From Maharashtra, there are reports of this pest causing crop loss up to 46 per cent in sunflower (AICRP, 1979). In order to develop suitable management techniques, it is essential to have thorough understanding of the population dynamics and damage potential of the leafhoppers and the influence of abiotic parameters, on the leafhopper infestation need to be studied. Therefore, an experiment was conducted to know the seasonal incidence of leafhopper, *A. biguttula biguttula* on sunflower.

MATERIALS AND METHODS

Field experiments were conducted at Main Agricultural Research Station, Raichur (16.21' N and 77.3'E) Karnataka from 2011 to 2019 during *rabi* seasons. Experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Sunflower hybrid DRSH-1 was selected for the study sown at 0.6 m x 0.3 m rows. Fertilizer application and agronomic practices were followed as per the University recommended production practice for the region. After fifteen days after sowing data on leafhopper was recorded at weekly interval up to maturity. Population was recorded from upper, middle and lower leaves of 50 plants. No pesticides were sprayed on the crops during the study period.

RESULTS AND DISCUSSION

The incidence of leafhopper on *rabi* sunflower crop was commenced at 48th MSW and continued almost throughout the crop period. The pest population fluctuated during early part of the cropping season and increased gradually and peaked at 50th MSW. Averaged over 2011-19 the leafhopper population ranged from 7.60 – 16.96 adults/6 leaves, wherein the maximum population was recorded during 2019 and the minimum in 2017. Annual normal weather parameters averaged over 39 years varied between 24.7 - 35.1 ^{o}C, 10.1- 20.4 ^{o}C, 0.00 – 8.20 mm, 62-93%, 20-52% and 1.9-9.6 Tmax, Tmin, Rainfall, RH1, RH2 and Bright sunshine hours respectively. Activity of leafhopper was observed throughout the year in sunflower ecosystem with population ranging from 2.12 to 16.69/6 leaves across the study years and mean population of leafhopper ranged from 5.55 to 10.15/6 leaves/plant and was at its peak during 1st MSW (January) and declined thereafter but remained active till harvest of the crop. The significant and negative correlation was observed between nymphal population and minimum temperature, while bright sunshine hours showed a significant and positive correlation. There existed a non-significant and positive correlation between leafhopper population and Rainfall. Whereas, the relation was negative and non-significant with maximum temperature, morning relative humidity and evening relative humidity.

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Evaluation of cold pressed oilseed cakes - A potential by-product for valorization

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ABSTRACT

In a sstudy taken up to evaluate the nutritional composition of cold pressed oilseed cakes, sesame and mustard oilseed cakes were richest sources of protein, fiber and minerals. The essential amino acids content among the oilseed cakes ranged between 32.98 to 41.05gm/100gm, with highest essential amino acid content in mustard seed cake. Oleic Acid (C18:1n9cis) and linoleic Acid (C18:2n6cis) acids were found in higher quantities among all the oilseed cakes. However anti-nutrients like oxalates, phytates and saponins were also present in all seed cakes with significantly higher content in sesame and mustard seed cakes indicating the need for various pre-treatments before using the oilseed cakes for various food formulations. The oil processing industry generates a large amount of oilseed cake every year and hence efforts must be aimed at minimizing and efficiently valorizing this nutritious by-product to support the concept of zero waste.

Keywords: Amino acids, Anti-nutrients, Composition, Essential nutrients, Oilseed cakes, Valoization

Oilseed cakes are a by-product of oil extraction resulting in fat free meal that is chiefly used as cattle feed, plant fertilizer, compost amendment, or plant conditioner. The oilseed cakes are rich sources of protein, nitrogenous compounds, minerals and bioactive components. The increase in oilseed production globally to meet the edible oil requirements inevitably is resulting in an increased production of agricultural and industrial by-products with a high potential for valorization (Petraru and Amariei, 2020), which in turn can be used as human food. Considering the nutiritional security of the exponentially increasing human population, and escalating food prices, these protein rich oilseed cakes can be a novel food ingredient that can be valorized for various food and food product formulations. The quality and functional properties of extracted oilseed cake proteins not only supplement the existing protein sources for the human consumption but also solve the problem of oilseed cakes disposal along with the additional income to the oilseed crop producers and processers. Hence, this study was taken up to evaluate the nutritional potential of the oilseed cakes obtained by cold pressing process of oil extraction.

MATERIALS AND METHODS

Five cold pressed oilseed cakes i.e., Mustard, safflower, sesame, coconut and groundnut were procured from four different locations in Hyderabad and Secunderabad of Telangana State, India and the samples were homogenised, pulverised and stored at ambient temperature at MFPI - Quality Control Laboratory, for further analysis. The processed samples were used to determine the nutrient composition; mineral content; anti nutrient composition; fatty acid composition using FAME method by Gas Chromatograph and amino acid composition on HPLC using standard AOAC methods. All the analysis were carried out in duplicates. Mean, standard deviation and F ratios were calculated and differences within each nutrient component were tested at a 95 % confidence interval.

RESULTS AND DISCUSSION

As per the results obtained, Groundnut seed cake had highest amount of protein (48.97g/100g±1.03), followed by sesame seed cake with 42.0597g/100g ±0.11, while mustard, safflower and coconut seed cakes had 18.14 to 32.67g/100g indicating that they are all excellent sources of protein. All the oilseed cakes were also rich sources of fibre content ranging between 7.11 g/100g ±0.04 to 18.62 g/100g ±0.52, and also ash content ranging between 2.72 g/100g ±0.11 and 9.19 g/100g ±0.01.

Among the amino acids tested in the oilseed cakes, it was observed that Glutamate content in all the seed cakes was highest ranging from 18.41 – 22.03gm/100gm, followed by lysine ranging from 11.36-16.35gm/100gm. Among the 9 essential amino acids, lysine, methionine, isoleucine, leucine, threonine were present in good quantities, whereas, histidine, phenylalanine, tryptophan, and valine were present in small quantities in all the tested oilseed cakes. The total essential amino acids content was in the range of 32.98 to 41.05gm/100gm, with highest essential amino acid content in mustard seed cake followed by coconut and sesame seed cake. The non-essential amino acids content ranged between 58.95 to 67.02 gm per 100gms, with highest content of non-essential amino acids in groundnut seed cake followed by safflower seed cake.

It was observed that 8.76 to 17.42% fat was present in the oilseed cakes. The fatty acids composition of oilseed cakes was similar to that of the oils as per the results obtained. Oleic acid (C18:1n9cis) content was found to be highest in sesame and groundnut seed cake, followed by Linoleic Acid (C18:2n6cis). Lauric acid (C12:0) content was found to be highest in coconut seed cake, followed by Myristic Acid (C14:0) and Palmitic Acid (C16:0).

The results of mineral estimate indicated that sesame seed cake was an excellent source of iron (121.57 mg/kg ±1.51), zinc (65.74 mg/kg ±0.16), calcium (8654.04 mg/kg ±5.77) and magnesium (2966.05 mg/kg ±0.33). Other seed cakes like safflower, mustard and groundnut seed cake had high calcium and magnesium content, while iron and zinc content ranged between 26.03 mg/kg ±0.28 to 58.88 mg/kg ±1.09, and 15.48 mg/kg ±0.54 to 61.78 mg/kg ±2.64 respectively in mustard, safflower, coconut and groundnut seed cakes. However, it was also observed that anti-nutreints like oxalates, phytates and saponins were present in all seed cakes with significantly higher content in sesame and mustard seed cakes. The direct utilization of oilseed cakes in human or animal nutrition is limited by the presence of such antinutrients, which influences the organoleptic properties, protein digestibility, and macro/micro elements bioavailability (Gupta et al., 2018). The elimination or inactivation of these toxic substances can be achieved by various methods of processing: physical (dehulling, heat-cooking, autoclaving, toasting), chemical (ammoniation, the addition of choline, methionine, ferrous sulphate, sodium carbonate), enzymatic and fermentative methods (Ancuţa and Sonia. 2020), that ensure better bioavailability of proteins, vitamins and minerals on consumption.

Valorization of oil seed cakes has to be taken up aggressively considering the nutritional composition, especially the concentrated forms of protein, fiber and mineral content, which can have several beneficial effects on health of human beings. The defatted edible cakes can be incorporated in multipurpose supplements, infant dairy products, traditional Indian food and bakery products etc, and also can be used as special ingredient for formulating foods for undernourished people or can be promoted as therapeutic dietary ingredients. Oilseed cakes can also serve as substrates for the production of low-cost value-added products, bioactive compounds such as enzymes, antibiotics, vitamins, natural pigments, flavors components, and health promoting components, such as dietary fibers, amino acids, flavonoids, phytochemicals and proteins. Effective utilization of a valuable by-product like oil seed cakes can lead to achievement and successful realization of the zero waste and circular economy concepts in foods industries. Also, utilization of oilseed cakes, provides an opportunity to add value and to fill the gap in protein demand that is constantly increasing globally.

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Cold pressed cooking oils: An enigma of choice based on Omega-6 to Omega-3 ratio

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ABSTRACT

A range of cold pressed edible oils which are commonly used in households of India were decoded with gas chromatography for their fatty acid composition and n-6/n-3 ratios. Among the nine cold pressed oils tested coconut oil contained highest amount of saturated fat. Safflower and Mustard had about similar amount of unsaturated fatty acids, however the content of monounsaturated fatty acids was high in case of mustard oil (59.16 %) and poly unsaturated fatty acids were high in safflower oil (73.61 %). Every oil examined, with the exception of mustard oil, has much more omega 6 than omega 3 fatty acids. The ratio of n-6 to n-3 fatty acids was significantly higher in other oils and more favourable in case of mustard oil.

Keywords: Cold pressed oils, Fatty acid composition, Oil composition, Omega 3 and 6 fatty acids

Cooking oils are a crucial component of Indian diets, thus far there are many widely marketed edible oils that make a variety of health claims. Therefore, choosing the correct edible oil is crucial, especially in the Indian culture where cooking styles differ from those used in the west. The healthy (unsaturated fat), bad (saturated fat), and ugly (trans-fat) fats outlined in fat metabolism are now understood by the majority of folks. Each oil has a different composition of fatty acids and the content differs with the source of oil and the production conditions of that particular crop. People's cardiac health is significantly influenced by n-3 and n-6 fatty acids, two essential components of polyunsaturated fatty acids, and their ratio. Due to the growing trend towards a healthy lifestyle, people are preferring cold-pressed oils instead of refined oils to maintain their best cardiovascular health. In order to determine the amount of essential fatty acids in typical domiciliary oils, the current study was conducted on cold-pressed oils rather than refined oils.

MATERIALS AND METHODS

Cold pressed oils of selected crops were collected from the local market. Fatty acids were estimated by using gas chromatograph (7890B of Agilent technologies) with Flame ionization detector and – DBFFAP column (Nitro terephthalic-acid-modified polyethylene glycol (PEG) of high polarity for the analysis of volatile fatty acids) and by AOAC (2001. 996.06) method. Fatty acid methyl esters were generated by trans-esterifying the isolated fat with 0.5 M methanolic KOH. Initial temperature of the column was maintained at 100°C for 5 min then it was raised at the rate of 5°C /min till it reached 240°C and the carrier gas used in the column was nitrogen. FAMEs were identified by comparing the retention times in the chromatogram with that of reference standard. 37 components FAME mix (SUPELCO) was used as standard. FA content was expresses as percentage of total FAMES. The analysis was done in replicates and the values were expressed as mean ± SD.

RESULTS AND DISCUSSION

The FA profile is the main determinant of the oil quality. Coconut oil exhibited highest saturated fatty acid (SFA) content (89.34 %) and mustard oil recorded the lowest (7.14 %). About 58 % of the SFA in coconut oil was contributed by medium chain fatty acids (MCFA). Due to their immediate absorption and quick utilisation in the creation of energy, MCFAs do not contribute in the biosynthesis and transport of cholesterol. So, it can be said that though coconut has highest amount of SFA content it is safe to consume and do not show any adverse effect on cardiac health (Mandal and Mandal, 2011). Monounsaturated Fatty acids in the tested oils were in the range of 18.36 to 59.16 % with the highest content recorded in mustard and lowest in safflower oil. A very high PUFA content was observed in case of safflower oil (74.13 %) followed by soybean (61.30 %). Safflower and soybean oils would not be the ideal option given their PUFA concentration because they are thought to be pro-inflammatory rather than anti-inflammatory.

An Omega -6 fatty acid Linoleic acid (LA), and an Omega-3 fatty acid, α-linolenic acid are the only two fatty acids which are considered essential for human body. The linoleic acid content in the tested oils ranged from 21.11 % to 73. 61 %. Safflower, sunflower and Soybean are the rich sources of omega-6 fatty acids. The linoleic acid content in safflower is about 3 times higher than that of mustard oil and two times higher than that of rice bran oil. Alpha-linolenic acid (ALA), a shorter chain omega-3 fatty acid, was higher in case of mustard oil (11.67 %). Soybean oil also recorded considerable amount of this omega-3 fatty acid. α-Linolenic acid content was not detected in Ground nut and coconut oils. MUFA are effective at raising insulin levels and regulating blood sugar, which helps prevent cases of hyperglycemia, hypoglycemia and signs of prediabetes. Even though it is vital to consume omega- 3 and Omega- 6 fatty acids, the quantity of each FA can alter the function of other fatty acid in the human body. Balance of these two fatty acids is crucial for many vital functions in the body (Artemis, 2010). In the present study healthy n-6/n-3 ratio was observed only in case mustard oil (1.81: 1) and all the other oils recorded higher values than the recommended. This is the reason why mustard oil has become a replacement for the olive oil in salad dressing in the recent days. Coconut and groundnut oils had the highest n-6/n-3 ratio among the oils tested.

Due to its advantageous LA/ALA ratio, low SFA, high MUFA content, and comparative stability during cooking, mustard oil can be a preferred option, especially in its cold-pressed form.

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Table. 1. SFA, MUFA, PUFA and n-6/n-3 ratios of various vegetable oils

Oil	SFA	MUFA	PUFA	Linoleic Acid (ω-6)	α-Linolenic acid (ω-3)	ω-6:3
Sesame Oil	16.52 ±1.07	40.68 ±0.55	42.80±1.45	42.47± 1.44	0.33±0.03	128.70: 1
Mustard Oil	7.14±0.27	59.16±0.29	33.59±0.01	21.11± 0.13	11.67 ± 0.12	1.81 : 1
Soybean Oil	15.99 ±0.40	22.71 ±3.17	61.30±2.79	54.02± 2.08	7.29 ± 0.75	7.41:1
Safflower Oil	7.51±1.94	18.36±2.66	74.13±0.74	73.61± 0.72	0.29± 0.05	253.82:1
Groundnut Oil	20.64±0.32	41.95±0.56	37.41±0.87	37.41 ±0.87	0	Very high
Rice Bran Oil	25.12±0.61	40.72±1.06	34.16±0.49	32.75± 0.47	1.42± 0.10	23.06:1
Sunflower Oil	10.79±0.14	30.84±0.39	58.72±0.36	58.58±0.38	0.14±0.02	418.43:1
Coconut Oil	89.34± 0.35	7.48± 0.13	3.19±0.20	3.19± 0.20	0	Very High
Corn oil	18.18±0.99	31.52 ±2.53	50.30±2.64	49.53 ± 2.65	0.77 ± 0.09	64.32 : 1

Value chain analysis of Safflower – A study in Vikarabad district of Telangana

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ABSTRACT

The study investigated the movement of safflower seeds from farmer to consumers and also the costs and returns incurred by the safflower farmers. Tracking the movement of safflower from farm to consumer will identify all the stakeholders involved in the value chain. For accomplishing these objectives primary data required was collected from the farmers and also the other stakeholders from the study area with the help of schedules. Value chain analysis identified that the main activities included input logistics, production, marketing and processing. Input logistics includes the activities that involve the movement of the inputs like seeds, fertilizers and pesticides from suppliers to farmers. The data obtained was analysed and it indicated that the value addition to safflower was restricted to marketing onty two products, refined and cold pressed safflower oil, while there was scope for many other products like dyes, cosmetics and food colouring products. Some possible strategies to increase the value chain in this crop are discussed.

Keywords: Safflower, Telangana, Value chain, Vikarabad

Value chain is an important aspect in growth of the crop. Safflower is an important oilseed crop especially under the rainfed condition. In Vikarabad District of Telangana, safflower is cultivated as a traditional crop and the value chain is also in place. During the production activity, the major actors are farmers who carry out the cultivation of safflower. Production involves various activities like land preparation, sowing, weeding and harvesting. After the harvest farmers mostly sell the produce to the traders and some quantity to the processors.

MATERIALS AND METHODS

Value chain analysis of safflower was carried out with the help of primary data collected from the farmers and market intermediaries in the study area. Through the analysis it was observed that the major actors in the safflower value chain were input suppliers, farmers, traders and processors. Costs and returns of safflower cultivation were calculated by collecting data from 120 farmers composed of 6 mandals from the study area. Most of the safflower cultivating farmers was small and marginal.

RESULTS AND DISCUSSION

Data analysis indicated that the farmers from Mariyapur village were carrying out seed production for Indian Institute of oil seeds research (IIOR), hence they sold the seeds to the institute after harvesting and farmers from Tandur and Basheerabad were selling the seeds to the Professor Jayashankar Telangana State Agricultural University Cold pressed safflower oil processing unit at ARS, Tandur. Next activity was identified as marketing in which the major actors were market intermediaries who purchased the harvested safflower seeds from farmers for further selling either to processors or other traders or for export purpose. Last stage in value chain was identified as processing where value addition occurred to the raw material and the major actors during processing were processors. Most of processors purchased the safflower seeds from the traders and few purchased directly from the farmers. During the value chain analysis of safflower, major value added products identified in the study area were refined and cold pressed safflower oil.

The cost of cultivation of safflower was Rs. 44,544/ha. The highest share in cost of cultivation was incurred on machine labour followed by human labour. The average yield of safflower was 17.5 q/ha and gross returns were Rs. 95,458/ha. The average net returns obtained by farmers were Rs. 50,915/ha. Hence, safflower cultivation is profitable to the farmers in the study area.

From the study it was observed that value addition to safflower was poor as only two products were being marketed although various other products like dyes, cosmetics and food colouring products can be produced. As a way forward, there is a need to provide training and demonstrations to farmers on value addition to safflower so, that farmer will strengthen their position among the stakeholders in the chain. As safflower cultivation is profitable, there is a need to encourage farmers to take up the cultivation of this crop with concomitant reduction in the cost of cultivation. In safflower cost of cultivation, major share of cost incurred was from hired machinery and to overcome this increased cost on machinery, farmers need to organize into groups or co-operatives and purchase their own machinery with the possible aid from the government. Establishment of custom hiring centers can help small and marginal farmers to hire machinery at a subsidized rate.

Characterization of sunflower (*Helianthus Annuus* L.) lines for *Alternariaster* leaf spot disease resistance

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ABSTRACT

Leaf spot disease is an important disease of sunflower that reduces the photosynthetic area and causes the yield loss. An investigation was undertaken for screening of breeding lines to *Alternariaster* leaf spot during *Kharif* 2021. Among 75 breeding lines including susceptible check KBSH-44 evaluated in augmented block design with two replications at Sunflower Scheme, MARS, Raichur, five lines *viz*., RSLP-18 (PDI=8), RSLP-22(PDI=8), RSLP-98(PDI=7.5), RCB-19-9(PDI=7.5) and PM-160 (PDI=9) with resistant reaction to *Alternariaster* leaf spot whereas RSLP-89, RSLP-99 and PM7 recorded medium resistance reaction in post-flowering stage.

Keywords: Alternariaster, Leaf spot, Resistance, Sunflower

Sunflower is one of the important oilseed crops grown in India next to groundnut. The sunflower oil is rich source of edible oil (40-52%) and is considered as good quality oil from health point of view because of balanced fatty acids composition. However, in recent years the crop productivity and production levels are stagnated with drastic reduction in sunflower area. Several pathogens attack sunflower crop *viz*., powdery mildew, downy mildew and sunflower necrosis. Among them, sunflower leaf spot disease caused by *Alternaria helianthi* infecting the crop from seedling stage to seed filling stage. The disease initially appears as small circular brown spots on lower leaves which later on become irregular and concentric rings.

MATERIALS AND METHODS

An investigation was undertaken for screening of breeding lines to *Alternariaster* leaf spot during *Kharif* 2021. A total of 75 breeding lines including susceptible check KBSH-44 were evaluated in augmented block design with two replications at Sunflower Scheme, MARS, Raichur. The incidence of *Alternariaster* leaf spot was scored in each entry on 0-9 scale (Mayee and Datar, 1986). Observations were converted to per cent disease index (PDI) using following formula given by Wheeler (1969).

RESULTS AND DISCUSSIONS

Among 75 lines, lines RSLP-18, RSLP-22, RSLP-89, RSLP-98, RSLP-99, PM 7, PM 160 and RCB-19-9 with PDI of 5.6%, 6%, 8%, 6.5%, 7.4%, 6.5%, 7% and 5%, respectively recorded resistant reaction to *Alternariaster* leaf spot at flowering stage. The early incidence of leaf spot disease drastically affects seed yield and oil content in sunflower (Amaresh and Nargund, 2000). However, there will be gradual increase in disease infection at post flowering to maturity stage which also affects yield and oil quality. The present investigation identified five lines *viz*., RSLP-18 (PDI=8), RSLP-22 (PDI=8), RSLP-98(PDI=7.5), RCB-19-9(PDI=7.5) and PM-160 (PDI=9) with resistant reaction to *Alternariaster* leaf spot whereas RSLP-89, RSLP-99 and PM7 recorded medium resistance reaction in post-flowering stage. Hence, identifying lines with less disease infection at post-flowering stage is critical in sunflower disease resistance breeding. These breeding lines can be used as resistant source in developing sunflower hybrids for *Alternariaster* leaf spot along with high seed yield and oil content.

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Identification of restorer lines for diversified CMS lines in Sunflower (*Helianthus annuus* L.)

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ABSTRACT

The material for the study consisted of three stable CMS lines *viz.*, CMS 103A, CMS104A, and CMS 38A as female lines and 50 new inbred lines as testers. All the three CMS lines and 50 inbred lines were crossed in a Line × Tester fashion and resultant 150 hybrids were evaluated for fertility restoration. Among common restorers across all three CMS lines, RCR-20-8 recorded highest gca for seed yield, oil content and plant height, followed by RCR-20-19 for head diameter and seed yield; RCR-20-13 for volume weight and early flowering. These lines can be used as testers for developing hybrids and also for development of new tester lines with combination of desirable characters.

Keywords: CMS lines, Line x tester, Restorer lines, Sunflower

Sunflower being a highly cross-pollinated crop ideally suited for exploitation of heterosis. The discovery of Cytoplasmic Male Sterility by Leclercq (1969) and fertility restoration by Kinman (1970) provided the required breakthrough in the development of hybrids. The practical utility of cytoplasmic male sterile lines realized when suitable maintainer and effective restoration lines are identified or developed. Commercial exploitation of cytoplasmic male sterility depends on the availability of stable restorers with good combining ability.

MATERIALS AND METHODS

The material for the study consisted of three stable CMS lines *viz.*, CMS 103A, CMS104A, and CMS 38A as female lines and 50 new inbred lines as testers. All the three CMS lines and 50 inbred lines were crossed in a Line × Tester fashion and resultant 150 hybrids were evaluated for fertility restoration. Evaluation for fertility restoration was done by recording presence/absence of anthers and pollen grains at the time of anthesis. Fertility restoration of male inbred lines was analyzed by visual observation for male sterility or fertility reaction of plants in their respective cross hybrids. The fertility restoration was confirmed by microscopic observation of pollen fertility by preparing anther smear in 1% Acetocarmine stain.

RESULTS AND DISCUSSIONS

For commercialization of hybrid technology, the limited availability of good restorer lines is the bottleneck (Sujatha *et al.*, 2011). In present study, 50 inbreds were categorized into restorer, maintainers and partial restorers based on their fertility restoration ability in hybrid combination (Vikas and Supriya, 2017). It is evident from the data that the probability of identifying the restorers out of new inbred lines screened with three different CMS lines, is 53.33 per cent, whereas probability of identifying maintainers from inbreds for three different CMS lines is 13.33%. Among 50 inbreds tested, 8 inbreds (RCR-20-2, RCR-20-7, RCR-20-8, RCR-20-3, RCR-20-19, RCR-20-17, RCR-20-11 & RCR-20-13) found to be common restorer for all three CMS lines and 5 inbreds (RCR-20-20, RCR-20-21, RCR-20-15, RCR-20-9 and RCR-20-10) were found to be maintainers for all three CMS lines. Among common restorers across all three CMS lines, RCR-20-8 recorded highest gca for seed yield, oil content and plant height, followed by RCR-20-19 for head diameter and seed yield; RCR-20-13 for volume weight and early flowering. These lines can be used as testers for developing hybrids and also for development of new tester lines with combination of desirable characters.

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Genome wide association studies reveals genetic loci associated with water logging tolerance in Soybean [*Glycine max* (L.) Merr.]

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ABSTRACT

In this investigation, a GWAS analysis was performed for four water logging tolerance traits in a panel of 265 soybean germplasm accessions with 66719 SNPs. A total of 29 SNPs and some candidate genes associated with different water logging tolerance traits were identified. This study also identified some soybean accessions, having superior water logging tolerance ability at vegetative and reproductive stages, which may be used as potential donors in soybean improvement programs.

Keywords: GWAS, Genotyping by sequencing, Germplasm Accessions, SNP, Soybean, Water logging

Water logging stress is the most destructive abiotic stress, affecting soybean production negatively in the country. Water logging stress is the major abiotic stress, threatens soybean production and limits soybean yield in India as well as world. The most appropriate approach to decrease the loss of yield due to excessive rains/water logging is the developing water logging tolerant cultivars with exploitation of contemporary genomic strategies (Chandra et al., 2020).Phenotyping of germplasm panel for the trait can identify the lines showing trait manifestation. The same germplasm panel if subjected to SNP analysis can identify SNPs associated with the trait segregation. In the present investigation, a germplasm panel of 265 accessions of soybean were screened for waterlogging tolerance and the same panel was genotyped using GBS and a total of 66719 SNPs were used for GWAS analysis after filtering to identify the SNPs associated with waterlogging tolerance.

MATERIALS & METHODS

In this study, a panel of 265 cultivated soybean germplasm lines was evaluated for vegetative stage - water logging tolerance during *Kharif* 2019(field), *Kharif* 2020(field) and *Kharif* 2021(pots) at ICAR-IISR, Indore. For this, soybean genotypes were phenotyped under water-logged conditions created at vegetative growth stages (V_2 - V_3) of plant by saturating the soil with water up to 10 cm above the soil surface in stressed plots/pots and maintained for 10 days (Chandra et al., 2022).Observations were recorded for four water logging tolerance traits i.e. plant survival rate (PSR), foliar damage score (FDS), stem elongation rate (SER) and adventitious root rating (ARR) in water logged fields/pots. The germplasm panel was genotyped using genotyping by sequencing approach and a total of 66719 SNPs were used for GWAS analysis after filtering.

RESULTS AND DISCUSSION

In this experiment, significant phenotypic variation for various water logging traits were observed among the genotypes in the panel. Genome wide association analysis using Mixed linear model (MLM) in TUSSEL 5.2 Software identified 29 significant SNPs for four waterlogging traits. A total of 20 GWAS loci were identified for plant survival rate for all three years, out of which 10 SNPs (Chr 6, Chr 10 &Chr 13), 6 SNPs (Chr 6, Chr 13 &Chr 15) and 4 SNPs (Chr 6, Chr 10, Chr 13 &Chr14) were significant for *Kharif* 2019, *Kharif* 2020 and *Kharif* 2021 respectively. Among these SNPs, three major SNPs i.e. Gm_13_33563377, Gm_13_33969566 and Gm_15_48546225 were found to be consistently coupled with plant survival rate across the multi-environments. Four SNPs were found to be associated with foliar damage score from chromosome 2, 6 and 16. Another four SNPs were identified from chromosome 7 and 9 which were linked to adventitious root rating and only one SNP (Chr 17) found to be linked with stem elongation rate. In this study, flanking regions of significant SNPs were searched for candidate genes. Some candidate genes related to oxidative stress, auxin and ABA synthesis pathway were identified in the genomic regions of significant SNPs positions. In this study, the genotypes which were identified as water logging tolerant at vegetative stage during all three years (2019, 2020 and 2021), were also tested for reproductive stage-water logging tolerance across multiple years, where some of the accessions i.e. TGX 317-37 E, JS 20-76, EC 389148, EC 456556, EC 456620 and EC 602288, were found to having water logging tolerance at both growth stages, so these genotypes can serve as potential donors in soybean breeding programs. This is the first report of genome wide association studies (GWAS) for water logging tolerance traits in soybean experimented in India. Identified potential donors, favorable SNPs and candidate genes for water logging tolerance would overlay the approach for soybean breeding program for water tolerance.

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Combining ability for various parameters in sunflowers as a classical breeding approach for superior hybrid development

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ABSTRACT

An experiment for estimating the combining ability in sunflower for various agronomic traits and oil content was carried out in 2021-22 at Punjab Agricultural University, Ludhiana, in which 91 hybrids were studied along with their parents, i.e., seven CMS lines and 13 high oleic testers. Significant positive and negative variations were noticed in GCA and SCA for characters like days to flowering initiation, fifty per cent flowering, plant height, head diameter, seed yield per plant and oil content. Dominant gene action was predominant for all these characters and high SCA was observed for high GCA × high GCA for flowering initiation, head diameter, and seed yield per plant and low GCA × high GCA for fifty per cent flowering, plant height and both high GCA × high GCA and low GCA × low GCA for oil content.

Keywords: Combining ability, GCA, Hybrid production, Sunflower, SCA

Heterosis breeding is one of the most important breeding techniques used in sunflowers, from as early as the 1920s in Russia, performed to increase the vigour of the first filial generation in comparison to its parents, and to get hybrids with high yield stability (Kaya *et al.*, 2015), and Sprague and Tatum (1942) were first to infer that combining ability acts as the best method to identify the combination of inbreds to cross for better hybrid production, by indicating the amount of heterosis with the minimum number of crosses. This heterosis study was carried out to estimate the magnitude of combining ability and selecting superior inbreds for various agronomic traits and oil content.

MATERIALS AND METHOD

To carry out this experiment for heterosis breeding and combining ability, seven CMS lines were crossed with thirteen high oleic tester lines in spring 2021, at the campus of Punjab Agricultural University, Ludhiana, and the resultant 91 hybrids were tested for various plant and yield parameters in Spring, 2022, in three replications, at the same location.

RESULTS AND DISCUSSION

The line × tester analysis of observed data indicates nine sources of variation, and detail of them with the mean sum of squares is presented in Table 1. The data shows significant positive GCA for two lines and five tester lines, while significant negative GCA for four lines and four testers, whereas 23 hybrids showed significant positive SCA and 19 hybrids showed significant negative SCA, for days of flowering initiation, with high SCA for the cross of high GCA × high GCA and predominance of dominant gene action. Similarly, two lines and three testers showed significant positive GCA, while, three lines and three testers showed negative GCA, and 18 hybrids with positive significant SCA and 18 with negative SCA, with high SCA for low GCA × high GCA, and dominant gene action, for fifty per cent flowering. For Plant height, positive significant GCA is shown by two lines and four testers, and negative significant GCA by two lines and three testers, while 22 hybrids are proved to have significant positive SCA and 21 hybrids showed significant negative SCA, with high SCA for low GCA × high GCA, and predominance of dominant gene action. In addition to the above, four lines and three testers have significant positive GCA while three lines and one tester had negative GCA effect, whereas 21 hybrids showed significant positive SCA, and 18 hybrids showed significant negative SCA for head diameter, with high SCA for high GCA × high GCA, and dominant gene action was most prevalent. In the same way, three lines and two lines show significant positive GCA, and three lines and four testers show negative GCA, while 22 hybrids show positive significant SCA and 24 showed negative significance, with high SCA for high GCA × high GCA and prevalence of dominant gene action. As for oil content, positive significant GCA was shown by four lines and six testers, and negative significant GCA was shown by two lines and three testers, while 19 hybrids showed positive SCA, with high SCA for high GCA × high GCA and low GCA × low GCA, the predominance of dominant gene action. The lines and testers with the highest GCA are presented in Table 2, and the best specific cross combinations are presented
in Table 3.

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Table 1 Analysis of Variation for combining ability for agronomic traits and oil content

Source	df	Days to flowering initiation	Days to fifty per cent flowering	Plant height	Head diameter	Seed yield per plant	Oil content
Replication	2	19.462462	38.642643	4099.5435*	96.47444	121.92670	29.692470
Treatments	110	31.366476*	24.141414*	825.8028*	39.61717*	329.08203*	23.186047*
GCA (Parents)	19	42.521930*	49.455263*	476.9263	22.85062*	16.46756	37.078639*
Parents vs. Crosses	1	109.194180	173.319475*	31110.0969*	1528.20801*	7562.25890*	86.043876
Crosses	90	28.146683*	17.139845 *	562.9624*	26.61687*	314.70978*	19.554746*
Lines	6	104.490842	60.422466	1269.2222	121.96705*	495.25490	67.817874
Testers	12	22.782662	14.318681	558.2814	32.59132	557.26430	38.096909
SCA (Lines X Testers)	72	22.678673*	14.003154*	504.8876*	17.67529	259.23861*	12.442458*
Error	220	7.029129	6.691127	230.1375	11.10390	60.34882	5.125987

* means significant at p=0.01 respectively

Table 2 Best General Combining Ability

Character	Line	GCA Effect for line	Tester	GCA Effect for tester
Days to flowering initiation	103A	2.278	HOHAL-17-1	0.883
Days to fifty per cent flowering	84A	2.004	HOHAL-85-3	-1.227
Plant height	88A	9.051	HOHAL-17-1	-11.282
Head diameter	86A	2.247	HOAL-30-2	2.869
Seed Yield per Plant	86A	4.101	HOAL-30-2	13.625
Oil content	73A	-1.610	HOHAL-85-3	-3.709

Table 3 Best Specific cross combination

Character	cross	SCA Effect	GCA for line	GCA for tester
Days to flowering initiation	73A × HOHAL-85-1	8.088	-1.516	0.168
Days to fifty per cent	73A × HOHAL-85-1	5.744	-1.458	0.154
flowering	73A × HOHAL-70-2	5.744	-1.458	1.154
Plant height	73A × HOAL-2-P_3	27.183	-7.564	6.766
Head diameter	103A × HOAL-30-2	5.985	1.211	2.869
Seed Yield per Plant	103A × HOAL-30-2	45.476	3.836	13.625
Oil content	84A × HOHAL-21-1	5.466	0.631	0.590

Identification of determinate sesame lines (*Sesamum indicum* L.): A step forward in vegetable oil

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ABSTRACT

An experiment was conducted at Bihar Agricultural University, Sabour, Bihar in the year 2020 and 2021 during summer season with 11 elite lines Sesame (*Sesamum indicum* L.) including two national checks (GT-10, TKG-22 and one zonal check JTS-08) to identify genotypes that had determinate habit so that the capsules matured uniformly. Three lines, BRT-04, BRT-08 and BRT-10, were identified as determinate plant type ones and BRT- 09 was identified as semi determinate type.

Keywords: Determinate type, Elite germplasm, Sesame

Oilseeds are the primary source of vegetable oils, and nine oilseeds are cultivated in the country of which seven are edible, i.e., soybean, groundnut, rapeseed-mustard, sunflower, Niger, sesame, safflower are edible ones and castor and linseed are non-edible. Sesame (*Sesamum indicum* L.) is one of the most important oilseed crops and is also the oldest crop known to humanity. It is a short duration crop grown throughout the year. Because of the presence of high antioxidants, sesame seeds are known as **"seed of immortality".** Sesame oil is one of the healthiest cooking oils because of rich source of oleic acid (40-50%) and linoleic acid (35-45%). It is a good source of micronutrients like Copper, calcium, and magnesium. It has high medicinal value, which is effective in reducing bad cholesterol level and known to be beneficial for Alzheimer patient.

MATERIALS AND METHOD

An experiment was conducted at Bihar Agricultural University, Sabour, Bihar in the year 2020 and 2021 during summer season. Station trial was conducted with 11 elite lines including two national checks (GT-10, TKG-22 and one zonal check JTS-08). The trial was conducted in a randomized block design with three replications. Plot size was 6.3sq m. (3m row length and 7 row). The data on days to maturity, seed per capsule, test weight and yield per hectare were collected and analysed.

RESULTS AND DISCUSSION

Three genotypes BRT-09-8 (1270 kg/ha), BRT-10-08 (1229 kg/ha) and BRT-08-8 (1182 kg/ha) were found to be significantly superior to the best check JTS-8 (902 kg/ha) and one genotype BRT-08 (1025kg/ha) was significantly superior to the check TKG-22 (829 kg/ha). One of the important characteristics' days to maturity of all the entries was found to be significantly superior from all check GT-10 (84 days) in earliness and the range was in between 72 to 78 days. Three lines were identified as determinate plant type i.e., BRT-04, BRT-08 and BRT-10, while BRT- 09 was been identified as semi-determinate plant. Determinate type helps in uniform ripening of capsules. Seed/capsule was also significantly superior in these lines compared to checks. Test weight were observed at par with JTS-8 that gave the highest seed weight among the checks (3.29g).

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Genotype	Seed yield (kg/ha)	Days to Maturity	No. of seeds/capsule	Test weight (g)
BRT-04	1217	75	52	3.05
BRT- 12	1026	79	53	3.05
BRT-08	1360	78	58	2.92
BRT-08-08	1053	79	68	2.86
BRT-09	1100	79	55	3.19
BRT-09-08	905	80	69	3.04
BRT-10	1312	77	56	3.15
BRT-10-08	1026	81	71	2.94
GT-10 (C)	936	89	54	3.17
TKG-22(c)	862	92	59	3.22
JTS-8(c)	905	95	56	3.23
CD at .05	156			
CV %	8.64			

Management of soil borne diseases of safflower through seed dressing with new fungicide molecules and biopolymer based Trichoderma

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ABSTRACT

A field experiment was conducted for two consecutive *rabi* seasons during 2020-21 and 2021-22 to evaluate the new fungicide molecules and biopolymer based *Trichoderma* as a seed dressers for management of soil borne diseases of safflower. Among the different treatments, seed treatment with Penflufen 13.28% w/w + Tryfloxistrobin 13.28%w/w FS @ 1ml/kg seed was found most effective as it recorded significantly highest germination (96.5%), least incidence of Fusarium wilt (5.4%) and Macrophomina root rot (5.6%) and significantly highest seed yield (1103 kg/ha), net monetary returns (Rs.33940/-) and B:C ratio (2.69), however, it was statistically at par with seed treatment of biopolymer based *T. harzianum*, Th4d@10 ml/kg seed (1017 kg/ha) and seed treatment with *T. harzianum*, Th4d WP @ 10g/kg seed (948 kg/ha) for seed yield.

Keywords: Biopolymer based *T. harzianum*, New fungicides, Safflower, Seed dressing,

Safflower crop suffers from many soil borne diseases starting from seed germination to crop maturity leading to considerable yield losses. The wilt caused by *Fusarium oxysporum* f.sp. *carthami* is reported to lead yield losses up to 80%, while the soil borne, *Macrophomina* spp., causes root rot in safflower leading to considerable yield losses. With this view, the present investigation was undertaken to evaluate the new fungicide molecules and biopolymer based *Trichoderma* as a seed dressers for management of soil borne diseases of safflower.

MATERIALS AND METHODS

A field experiment was conducted in randomized block design with three replications during *rabi* season of 2020-21 and 2021-22 to evaluate the new fungicide molecules and biopolymer based *Trichoderma* having known biocontrol potential and commercialized by ICAR-Indian Institute of Oilseeds Research, Hyderabad for management of soil borne diseases of safflower. The safflower variety, PBNS-12 was sown during 2nd fortnight of September at 45 x 20 cm spacing with the gross plot size of 2.25 x 4.0 m and net plot size of 1.35 x 3.60 m and 50: 25 kg N and P_2O_5 per hectare were applied at the time of sowing as basal dose. The fungicidal and bioagent seed treatment was given at the time of sowing.

RESULTS AND DISCUSSION

The results in respect of germination, disease incidence, seed yield and economics of safflower are presented in Table 1. Among different treatments, the seed treatment with Penflufen 13.28% w/w + Tryfloxistrobin 13.28%w/w FS @ 1ml /kg seed was found most effective as it recorded significantly highest germination (96.5%) and least incidence of Fusarium wilt (5.4%) and Macrophomina root rot (5.6%). The next effective treatments against Fusarium wilt and Macrophomina root rot control were seed treatment with biopolymer based *Trichoderma harzianum*, Th4d @10ml/kg seed (8.5% and 8.1%, respectively) and seed treatment with *Trichoderma harzianum*, Th4d WP @ 10g/kg seed (9.7% and 9.1%, respectively). The data on seed yield of safflower showed that seed treatment with Penflufen 13.28% w/w + Tryfloxistrobin 13.28%w/w FS @ 1 ml /kg seed recorded significantly highest seed yield (1103 kg/ha), however, it was statistically at par with the seed treatment of biopolymer based *T. harzianum*, Th4d@10 ml/kg seed (1017 kg/ha) and seed treatment with *T. harzianum*, Th4d WP @ 10g/kg seed (948 kg/ha). The cost-benefit analysis of different seed treatments showed that seed treatment with Penflufen 13.28% w/w + Tryfloxistrobin 13.28%w/w FS @ 1 ml /kg seed recorded highest net returns of Rs.33940/- and B:C ratio of 2.69 followed by seed treatment with biopolymer based *T. harzianum*, Th4d @10 ml/kg seed (Rs.29783/-, 2.49) and seed treatment with *T. harzianum*, Th4d WP @ 10g/kg seed (Rs.26422/, 2.32).

In the present investigation, most effective and economical management of soil borne diseases of safflower and higher seed yield could be obtained by seed treatment with Penflufen 13.28% w/w + Tryfloxistrobin 13.28%w/w FS @ 1 ml /kg or seed treatment with biopolymer based *T. harzianum,* Th4d @10 ml/kg seed. Prasad and Anjani (2008) reported that seed treatment with *Trichoderma harzianum* and *T. viride* @ 10g/kg seed was very effective in reducing wilt incidence and increased the seed yield under field conditions. Moreover, Murumkar *et al*. (2016) reported that Cymoxanil 8% + Mancozeb 64% @ 2 g/kg or *Trichoderma harzianum* Th4d SC @ 1 ml/kg seed was found effective for the management of Phytophthora seedling blight of safflower. Furthermore, Murumkar *et al*. (2020) reported that seed biopriming with *Trichoderma harzianum* Th4d WP @ 10g/litre water for 12 hrs was found most effective and economical for seed/soil borne diseases of safflower. The results of the present investigation are also in agreement with these findings.

From the above study, it could be concluded that seed treatment with Penflufen 13.28% w/w + Tryfloxistrobin 13.28%w/w FS @ 1 ml /kg seed or biopolymer based *T. harzianum,* Th4d @10 ml/kg seed was found most effective and economical for management of soil borne diseases of safflower.

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Table 1 Effect of new fungicide molecules and biopolymer based Trichoderma seed treatments on disease incidence, seed yield and economics of safflower under dryland conditions (Pooled data: 2020-21 and 2021-22)

Treatments	Germination (%)	Disease incidence (%)*		Seed yield (kg/ha)	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	B:C ratio
		Fusarium wilt	Macrophomina root rot					
Seed treatment with Tebuconazole 5.4% w/w FS @ 0.4 ml/kg seed	88.9	16.0	12.3	833	40857	20110	20747	2.04
Seed treatment with Fluxapyroxad 333 G/L FS @ 1ml /kg seed	90.2	16.0	12.4	829	40602	20194	20408	2.03
Seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 2.0 g /kg seed	90.4	12.8	11.2	886	43415	20156	23259	2.17
Seed treatment with Penflufen 13.28% w/w + Tryfloxistrobin 13.28%w/w FS @ 1 ml /kg seed	96.5	5.4	5.6	1103	54107	20167	33940	2.69
Biopolymer based *Trichoderma harzianum* Th4d @10 ml/kg seed	93.0	8.5	8.1	1017	49897	20114	29783	2.49
Seed treatment with *Trichoderma harzianum* Th4d WP @ 10g/kg seed	91.9	9.7	9.1	948	46536	20114	26422	2.32
Control (untreated)	86.7	24.2	18.1	656	32184	20084	12100	1.61
C.D. at 5%	3.1	2.3	1.6	195				

*Figures in parentheses are arcsine values. Market rates: Safflower- ₹ 5300/q; *Trichoderma harzianum* - ₹ 300/kg; Tebuconazole 5.4% FS- ₹ 330/50ml; Fluxapyroxad 333 G/L FS – ₹ 440/40 ml; Thiophanate methyl 45% + Pyraclostrobin 5%FS - ₹ 1440/400 ml; Penflufen 13.28% w/w+Trifloxystrobin 13.28% w/w FS- ₹ 330/40 ml

Phule Gold (SSF 15-65): A new high oil and high oil yield variety of Safflower (*Carthamus tinctirius* L.), suitable for cultivation in India

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ABSTRACT

Safflower (*Carthamus tinctorius* L.) variety Phule gold (SSF-15-65) is derived by hybridization through pedigree selection method from a cross of Bhima x GMU 2724. It has semi-spreading habit with medium bold seeds. The variety is moderately tolerant to aphids and wilt. In various multilocation Coordinated trials conducted during 2017-18, 2018-19 and 2019-20 i. e. for 3 years, Phule gold (SSF-15-65) consistently recorded better performance over national check A1 and PBNS-12. Phule gold (SSF-15-65) recorded 24.80% higher oil yield over A1 and 17.10% over the check PBNS-12. The average oil content was 34.60 %. It was responsive to higher doses of fertiliser and late sown conditions. The variety was released and notified in 2020 for rainfed and irrigated safflower growing areas of the country (Maharashtra, Karnataka and Telegana state).

Keywords: High oil content, High oil yield, Phule Gold, Safflower variety, SSF 15-65

Safflower (*Carthamus tinctorius* L.) is an important *rabi* oilseed crop of the country. The area under safflower in India was 0.56 lakh ha, having 0.35 lakh ton production and productivity of 640 kg/ha (Anonymous 2020-21). In Maharashtra it is grown over an area of 0.21 lakh ha with production 0.12 lakh ha and average yield of 569 kg/ha. A numbers of high yielding spiny varieties, *viz*., Tara, Bhima, SSF 658, SSF 733, SSF 748, SSF 708, SSF 13-71 and SSF 12-40 from 1976 to 2019have been released for commercial cultivation *viz.,*. The area under this crop is declining due to several reasons. The availability of seed of high oil with high yielding variety of the crop is one of the reasons. To develop the high yielding with high oil variety, the work was under taken. The spiny genotype Phule gold (SSF-15-65) was developed by AICRP on Safflower, Solapur and has been promising better than existing spiny varieties.

MATERIALS AND METHODS

The spiny variety Phule gold (SSF-15-65) is developed by pedigree method from the cross between Bhima x GMU 2724 at All India Coordinate Research Project on Safflower, Dry Farming Research Station, Solapur. The Phule gold (SSF-15-65) was tested at 20 location in coordinated trials viz. IVT, AVT-I and AVT-II during rabi 2017-18 to rabbi 2019-20 under irrigated and rainfed conditions. The observation was recorded for seed yield, oil yield and ancillary data and comparison was made with spiny checks A1 and PBNS-12. The recommended packages of practices were followed while conducting the trial. The variety was also screened for its agronomical adaptability to different cropping situations, disease and pest reaction under artificial and natural condition at different coordinated centres all over India and the observation regarding its adaptability to different agronomical situation, disease and pest reaction were assessed.

RESULTS AND DISCUSSION

The variety Phule gold (SSF-15-65) recorded high oil yield (575.0 kg/ha) as compared to the check A1 (460.0 kg/ha) and PBNS-12 (490.0 kg) which was 24.80 % and 17.10% high over the check respectively (Table 1). This variety also exhibited significantly superior oil yield over both the spiny checks in coordinated trials at different locations for three successive years. The data presented in Table 2 indicated that the new variety Phule gold (SSF-15-65) also gives high oil % (34.60) which was higher by 24.05% and 18.76% over the check A1(27.80) and PBNS 12(30.06).. The genotype is moderately tolerant to aphid. The incidence of alternaria leaf spot and wilt in Phule gold (SSF-15-65) is comparable with the check with yield advantage. In agronomic trial the spacing of 45 x 20 cm was optimum. The 50% higher dose than recommended fertilizer recorded higher seed yield it different fertilizer trials indicating better response to higher fertilizer application. In the trial on different sowing dates, the genotypes also showed better performance up to mid-October sowing. The seed is white in colour, contains 35% percent oil. Considering the higher oil yield and performance in agronomic adaptability trials, the genotype Phule gold (SSF-15-65) was identified in Varietal Identification Committee held at Hyderabad on 13-14 August 2020 for cultivation in both irrigated as well as rainfed situations of the country.

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Table 1: Summery of oil yield of Phule gold (SSF-15-65) in Coordinated trials

Year of testing	Number of trials	Oil yield (kg/ha)			% increase over	
		SSF 15-65	A1 (C)	PBNS12 (C)	A1 (C)	PBNS12 (C)
2017-18	8	601	575	527	16.70	14.04
2018-19	6	570	409	448	39.36	27.23
2019-20	6	544	439	484	23.92	12.40
Total	20					
Weighted mean		575	460	490	24.00	17.10

Table 2. Summary Oil Content data in Coordinated Varietal Trials

Quality Characteristic	SSF 15-65	National Check A1	Zonal Check PBNS-12	% increase over	
				A1 (C)	PBNS12 (C)
First Year (2017-18)	34.60	28.60	29.10	-	-
Second year (2018-19)	33.60	26.20	28.00	-	-
Third Year (2019-20)	35.64	28.23	30.29	-	-
Mean	34.60	24.05	29.13	24.05	18.76

Mechanized cultivation in safflower (*Carthamus tinctorius* L.)

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ABSTRACT

The objective was to introduce mechanization in safflower based cropping systems and compare it with traditional method without mechanization and work out energy budgeting and economics. The un-replicated field experiment was conducted in the year 2018-19, 2019-20 and 2020-21 with two sets of treatments (mechanization and farmer's practice) on an area of 25x70 sq.m. The safflower variety SSF 708 was sown in 45x20 cm spacing. Mechanized cultivation in safflower recorded significantly higher yield of safflower than farmer practice. The seed yield increase was 13.9% under mechanized condition than farmer's practice. About Rs 5000/ha and time was saved in mechanized condition.

Keywords: Mechanized harvesting, Safflower, SSF 708

Safflower (*Carthamus tinctorius* L.) is an important *rabi* oilseed crop of the country. The area under safflower in India is 0.56 lakh ha, having 0.35 lakh ton production and productivity of 640 kg/ha (Anonymous 2020-21). In Maharashtra, it is grown in an area of 0.21 lakh ha with production 0.12 lakh tonnes at an average yield of 569 kg/ha. A number of high yielding spiny varieties, Tara, Bhima, SSF 658, SSF 733, SSF 748, SSF 708, SSF 13-71, and SSF 12-40have been released between 1976 and 2019 for commercial cultivation *Viz.*, . To introduce mechanization in safflower based cropping system and compare it with traditional method without mechanization and work out energy budgeting and economics, the said trial was conducted at AICRP on Safflower, Solapur

MATERIALS AND METHOD

The field trial on Comparative performance of safflower under selective mechanization *vis-à-vis* Farmers practice in terms of seed yield, economics and energy budgeting was conducted at AICRP on Safflower, Solapur during 2020-21. The sowing was done with the help of bullock drawn ferti-cum-seed drill and tractor (kubota) drawn multispeed drill. All the operations were carried out as per the treatments and the time required and the cost incurred thereon was worked out. The plot wise yield was recorded at the time of harvest and the economics was worked out.

RESULTS

The selective mechanized plot was found more effective in respect of labour time and cost saving over farmer's practice in all the operations. The mechanized sowing allows the placement of seed and fertilizer in a single time at pre fixed plant spacing. Hence, the cost on thinning was reduced. The mechanical cultivator was found more cost effective than bullock/ manual interculturing or hoeing. The harvesting was done as per the treatments and the yield was recorded. The selective mechanized plot with 13.9% superiority has recorded higher seed yield (1178 kg/ha) than that of farmers practice (1034 kg/ha). Common growth parameters viz. plant height, branches, 100 seed weight and the volume weight were also found superior over farmers practice.

Maintenance of plant geometry might have allowed the lesser competition of adjacent plants. The selective mechanized plot was found more effective in respect of labour, time and cost saving over farmer's practice in all the operations. The mechanized sowing allows the placement of seed and fertilizer in a single time at pre fixed plant spacing. Specialized mechanization practice having less time and labour consuming (Singh, 1968). Hence, Mechanization in safflower is found profitable over farmer practice.

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Pritam bhutada, et all Mechanized cultivation in safflower (*Carthamus tinctorius* L.) *J. Oilseeds Res., 37 (Special Issue), Feb.*, 2020:156-157

Table 1 Comparative data on time and cost required under farmers practice and mechanized operations

Operation	Time required (plot^{-1})		Cost incurred (Rs plot^{-1})		Cost incurred (Rs ha^{-1})	
	Selective Mechanized Plot	Farmers Practice	Selective Mechanized Plot	Farmers Practice	Selective Mechanized Plot	Farmers Practice
Sowing	90 min	150 min	550	720	2932	3838
Inter cultivation	1 male for 2 hrs	4 women 8 hrs	292	800	1556	2665
Need based plant protection	2 x 1.5 hr	1	450	600	2399	2932
Harvesting and threshing	1.0	6	600	1000	3198	5863
Winnowing	-	1	1892	3320	10084	15297

Table 1: Comparative data on seed yield, growth and economics of safflower under different treatments

	Selective Mechanized Plot	Farmers Practice
Seed yield (kg ha^{-1})	1178 kg	1034 kg
Plant height (cm)	76.9	56.8
number of branches plant^{-1}	12.8	9.7
number of capitula plant^{-1}	22.9	17.6
Weight of capitula (g)	28.4	23.9
Length of roots (cn)	31.7	42.1
Dry weight of roots (g)	6.42	5.02
Common Yield attributes (Mean of 5 plants)		
100-seed weight (g)	5.86	5.33
Volume weight (g lit^{-1})	716.3	692.1
Economics		
Gross returns (Rs/ha)	56544	49632
Net returns (Rs/ha)	37595	29443
Cost of cultivation (Rs/ha)	18949	20189
B: C ratio	2.98	2.46
Selling Rate (Rs./q)	4800	4800

Phule Kiran (SSF 16-02): A new spiny and high yield Safflower variety for rainfed and irrigated conditions of the country

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ABSTRACT

A Safflower variety Phule Kiran (SSF 16-02) derived through the pedigree selection method from a germplasm GMU-2757 was evaluated in station trial for yield during 2015-16 and tested in University multilocation varietal trial during 2016-17, simultaneously; it was evaluated in All India Coordinated Varietal Trial from 2017-18, 2018-19, and 2019-20. Based on the performance in station, university multilocation varietal trial, and coordinated trials, Phule kiran (SSF 16-02) recorded 9.84 % and 17.47 higher yield over the check A1 and PBNS 12 respectively. Also SSF 16-02 recorded 14.98 % and 18.67 % higher oil yield over the checks A1 and PBNS 12 respectively. It was responsive to higher doses of fertiliser and late sown conditions. The variety Phule kiran (SSF 16-02) was identified in Annual Group Meeting held at IIOR, Hyderabad during 13-14th August 2020 for rainfed and irrigated safflower growing areas of the country (Maharashtra, Karnataka, Madhya Pradesh, Chhatisgad and Telegana state).

Keywords; Genotype and Phule Kiran (SSF 16-02), Safflower

Safflower (*Carthamus tinctorius* L.) is an important *rabi* oilseed crop of the country. The area under safflower in India was 0.56 lakh ha, having 0.35 lakh ton production and productivity of 640 kg/ha (Anonymous 2020-21). In Maharashtra it is grown over an area of 0.21 lakh ha with production 0.12 lakh tonnes and average yield of 569 kg/ha. Many high yielding spiny varieties have been released for commercial cultivation between 1976 and 2019. The area under this crop is declining due to several reasons. The availability of seed of high oil with high yielding variety of the crop is one of the reasons. To develop the high yielding with high oil variety, the work was under taken.

MATERIALS AND METHODS

The spiny variety Phule Kiran (SSF 16-02) is developed by selection method from a Selection of germplasm GMU-2757 at All India Coordinate Research Project on Safflower, Dry Farming Research Station, Solapur. The Selection from GMU-2757 was tested at 26 location in coordinated trials viz. IVT, AVT-I and AVT-II during rabi 2017-18, 2018-19 and 2019-20 under irrigated and rainfed conditions. The observation was recorded for seed yield, oil yield and ancillary data and comparison is made with spiny check A1 and PBNS-12. The recommended packages of practices were followed while conducting the trial. The variety is also screened for its agronomical adaptability for different cropping situation disease and pest reaction under artificial and natural condition at different coordinated centre locations all over the India and observation regarding its adaptability to different agronomical situation, disease and pest reaction were noted.

RESULT AND DISCUSSION

The seed yield performance of Phule Kiran (SSF 16-02) was presented in Table 1 showed that the variety Phule Kiran (SSF 16-02) recorded high seed yield (2058 kg/ha) as compare to the check A1 (1872 kg/ha) and PBNS-12 (1884 kg) which was 9.89 % and 9.20 % high over the check respectively. The new variety Phule Kiran (SSF 16-02) exhibited significantly superior oil yield over both the spiny checks in coordinated trials at different locations, the variety Phule Kiran (SSF 16-02) recorded high oil yield (591 kg/ha) as compare to the check A1 (514 kg/ha) and PBNS-12 (498 kg) which was 14.98 % and 18.67 % high over the check respectively.

The data presented in Table-2 indicated that the new variety Phule Kiran (SSF 16-02) also gives high oil % (30.55) which was higher over the check A1 (27.98) and PBNS 12(29.38). The genotype is moderately tolerant to aphid. The incidence of alternaria leaf spot and wilt in SSF 13-71 is comparable with the check with yield advantage. In agronomic trial the spacing of 45 x 20 cm was optimum. The seed is without papus and is white in colour, contains 29.20% percent oil. The variety is tolerant to aphid and resistant to Fusarium Considering the higher seed and oil yield and performance in agronomic adaptability trials. The variety Phule Kiran (SSF 16-02) was identified in Varietal Identification Committee held at Hyderabad on 13-14 August 2020 for cultivation in both irrigated as well as rainfed situations of the country.

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Table 1: Summery of seed yield of SSF 16-02 in Coordinated trials

Year of testing	Number of trials	Seed yield (kg/ha)			% increase over	
		SSF 16-02	A1 (c)	PBNS12(c)	A1 (c)	PBNS12 (c)
2017-18	10	2039	1955	2029	4.51	0.49
2018-19	08	2080	1859	1800	11.89	15.56
2019-20	08	2058	1782	1787	15.49	15.17
Total	**26**					
Weighted mean		2058	1872	1884	9.89	9.20

Table 2. Summary Oil Content % data of Coordinated Varietal Trials

Quality Characteristic	Proposed Variety SSF 16-02	National Check 1 A1	Zonal Check 2 PBNS-12
2017-18	31.00	28.80	29.60
2018-19	30.00	26.80	28.5
2019-20	30.56	28.08	30.05
Mean	30.55	27.98	29.38

Identification of resistant sources against *Fusarium* wilt of safflower

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ABSTRACT

A field evaluation of 37 advanced generation breeding material and parental lines of safflower was carried out under wilt sick plot condition at Solapur, Tandur and IIOR, Hyderabad for identifying resistant sources against Fusarium wilt. Four genotypes *viz*., GMU-5032, GMU-4109, SAF-19-20, and SAF-19-09 were found resistant to Fusarium wilt at all three locations. These resistant sources can be used in breeding programme for development of a variety resistant to Fusarium wilt.

Keywords: Fusarium wilt, Safflower genotypes, Screening, Wilt resistant

The safflower wilt causes yield loss up to 93% in susceptible varieties (Sastry and Ramchandram, 1994). Use of wilt-resistant cultivars is the most effective strategy for sustainable safflower cultivation (Kalpana Sastry and Ramachandram, 1992). To fulfil this need, efforts were made to test the promising safflower genotypes in wilt sick plots of different locations for identifying the resistant sources to *Fusarium* wilt.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2019-20 and 2020-21 testing 37 promising safflower genotypes against Fusarium wilt disease in the wilt sick plots of different AICRP safflower centres *viz.*, Solapur (M.S.), Tandur (T.S.) and IIOR, Hyderabad (T.S.) in India employing randomized block design with three replications. The inoculum load of *Fusarium oxysporum* f.sp. *carthami* in the wilt sick plot was 5 X 10^5 cfu g^{-1} of soil.

RESULTS AND DISCUSSION

At Solapur, five entries *viz.*, GMU-4109, SAF-19-20, SAF-P-1906, SAF-19-09 and GMU-5032 were resistant (wilting < 10%) and three entries *viz.*, PBNS-191, GMU-824 and SAF-P-1904 were moderately resistant to Fusarium wilt. At Tandur, two entries *viz.*, GMU-5032 and SAF-P-1904 were resistant to Fusarium wilt, while five entries *viz.*, PBNS-191, GMU-4109, SAF-19-20, GMU-824 and SAF-19-09 were moderately resistant to Fusarium wilt disease. At IIOR, Hyderabad, the entry GMU-824 was free from wilt, while five entries *viz.*, PBNS-191, GMU-4109, SAF-19-20, SAF-19-09 and GMU-5032 were resistant to Fusarium wilt.

Table 1 Screening for confirmation of resistance to Fusarium wilt of safflower (2020-21)

S.No.	Entry	Wilt incidence (%)		
		Solapur	Tandur	IIOR, Hyderabad
1.	PBNS-191	12.7	12.2	8.7
2.	GMU-4109	8.2	12.5	3.1
3.	SAF-19-20	7.0	15.0	9.5
4.	SAF-P-1906	5.8	25.7	21.0
5.	GMU-824	13.0	15.4	0.0
6.	SAF-19-09	7.4	14.3	7.7
7.	GMU-5032	7.5	4.6	2.1
8.	SAF-P-1904	12.2	2.3	43.0
9.	Nira (SC)	100.0	100.0	100.0
10.	TSF-1 (RC)	9.3	0.0	12.0

SC = Susceptible check TC = Tolerant check

Eight entries *viz.*, PBNS-191, GMU-4109, SAF-19-20, SAF-P-1906, GMU-824, SAF-19-09, GMU-5032, and SAF-P-1904 found promising against Fusarium wilt at all three locations (Solapur, IIOR, Hyderabad and Tandur) were further screened in confirmation trial during 2020-21 (Table 1). Out of eight entries screened against Fusarium wilt disease, four entries *viz*., GMU-5032, GMU-4109, SAF-19-20 and SAF-19-09 were found resistant against Fusarium wilt at all three locations (Solapur, IIOR, Hyderabad and Tandur). These results are in conformity with Murumkar *et al*. (2012) who screened 15 promising safflower genotypes for their reaction to Fusarium wilt in the wilt sick plots of Solapur, Tandur and Phaltan locations and reported that the genotype GMU-3771 showed complete resistance against Fusarium wilt at all the three locations.

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Present status of major diseases of sunflower in Northern East Dry Zone of Karnataka

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ABSTRACT

A Fixed plot survey was conducted to assess the severity of Alternaria leaf blight, Sunflower necrosis disease, Powdery mildew and Sunflower leaf curl disease during Rabi 2020-21 and Kharif 2021 in Raichur, Koppal and Gulbarga districts of North Eastern Karnataka. The survey results revealed that disease severity was noticed in all locations surveyed. In surveyed area, the PDI of *Alternariaster* leaf spot was ranged from 42.2 % to 72.8 %. Sunflower necrosis disease incidence ranged from 3.5 to 21.9%. Whereas, during rabi 2020-21 powdery mildew PDI ranged between 30.0 to 75 per cent and leaf curl ranged between 0 to 18.7 per cent in three districts surveyed.

Keywords: Diseases, Sunflower, Survey, Karnataka

Sunflower (*Helianthus annuus* L.), a member of compositae family is the second most important edible oilseed crop next to soybean in the world. Sunflower is one of the most important edible oilseed crops in India. More than 30 diseases have been identified on sunflower (Gulya *et al.,* 1994). Among these diseases *Alternaria* leaf blight, Powdery mildew, Sunflower necrosis and Sunflower Leaf curl are major diseases found in North Eastern Dry Zone of Karnataka.

In India, Leaf blight caused by *Alternaria helianthi* is the most devastating disease in Karnataka. The disease is known to cause more than 80 per cent of yield loss under severe epiphytotic conditions in Northern Karnataka (Shankergoud *et al*., 2006). Sunflower necrosis disease (SND) is a potential threat in all traditional sunflower growing areas in India. Sunflower leaf curl disease caused by begomovirus of the geminiviridae family was reported for the first time from Main Agricultural Research Station (MARS), University of Agricultural Sciences (UAS) campus, Raichur, Karnataka, India.The loss due to powdery mildew is proportionate to the diseases intensity and varies considerably depending on the stage of the plant growth at which disease occurs (Dinesh et al., 2010).

It is quite essential to undertake survey and surveillance of the disease in every year which helps us to know the rhythmic changes in regional severity and status of the disease. Hence, in this study, a roving survey has been made to document the disease severity in major districts of North Eastern Karnataka, India.

MATERIALS AND METHODS

A Fixed plot survey for severity of Alternaria leaf blight in sunflower was taken in major sunflower growing areas during Rabi 2020-21 and Kharif 2021 in two taluks of Raichur, three taluks of Koppal, and two taluks of Kulbargi. In each taluka, minimum of three villages were selected and in each village three farmers' fields and in each field five spots were selected per acre to assess the severity of the disease. The survey was carried during vegetative to harvesting stage. Per cent severity of the disease was recorded in each field and averaged for each village. Scoring of the disease was done in field by using 0-9 scale given by Mayee and Datar (1986).

PERCENT DISEASE INDEX

The per cent disease index (PDI) was calculated by using the formula given by Wheeler (1969).

$$\text{PDI (\%)} = \frac{\text{Summation of all numerical ratings}}{\text{Total number of plants x maximum rating scale observed}} \text{x 100}$$

Sunflower Necrosis Disease and Sunflower leaf curl Disease: Observations on type of symptoms, time taken for local and systemic infection, per cent disease incidence (PDI) and disease severity (DS) were recorded.

$$\text{PDI (\%)} = \frac{\text{Number of plants infected}}{\text{Total number of plants}} \text{x } 100$$

RESULTS AND DISCUSSION

Survey conducted during *rabi* 2020-21 revealed that, in Raichur, the powdery mildew ranged between 21 to 75 per cent. Highest was recorded at Lingasugur rural followed by MARS Raichur. The powdery mildew severity was quite high in the fields with dense population and under the shade of the trees. Similar observations were made by Kolte (1985) and opined that cool temperature and low relative humidity was reported to cause severe epidemics of powdery mildew of sunflower. The incidence of necrosis was within 3 to 20.8 per cent. Leaf curl was within 0-18.7 per cent. Highest necrosis (20.8%) and leaf curl (18.7%) was recorded in Kalapur village of Lingasugur taluk. In Koppal district, powdery mildew disease ranged from 17.3 per cent to 62 per cent and highest was recorded at Nawalhalli village. Regarding necrosis, it ranged between0 per cent to 12.7 per cent and highest incidence was recorded at Mornal village of Koppal taluka. With respect to leaf curl incidence, it ranged from 0 to 17.8 per cent and highest was at Mornal village.

Survey conducted during *kharif* 2021 revealed that, in Raichur highest *Alternariaster* leaf spot was 72.8% at MARS and least was in 49.3 % in Hedginal village of Sindhnoor Tq. Highest incidence of necrosis 21.9 % was noticed in Gurugunta village of Lingsugur taluk, and least was observed in Kalmal village (7.6 %) of Raichur Tq. The results confirmed with earlier reports of Mesta et al (2009) conducted survey during 2004 to 2006 in North Karnataka districts and reported that Alternaria leaf blight disease was ranges from 13.10 per cent to 45.60 per cent in sunflower crop.

In Kalburagi district highest PDI of *Alternariaster* leaf spot (52.3%) was recorded in Melkunda village of Aland Tq. and lowest PDI of *Alternariaster* leaf spot (42.5%) was recorded in Kadaganchi village of Kalburagi Tq. Highest disease incidence of necrosis (13.9%) was recorded in Melkunda village of Aland Tq. and lowest necrosis disease incidence (3.5%) was recorded in Narona village of Kalburagi Tq. In Koppal district highest PDI of *Alternariaster* leaf spot 57.6% was recorded in Wadganal village of Koppal taluk and highest necrosis disease incidence of 18.2% in Ozanhalli village of Koppal district. Similarly, Shirshikar (2002), recorded that sunflower sown in July, January and February had maximum disease incidence. However, September, October, November and December sowings showed relatively lower necrosis incidence (less than 4%).

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Selection of sunflower inbreds based on stability analysis using AMMI model

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ABSTRACT

Stability analysis for seed yield and oil content using AMMI model was carried among 44 sunflower inbreds evaluated in four growing seasons from spring 2018 to 2021. Higher variation was observed among the inbreds for seed yield in comparison to oil content across the years. As per AMMI analysis the genotype x environment interaction was partitioned into three principal component axis among which IPCA1 explained 48.7 % and 59.1% variation for seed yield and oil content respectively. Inbreds LTRR 341, RHA 265, P 147R, RHA 83R6, OPH 73 and P 107R P1 were found stable for seed yield whereas, OPH 98, OPH 99, OPH 118, OPH 90, OPH 73 and LTRR 341 were found stable for oil content.

Keywords: AMMI model, Inbreds, Stability analysis, Sunflower

Sunflower has wider adaptability across various climatic and temporal conditions due to higher inherent variability present among its germplasm. However, the crop expression may vary with variations among the environments. Additive main effects and multiplicative interaction (AMMI) model is well established tool in diagnosing the genotype x environment interactions. The informative biplots assist in identification of both stable inbreds, as well as the better performing inbreds in any specific environments (Cvejic *et al.*, 2019).

MATERIALS AND METHODS

The material under present study included 44 sunflower inbreds which were evaluated with respect to yield and oil content for four consecutive years at sunflower experimental area, Punjab Agricultural University, Ludhiana from 2018-2021. The inbreds were raised in two rows of 3m with spacing of 60 cm x 30 cm. Data for seed yield/plant (g) was observed from 5 randomly selected plants and average was recorded whereas for estimation of oil content 5g seed sample for taken at random. Adaptability and phenotypic stability analyses were performed using AMMI model by utilizing agricolae and metan package of R software.

RESULTS AND DISCUSSION

Seed yield per plant exhibited significant variation whereas, moderate variability existed for oil content. Analysis of variance using AMMI model revealed that only inbred main effect and environment main effects were significant while differences between inbred x environment interactions were non- significant for both seed yield per plant as well as oil content. The genotype x environment interaction was partitioned into three interaction principal component axis explaining 48.7%, 28.9% and 22.4% variation respectively. As per the AMMI analysis PC1, the inbreds showing higher stability for seed yield when plotted against PC1 were LTRR 341, RHA 265, P 147R, RHA 83R6, OPH 73 and P 107R P1 (Fig. 1). The biplot for PC1 and PC2 revealed that a total of 77.6% of variation was explained by these two components. The environments 2018, 2019 and 2021 were revealed as mega-environments (Fig 2) and helped in identification of high yielding inbreds in each location. In 2018, OPH 45 and OPH 109 were best performing, while in 2019, OPH 150 was best inbred and in 2021 high yielding inbreds were SF 3R, RHA 6DI and OPH 139. For oil content the variation explained by three IPCA were 59.1%, 30.3% and 10.6% respectively. Inbreds with higher stability for oil content as per Fig. 3 were OPH 98, OPH 99, OPH 118, OPH 90, OPH 73 and LTRR 341. For oil content environments 2018 and 2019 were similar in comparison to both 2020 and 2021. The inbreds with higher oil content during 2018 and 2019 was OPH 74 whereas for 2020 promising inbreds for oil content were OPH 92 and OPH 76. Overall highest yielding inbreds were OPH 137, OPH 75, OPH 76, OPH 90, OPH 86 and OPH 102, furthermore, the inbreds with high oil content RHA 83R6, P 150R1, OPH 139, OPH 86, OPH 74 and OPH 75. Among the environments, year 2020 saw drastic reduction in seed yield whereas, rest of the environments were comparable with each other. Similarly for oil content all the environments were comparable except for year 2021 which had significantly less oil content across the environments.

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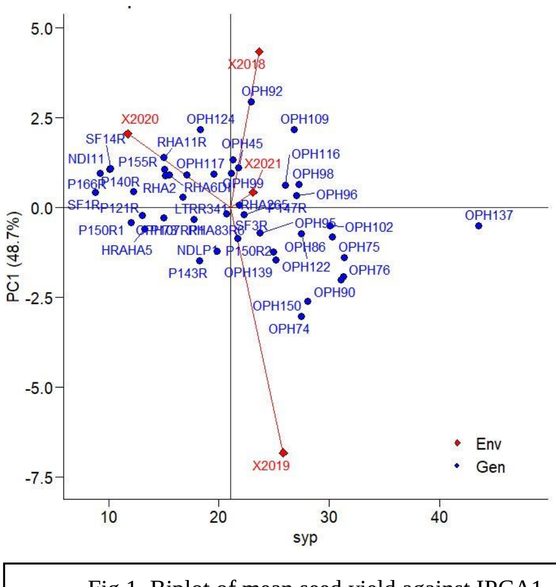

Fig 1. Biplot of mean seed yield against IPCA1

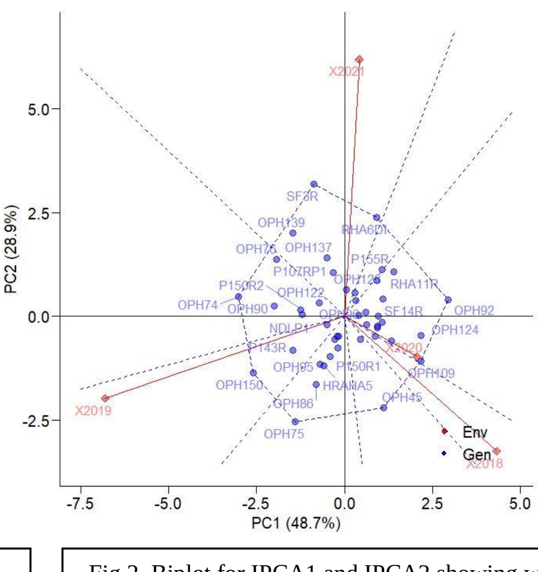

Fig 2. Biplot for IPCA1 and IPCA2 showing which inbreds were best for which environments

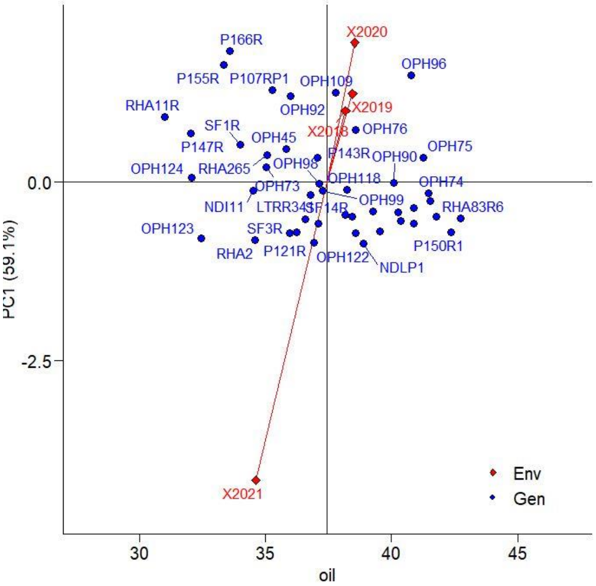

Fig 3. Biplot of mean oil content against IPCA1

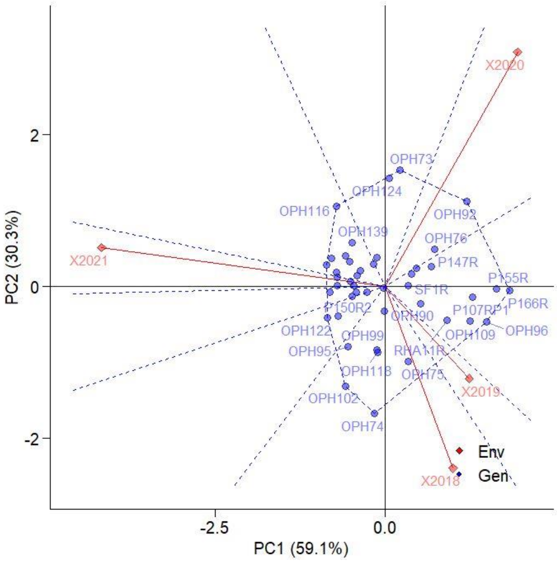

Fig 4. Biplot for IPCA1 and IPCA2 showing best inbreds for environments for oil content

Contribution of oil palm towards self sufficiency in vegetable oil production in Telangana: An analysis

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Telangana is an agrarian State with 56% of the population depending on agriculture. The gross cropped area of Telangana is 6.28 million ha while the net cropped area is 4.96 million ha with an average farm size of 1.12 ha. Horticulture is the growth engine of Telangana State and is one of the chief sources of income to the farmers and the State. It contributes upto 40.5% of Agricultural GDP of Telangana, amounting to 8.4% approximately. Telangana stands 3rd in area and 8th in production of fruits and vegetables in India. Major horticultural crops grown are chilli, turmeric, mango, citrus, oil palm, tomato, brinjal, bhendi, cucurbits, beans, leafy vegetables and others.

Oil palm as a crop is new to several districts of Telangana but the state ranks 6th in area, 2nd in production of oil palm in the country, while it ranks 1st in Oil Extraction Rate (19.22%) which is a model for fixing FFB price. Twenty six districts were identified suitable for the crop. After the introduction of oil palm in the state barely 10 years ago, the area has reached to 37,485 ha by the end of *Vanakalam* (Kharif) 2022. More area is coming up in *Yesangi* (Rabi) 2022, thus the area under oil palm should hopefully cross 80,000 ha by the end of 2022-23 season raising Telangana State to 2nd position in India (Department of Horticulture, 2021).

With respect to edible oils, groundnut, sesame, soybean, sunflower and safflower are the edible oilseed crops cultivated in Telangana (*Department of Food and Public Distribution, GOI, 2021*), The annual per capita consumption of edible oil in Telangana was 14.64 L in the year 2016 (*Food Consumption Pattern in Telangana State – 2017*), the annual requirement of edible oils is 0.51 million MT (calculated based on a population of 35 million).

Factors favoring oil palm cultivation In Telangana climate (Rainfall, temperature, relative humidity)

The average annual rainfall of the state is 906.6 mm of which 70-80% is received from the South-West monsoon. The annual rainfall ranged from 579.30 mm in Jogulamba Gadwal district to 1199.50 mm in Bhadradri Kothagudem district (*Based on 33 year data*).

The mean maximum temperatures in Telangana ranged from 33.1^{O} C in Sangareddy district to 35.3^{O} C in Khammam district, the mean minimum temperatures ranged from 20.3^{O} C in Vikarabad district to 23.0^{O} C in

Khammam district. The extreme temperature ranged from a minimum of 1.8^{O} C in Kumuram Bheem Asifabad district to maximum of 48.9^{O} C in Mancherial, Jagtial and Nalgonda districts. The relative humidity among the months in a year ranged from 92% (mean max) in September to 25% (mean min) in April.

Soils

The soils of Telangana have been classified into seven distinct type's *viz*., Red Loamy Sands, Red Sandy Loams, Lateritic Soils, Shallow to Medium Black Soils, Deep Black Soils, Salt Affected Soils and Alluvial Soils. The state has problematic soils classified under alkaline and saline soils.

Irrigation

The gross irrigated area of the state is 3.16 million ha and the net irrigated area is 2.29 million ha. Under Mission Kakatiya programme, more than 46,000 tanks were de-silted and linked by canals. Additional area of 0.73 million ha will be irrigated after the Kaleswaram Lift Irrigation Scheme comes into operation. The year wise increase in gross irrigated area in Telangana is 219% from 2014 to 2021 (*Weather and Climatology of Telangana - 2022*).

Reasons for wider Scope -Oil Palm Cultivation in Telangana

- Increase in irrigated area through projects and reviving tanks. The crop is being recommended to areas where there is enough irrigation through ground water, tanks or canals.
- Rise in ground water, increase in forest cover, has lead to an increase in relative humidity in general in the state.
- The high temperature in the months of April, May and June and the deficit in rainfall during November to June can be managed with sufficient irrigation.
- The micro climate in the oil palm garden improves gradually and humidity will further rise. Hence, cluster approach while planting is recommended for oil palm.

How palm oil produced in Telangana fills the gap in edible oil shortage in state

Oil palm is the highest oil yielding crop producing 4-6 MT of oil per ha while other oilseeds crops can produce only 0.6 MT per ha. Oil palm with 8.6% of area on the world map produces 36% of the vegetable oil while soybean produces 25.5% oil from 39% of land, while sunflower has the area and production in proportion (8.3 % area with 9% of oil). Farmers are also benefitted from the crop by high yields and fixation of appropriate FFB price by the committee constituted by the Government of India. Considering the high oil yield and monetary benefit to the farmers, the Government of India has came up with an area expansion plan with a budget outlay of Rs.11,000 crore. Farmers will reap the benefits from the crop while the crop expenses are met through subsidies to the tune of 50-75%.

Telangana Government has an ambitious project of bringing 8.00 lakh ha under oil palm in Telangana. Once achieved it would yield 14.00 million MT of FFB at the rate of 7 MT of FFB as average productivity per acre producing 2.80 million MT of CPO. This meets 33% of 8.5 million MT Indian palm oil import requirement. The progress is quite encouraging after allotting new districts to oil palm factories and 30 nurseries have been started in 26 districts. Presently, these nurseries hold about 80,00,000 seedlings ready for planting.

Constraints in oil palm area expansion

- Fluctuation in FFB price has brought down the confidence of the farmers
- Lack of quality indigenous planting material
- Establishment of processing industries in time
- Poor yields due to low knowledge in production technology
- Complicated harvesting process once the palms grow tall

Some salient recommendations of the recent Dr. B. M. C. Reddy Committee

- Minimum support price for FFB
- Establishment of price stabilization fund
- Training in the use of improved harvesters
- Establishment of oil palm seed gardens
- Encouraging ancillary industries

Future plan for expansion of oil palm in Telangana

- The Government of India is facilitating the oil palm expansion project in Telangana through National Mission on Oil Seeds and Oil Palm.
- Farmers are benefitted by 50-75% subsidy on various components of cultivation.
- Farmers need to be encouraged to grow the crop in view of the massive yields and returns from the crop which cannot be compared to any other crop with similar financial input and effort.
- The vegetative growth of newly planted seedlings is quite satisfactory and the farmers are confident about a good crop in future.

Way forward

- Establishment of special oil palm cell in the state
- Monitoring the nurseries for quality of the seedlings supplied
- Need to have a proper advisory system to the farmers and extension workers regularly.

- Farmers and field level extension workers shall be trained through online classes by conducting training programmes.
- Dissemination of information through electronic and social media.
- Encouraging intercrops in oil palm for improving micro climate and income generation.
- Establishment of processing industries in time.
- Focus on by-product utilization.
- Establishment of seed gardens for supply of quality indigenous seed.

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Bio-intensive Management of root & Stem rot (*Macrophomina phaseolina* (Tasi) Goid) of Sesame

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ABSTRACT

Field experiments were conducted on sesame during *Kharif* 2014 to 2016 at JNKVV farm, with seven treatments and three replications using susceptible variety of Sesame (*Sesamum indicum* L.),VRI-1, to find out the effect of *Trichoderma viride* and *Pseudomonas florescence* (either alone or in combination) on incidence of charcoal rot disease caused by *Macrophomina phaseolina* (Tasi) Goid. Seed treatment with *Trichoderma viride* (5g/kg seed) + *Pseudomonas florescence* (10g/kg seed) and soil application of *T. viride* or *pseudomonas florescence*@2.5 kg/ha before sowing was found effective for the management of this disease.

Keywords: Biological management, Macrophomina, Sesame

Sesame (*Sesamum indicum* L.) is one of the world's oldest oilseed crops and has been cultivated in Asia since ancient times and largely produced for its oil and is also used as a flavoring agent. The seeds of sesame contains 40 to 63 percent oil, which contains significant amount of oleic and linoleic acids. Sesame phyllody is the most destructive disease in India. Among the fungal diseases, *Macrophomina* root & stem rot *Alternaria* leaf blights, *Phytophthora* leaf spot, *Cercospora* leaf spot, Powdery Mildew are important diseases of sesame. *Macrophomina phaseolina* earlier reported by Aly *et al.* (2001), that *Tricoderma* spp. and *Pseudomonas florescence* could effectively used for the suppression of *Macrophomina phaseolina*, the pathogen causing charcoal rot disease in Sesame (*Sesamum indicum* L.). Present investigation was undertaken on similar lines, to ensure the disease control in Madhya Pradesh, India.

MATERIALS AND METHODS

A field experiment was conducted at Project coordinated unit, Sesame and Niger field under Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, during *Kharif* 2014 to 2016 to find out the effect of *Trichoderma viride*, *Pseudomonas fluorescence* and botanicals on incidence of root rot/stem rot disease in sesame. The susceptible cultivar (VRI-1) was employed for this purpose. The experiment comprised of 7 treatments *viz.* T_1: Seed treatment *T. viride* 4 g /kg + soil application of *T.viride* 2.5 Kg/ha enriched in 50 Kg of FYM twice before sowing and 30 DAS; T_2: Seed treatment *P. fluorescens 10* g /kg + Soil application of *P. fluorescens* 2.5 Kg/ha enriched in 50 Kg of FYM twice before sowing and 30 DAS; T_3: Seed treatment *T. viride* 5 g /kg + soil application of *T. viride* 2.5 Kg/ha enriched in 50 Kg of FYM twice before sowing and 30 DAS+ soil application (basal) of neem cake @ 250 kg/ha; T_4:Seed treatment *P. fluorescens*10 g /kg + soil application of *P. fluorescens* 2.5 Kg/ha enriched in 50 Kg of FYM soil twice before sowing and 30 DAS + soil application (basal) of neem cake 250 kg/ha; T_5:Seed treatment *T. viride* + *P. fluorescens*10 g /kg + Soil application of *P. fluorescens*@ 2.5 Kg/ha + *T. viride* 2.5 Kg/ha enriched in 50 Kg of FYM twice before sowing and 30 DAS + soil application (basal) of neem cake @ 250 kg/ha; T_6:Seed treatment carbendazim 2 g /kg + soil drenching with carbendazim 1 g / l; T_7 control. The incidence of charcoal root rot was recorded by counting the number of infected and healthy plants in a random quadrate from each plot

RESULTS AND DISCUSSION

The results obtained have been presented in table1. Treatments$T_4$and T_5were found to be effective in reducing disease intensity to11% in comparison to 38% in control. This interaction suggested that a single isolate of antagonist can be highly effective against *M. phaseolina*. Aly *et al*., (2001) reported similar interaction effect. Rajpurohit (2004) and Gupta *et al*., 2018 also reported that seed treatment of *T. viride* reduced stem and root rot of sesame and increased seed yield. These finding supports the results obtained in the present study. It was concluded that the, Seed treatment with *Trichoderma viride* (5g/kg seed)+*Pseudomonas florescence* (10g/kg seed)+ soil application of *T. viride* or *P. florescence* before sowing @ 2.5 kg/ha was effective for the Biological management root and stem rot *(Macrophomina phaseolina)* of sesame.

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Assessment of factor productivity and individual input effect on yield and economics of soybean [*Glycine max* (L.) Merrill]

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ABSTRACT

In India, the area under soybean is steadily increasing, while production and productivity is comparably low to the world average. To bridge this gap, production factors deciding per-unit production plays a vital role. In the present study, soybean grown with full package (2371 kg/ha) gave significantly higher yield over omission of weed management (1873 kg/ha) and insecticide application (1993 kg/ha). Increase in seed yield with full package over omission of weed management was (21.00%) and omission of insecticide application was (15.94%). The yield gap was higher with weed management (498 kg/ha) and insecticide application (378 kg/ha). Economic gain due to full package was maximum (Net Returns: Rs. 88226/ ha) compared to omission of individual factors.

Keywords: Factor productivity, Whole package, Weed, Soybean

Soybean (*Glycine max,* L.) is a unique crop with high nutritional value also known as “Miracle bean, Golden bean, and Crop of the planet”. Seed yield and productivity declines if the production factors required for soybean crop are lacking and even results in complete failure of the crop as the severity prolongs. This translates to high economic loss to the soybean farming community. Lack of seed treatment before sowing with fungicide, insecticide application, recommended dose of fertilizer, weed management due to unavailability of labor or continuous rain, lack of sufficient soil moisture due to long dry spells during crop growth period, imbalanced nutrition, improper insect and disease management affect the seed yield and productivity of soybean. Factors of production and management practices determines the success of crop husbandry for getting a sustainable yield. Information on the yield gap arising due to the lack of individual crop management practices and quantifiable yield loss due to it is lacking. Hence, present study was investigated to pinpoint and access the factors and its significance on yield attributes and economics of cultivation on soybean productivity.

MATERIALS AND METHODS

Field experiment was executed during *kharif* 2021 at research farm of All India Co-ordinated Research Project on Soybean, University of Agricultural Sciences, Dharwad, Karnataka, India. The experiment was laid out in randomized block design with three replications consisted of seven treatments *viz.*, T_1: Full package (Seed treatment, seed inoculation, RDF, weed management, insecticide application, Ridge and furrow), T_2: Full package – Omission of seed treatment, T_3: Full package – seed inoculation, T_4: Full package – RDF T_5: Full package – weed management, T_6: Full package – insecticide application and T_7: Full package – Ridge and furrow. RDF 40 kg N + 80 kg P_2O_5 + 25 K_2O/ha was supplied as basal application as per the treatments. Soybean variety MACS 1188 was used. Crop was raised with recommend package of practices. Observations were recorded on yield attributes. The economics and the yield gap based on yield difference in various treatments were estimated. Data was analyzed using standard statistical procedure (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

There was an increase of 21 % seed yield under treatment T_1 over T_5 and 16 % over T_6. Increment in seed yield due to fully package supported the essentiality of optimum cultivation practices required for obtaining the higher yield and evidenced the importance of individual cultivation practices to harvest maximum yield. Higher seed yield under treatment T_1: full package attributed to the maximum number of pods (74.33), seed index (13.8), straw yield (4268 kg ha^{-1}) due to supply of all inputs and optimum management practices.

It showed decreasing order of an input/ the management practice, which put forth the importance of an individual factor or management practice for raising the soybean crop and obtaining maximum yield. Per cent decrease in yield over full package with weed management (T_5) omission was higher in all treatments except full package without insecticide application (T_6) due to maximum yield loss. The results showed that absence of weed management for nutrient supplied, moisture, light, that competes for resources and no insecticide application to manage the insect-pests contribute to maximum yield losses compared to rest of the crop management practices. Seed yield increase in soybean due to high input system. Results are in line with the findings of Marburgs *et al.* (2016).

The crop management with full package (T_1) gave maximum gross returns (Rs. 1,30,426/- ha $^{-1}$), net returns (Rs. 88,226/- ha $^{-1}$) and benefit cost ratio of 3.09 over full practice excluding weed management (T_5) and insecticide application (T_6). Results are supported by finings of Jaybhay *et al.* (2022). However, the least yield gap was recorded under treatment T_2: full package-seed treatment (68 kg ha^{-1}) which showed it has least effect on soybean seed yield than other management practices.

It can be concluded that soybean crop requires all the optimum inputs and management practices comprising seed treatment, seed inoculation, RDF, weed management, insecticide application, ridge and furrow to obtain higher seed yield.. Weed management and insecticide application are major factors contributing to soybean yield loss and attributed to maximum yield gaps compared to full package.

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Table 1 Influence of soybean yield attributes and economics under various treatments of partial factor productivity

Treatment	Pods/ plant	Seed index (g)	Straw yield (kg/ha)	Seed Yield (kg/ha)	Gross Returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C ratio	% yield reduction over full package	Yield gap (kg/ha)
1. Full package (Seed treatment, seed inoculation, RDF, weed management, insecticide application, Ridge furrow)	74.33	13.8	4268	2371	130426	42200	88226	3.09	-	-
2. Full package -seed treatment	71.87	13.7	3915	2303	126657	42100	84557	3.01	2.86	68
3. Full package- seed inoculation	69.43	13.6	3610	2256	124083	42000	82083	2.95	4.85	115
4. Full package -RDF	67.20	13.4	3317	2211	121625	38139	83486	3.19	6.74	160
5. Full package-weed management	60.97	13.0	2247	1873	103009	34980	68029	2.94	21.00	498
6. Full package-insecticide applicn.	67.10	13.3	2790	1993	109618	39100	70518	2.80	15.94	378
7. Full package-Ridge furrow	71.30	13.6	3645	2278	125311	38300	87011	3.27	3.92	93
SEm	2.22	0.4	160	98	5392		5392	0.14		
CD (P=0.05)	6.85	1.2	493	302	16614		NS	NS		

Response of soybean to novel bio formulation on growth and yield enhancement in Soybean

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ABSTRACT

A field experiment was conducted in *kharif* 2021 to assess the response of bioformulations in conjunction with RDF on soybean. Seven treatments comprised of bioformulation combinations of recommended dose of fertilizers in conjunction with BioZn, Bio NPK, *Rhizobium* + MDSR 14 + 12c, one absolute RDF along with control were analyzed in a randomized block design and were replicated thrice. Maximum yield (2702 kg/ha) was obtained with application of RDF only followed by 75 % RDF + *Rhizobium* + MDSR 14 + 12c (2563 kg/ha) which signified the yield improvement is possible with combined application of fertilizers and biofertilizers.

Keywords: Bioformulation, Growth, Soybean, Yield

Soybean (*Glycine max*) is a leguminous crop cultivated in different agro climatic regions in India. There is ample scope for increasing the average yield by way of using appropriate RDF levels along bio formulations like Rhizobium and phosphate solubilizing bacteria cultures. These cultures not only increase the yield, also save nitrogenous and phosphatic fertilizers and upgrade fertility status of soil. The seed treatment with suitable rhizobium culture before sowing can increase pulse production to an extent of 10-15 per cent (Pradip Kumar and Sharma, 2018). It liberates growth promoting substances and vitamins and helps to maintain soil fertility. PSB can prove to be an effective low technology for the farmers as expense on costlier fertilizer can be lowered down.. Therefore, the present investigation was undertaken to know the response of soybean to novel bio formulations on growth and yield enhancement in Soybean.

MATERIALS AND METHODS

A field experiment was conducted at AICRP on Soybean, MARS, University of Agricultural Sciences, Dharwad under rainfed conditions. The soil of was medium black clayey in texture, with pH of 6.93. Soybean variety DSb 21 was used in the trial. The recommend dose of fertilizer *viz*., 40:80:25, $N:P_2O_5:K_2O$ kg/ha was applied. The experiment was executed in a randomized block design with three replications with following treatments : T_1-Control, T_2– RDF only, T_3– 75 % RDF only, T_4– 75 % RDF + Bio Zn, T_5 –75 % RDF + Bio NPK, T_6– 75 % RDF + Bio Zn + Bio NPK, T_7– 75 % RDF + Rhizobium + MDSR14 + 12c. The crop was sown on 22nd June, 2021 and harvested on 30th September, 2021. Crop was raised with recommend package of practices. Observations were recorded on growth and yield attributes *viz*., plant dry weight at 60 DAS, nodule numbers at R2 and R5 stages, number of primary branches per plant, number of pods/ plant, seed yield and straw yield. Data was analyzed using standard statistical procedure (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Seed treatment with RDF only elicited significant response in terms of plant dry weight (77.4 g) and 20 nodule numbers at R2 (full blooming) and 42 at R5 (seed filling initial) stages. Increased number of branches per plant, number of pods per plant and higher yield index of seed and straw was recorded under RDF only followed by bioformulation seed treatment with 75 % RDF + Rhizobium + MDSR14 + 12c was recorded (Table 1). Increase in yields was the result of balanced nutrition and favourable soil environment which promoted better assimilation leading to profuse growth and ultimately better yields. This might be due to application of NPK fertilizer along with biofertilizers helped in slow and steady rate of nutrient release into soil solution to match the required absorption pattern of soybean thereby increase yield. Results are in close conformity with Ekta Joshi *et al*. (2018).

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Table 1: Response of novel bio formulations on yield enhancement in Soybean

Treatment	Plant dry weight	Nodule No. (R2)	Nodule No. (R5)	Branches/ plant	Pods/ plant	Seed yield (kg/ha)	Straw yield (kg/ha)
1. Control	62.3	10.7	33.67	4.5	52.0	2197	3516
2. RDF only	77.4	20.0	42.00	5.8	65.8	2702	4324
3. 75 % RDF	64.6	16.0	36.33	4.9	48.7	2361	3778
4. 75 % RDF + Bio Zn	71.7	16.3	37.67	5.0	49.9	2479	3967
5. 75 % RDF + Bio NPK	72.6	18.3	38.33	5.1	52.8	2497	3995
6. 75 % RDF+Bio Zn+Bio NPK	74.3	19.7	39.33	5.3	53.4	2534	4054
7. 75 % RDF + Rhizobium + MDSR14 + 12c	74.6	24.3	43.67	5.4	60.3	2563	4100
SEm	2.9	1.0	1.55	0.2	1.9	83	133
CD (P=0.05)	9.0	3.2	4.78	0.7	5.9	257	411

(12c= *Burkholderia arboris*- High P solubilizing bacteria)

Seed treatment with RDF only would be effective for growth and yield enhancement in Soybean followed by 75 % RDF + Rhizobium + MDSR14 + 12c treatment.

Influence of biostimulants on growth, yield and benefits of soybean in Northern transition zone of Karnataka

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ABSTRACT

Field experiment was executed on “Influence of biostimulants on growth, yield and economics of soybean in Northern transition zone of Karnataka. Eleven treatments consists of foliar application at various concentration of Biostimulants (CropMax and Biozyme) at flowering and pod formation stage. Significantly higher dry matter accumulation (80.68 g/plant), seed yield (2,693 kg/ha), net returns (Rs. 1,03,702/ha) and BC ratio (3.4) were recorded with the foliar application of CropMax @ 700 ml/ha at flowering followed by Biozyme @ 625 ml/ha at pod formation stage.

Keywords: Biostimulants, Biozyme, Crop max, Growth, Soybean

Soybean is one of the major oilseed crops in Global scenario. In India it is grown over an area of 12.8 m ha with production of 13.12 mt with productivity of 1077 kg/ha (Anon., 2022). The potentiality of soybean is 3-4 t/ha. In order to face the upcoming challenges and to accomplish the potential yield productivity in the farmer’s field, one of the ways is use of biostimulants. Biostimulants are involved in up-regulation of genes linked to nutrient metabolism, nutrient uptake and photosynthesis (Erthani *et al.*, 2017), which are involved in plant response to stresses at crucial stages thus continuous supply of nutrients. (Pramanick *et al.,* 2013).

MATERIALS AND METHODS

The experiment was conducted at the Research farm of AICRP on Soybean plot, University of Agricultural Sciences, Dharwad during *kharif*-2021. The experiment plot was clay in texture with neutral reaction, EC (0.32 dS/m), organic carbon (0.44 %) and available N:P:K of 263:30.5:366 kg/ha. Experiment was conducted in Randomized complete block design with 11 treatments and three replications. Treatments consists of double spraying of CropMax @ 375, 500, 625 and 750 ml/ha at flower initiation and at pod formation stage (T_1 to T_4), spraying of CropMax @ 375, 500, 625 and 750 ml/ha at flower initiation stage followed by Biozyme spray @ 625 ml/ha at pod formation stage (T_5 to T_8), dual spray of Biozyme @ 625 ml/ha at both the stages (T_9), Control-1 with Urea-2% and KNO_3-1% spray (T_{10}) and Control-2 with water spray (T_{11}) along with RDF for all the treatments.

RESULTS AND DISCUSSION

Spraying of CropMax @ 750 ml/ha at flower initiation stage followed by Biozyme @ 625 ml/ha at pod formation stage recorded significantly higher dry matter accumulation (80.68 g/plant), number of pods/plant (58.7), test weight (9.23 g), seed yield (2693 kg/ha), haulm yield (3977 kg/ha) and BC ratio (3.40) which was on par with T_7 (79.69 dry matter g/plant, 56.1: number of pods/plant, 9.13 g test weight, 2655kg/ha seed yield, 3970 kg/ha haulm yield and B: C ratio 3.35) confer in Table 1. This might be due to higher leaf area and number of leaves resulting from higher light interception, maintaining chlorophyll content and higher photosynthesis ultimately leading to higher dry matter accumulation. Spraying of CropMax improves the uptake and absorption of nutrients through the root system. The spraying of biostimulants might have increased the source capacity of the leaves, enhancing the supply of assimilates for pod filling resulting in higher productivity per plant which lead to increase in seed and haulm yield (Kocira, 2018).

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Table 1 Influence of biostimulants on growth, yield and benefits of soybean

Treatment No.	Treatment details	Dry matter accumulation (g/plant) at harvest	Pods/ plant	Test weight (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)	BC ratio
T_1	CropMax @ 375 ml/ha followed by CropMax @ 375 ml/ha	75.99^{cd}	43.8^{d}	8.50^{ab}	2505^{bc}	3875^{b-d}	3.18^{c}
T_2	CropMax @ 500 ml/ha followed by CropMax @ 500 ml/ha	76.45^{b-d}	44.2^{cd}	8.70^{ab}	2517^{bc}	3900^{a-d}	3.20^{bc}
T_3	CropMax @ 625 ml/ha followed by CropMax @ 625 ml/ha	77.06^{b-d}	46.9^{bc}	8.87^{ab}	2539^{bc}	3901^{a-c}	3.16^{c}
T_4	CropMax @ 750 ml/ha followed by CropMax @ 750 ml/ha	79.16^{a-c}	56^{a}	9.07^{ab}	2606^{abc}	3954^{a-c}	3.26^{a-c}
T_5	CropMax @ 375 ml/ha followed by Biozyme @ 625 ml/ha	77.58^{a-c}	47.6^{b}	8.93^{ab}	2552^{abc}	3907^{a-c}	3.24^{bc}
T_6	CropMax @ 500 ml/ha followed by Biozyme @ 625 ml/ha	78.85^{a-c}	55.9^{a}	9.00^{ab}	2589^{abc}	3933^{a-c}	3.28^{a-c}
T_7	CropMax @ 625 ml/ha followed by Biozyme @ 625 ml/ha	79.69^{ab}	56.1^{a}	9.13^{a}	2655^{ab}	3970^{ab}	3.35^{ab}
T_8	CropMax @ 750 ml/ha followed by Biozyme @ 625 ml/ha	80.68^{a}	58.7^{a}	9.23^{a}	2693^{a}	3977^{a}	3.40^{a}
T_9	Biozyme @ 625 ml/ha followed byBiozyme @ 625 ml/ha	75.71^{cd}	43.1^{d}	8.53^{ab}	2498^{c}	3868^{cd}	3.17^{c}
T_{10}	Control-1 (Urea @ 2 % and KNO_3 @ 1 %)	77.10^{bc}	47^{bc}	8.93^{ab}	2544^{bc}	3906^{a-c}	3.26^{a-c}
T_{11}	Control-2 (Water spray)	73.53^{d}	41.7^{d}	8.30^{b}	2467^{c}	3799^{d}	3.17^{c}
	S.Em. ±	1.0	0.97	0.23	45	30	0.05

Means followed by the same alphabet (s) within a column are not significantly differed by DMRT (P=0.05)

Note: T_1 to T_{10}, foliar application at flower initiation (25-35DAS) and at pod formation stage (45 – 50 DAS).

Effect of different organic inputs on agronomic and economic performance of sesame under rainfed conditions of North Maharashtra

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ABSTRACT

A field experiment was conducted at Oilseeds Research Station, MPKV, Jalgaon to assess the performance of most suitable organic source for sesame production and its economics during the *kharif* season of 2021. Application of FYM on N equivalent basis + foliar application of 3% Panchgavya at flowering and capsule formation stage + Foliar application of *Pseudomonas* and *Azotobacter* 2 lit /ha both + soil application of *Pseudomonas* and *Azotobacter* (2.5 lit /ha + 200 kg FYM) recorded numerically higher seed yield (568 kg/ ha) over rest of the treatments, whereas higher net returns (₹ 26078/ha) and B: C ratio of 2.13 was obtained under application of RDF (50 % N as basal and remaining 50 % in 2 split doses) over rest of the organic sources.

Keywords: Economics, Productivity, Organic farming, Sesame

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop grown in India. The crop is grown in various agroclimatic regions mostly grown semi-arid tropics under rainfed conditions by mostly by small and marginal farmers. India ranks first in the world in terms of sesame-growing area (23%) and second largest producer of sesame in the world after Myanmar. It is cultivated in an area of 19.47 lakh ha. With a production of 8.66 lakh tonnes. The average yield of sesame 413 kg/ha is lower than other sesame growing countries (535 kg/ha). This probably indicates great opportunity for a higher increase in sesame productivity in India. Organic farming is gaining wide acceptance worldwide for agricultural production. The international demand and export of sesame are continuously increasing (Gopinath *et al*., 2011). Nutrient management is one of the most critical management areas for organic growers. Hence, keeping this in view present investigation was carried out to assess the yield and economics of organic sesame.

MATERIALS AND METHODS

A field experiment was conducted at Oilseeds Research Station, MPKV, Jalagaon to assess the performance of most suitable organic source for sesame production and its economics during the *kharif* season of 2021. Experiment was conducted in randomized block design (RBD) with three replications comprising of 10 treatment combinations of different organic sources and bio fertilizers as well as bio pesticides compared with conventional chemical fertilizer treatment. The soils of experimental field was deep black soils low in nitrogen, moderate in phosphorus and rich in potassium with slightly alkaline in nature. A white seeded sesame variety JLT-408 was sown at 45 x 10 cm spacing using 2.5 kg/ha seed rate in first week of July, with all the recommended package of practices. Data on yield attributing traits and seed yield were recorded. The economics of sesame cultivation was worked out with all the prevailing market prices of inputs used. On the basis of gross realization and cost of cultivation B: C ratio was worked out.

RESULTS

The results of experiment revealed that all the treatments of organic nutrient management produced at par effect on seed yield during *kharif* season. However, application of FYM on N equivalent basis + foliar application of 3% Panchgavya at flowering and capsule formation stage + Foliar application of *Pseudomonas* and *Azotobactor* 2 lit /ha both + soil application of *Pseudomonas* and *Azotobactor* (2.5 lit /ha + 200 kg FYM) recorded numerically higher seed yield (568 kg/ha) over rest of the treatments, whereas higher net returns (₹ 26078/ha) and B: C ratio of 2.13 was obtained under application of RDF (50 % N as basal and remaining 50 % in 2 split doses) over rest of the organic sources, which was mainly due to cost of organic inputs particularly cost of FYM and Neem Seed Cake was at higher side and it lowers net returns of organic sesame production.

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Table 21: Seed yield (kg/ha) and economics of sesamum as influenced by different treatments (*Kharif* 2021)

Treatments	Seed yield (kg/ha)	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net Returns (₹/ha)	B:C ratio
Application of FYM on N equivalent basis	509	45813	28200	17613	1.62
Application of Neem cake on N equivalent basis	514	46271	26700	19571	1.73
T1 + foliar application of 3% Panchgavya at flowering and capsule formation stage	543	48846	29820	19026	1.64
T2 + foliar application of 3% Panchgavya at flowering and capsule formation stage	554	49880	28320	21560	1.76
T3 + Foliar application of Pseudomonas and Azotobactor 2 lit /ha both	557	50087	29750	20337	1.68
T4 + Foliar application of Pseudomonas and Azotobactor 2 lit /ha both	561	50497	28250	22247	1.79
T5 + soil application of Pseudomonas and Azotobactor (2.5 lit /ha + 200 kg FYM)	568	51091	29325	21766	1.74
T1 + Soil application of liquid biofertilizer (PSB and azospirillum 2.5 lit /ha + 200 kg FYM)	518	46656	29700	22956	1.57
T2 + Soil application of liquid biofertilizer (PSB and azospirillum 2.5 lit /ha + 200 kg FYM)	520	46785	28200	18585	1.66
RDF (50 % N as basal and remaining 50 % in 2 split doses)	547	49228	23150	26078	2.13
SE±	23	-	-	-	-
CD at (P=0.05)	NS	-	-	-	-
CV %	7.33	-	-	-	-

Effect and profitability of foliar application of thiourea on soybean yield

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ABSTRACT

A field study was conducted to know the "effect of soybean to the foliar application of thiourea in rainfed conditions" under Northern transition zone of Karnataka. Among various thiourea levels, foliar application of thiourea at 750 ppm at 20-25 DAS and at 50-55 DAS recorded significantly higher seed yield (2582 kg/ ha) and net return (₹ 56386/ha). Interaction effect showed that foliar application of thiourea at 750 ppm at 20-25 DAS and at 50-55 DAS in all the three varieties of soybean recorded significantly higher seed yield and profitability compared to all other treatment combinations. Thus foliar application of thiurea at 750 ppm proved most productive and remunerative compared to other thiourea levels for DSb-21 variety with seed yield (2587kg/ha) and net returns (56579 ₹/ha).

Keywords: Foliar application, Profitability, Soybean, Thiourea

Soybean *(Glycine max L.)* is a leguminous crop belongs to family leguminoceae also known as Chinese pea, Golden pea. It has an excellent health benefits and contains 40 per cent quality protein, 23 per cent carbohydrates and 20 per cent cholesterol free oil. As soybean is the cheapest source of protein hence it is called "Poor man's meat". Soybean has not only gained the vital importance in Indian Agriculture, but also plays a decisive role in oil economy of India with its unmatchable nutritional value, which make it one of the commercial crops among global scenario. In India it is grown over an area of 12.8 m ha with a production of 13.12 mt and productivity of 1077 kg/ ha (Anon., 2022). Foliar application of chemicals especially the nitrogen source would not only reduce the soil pollution but also improves uptake of the nitrogen.

MATERIALS AND METHODS

An experiment was laid out at research farm of AICRP, Soybean, University of Agricultural Sciences, Dharwad during *Kharif* 2020. The experiment was executed in factorial randomized complete block design with 12 treatments along with control. The treatments consisted of two factors, *viz*., soybean varieties (DSb-21, MACS 1188, JS 93-05) and thiourea levels (water spray, 250 ppm, 500 ppm, 750 ppm at 20-25 DAS and at 50-55 DAS) with control. All the parameters were recorded for data analysis and subjected to statistical analysis by adopting Fischer's method of analysis of variance technique (Gomez and Gomez, 1984). The level of significance used in 'F' test will be at 0.05 per cent.

RESULTS AND DISCUSSION

There was no significant difference within treatments with respect to number of pods/plant, seed yield, haulm yield, net returns and B:C ratio among three varieties of soybean. Thiourea spray at 750 ppm at 20-25 DAS and at 50-55 DAS exhibited significantly higher values for pods/plant, seed yield, haulm yield, net returns and B:C ratio (46.50, 2582 kg/ha, 4192 kg/ha, 56386□/ha, 2.48 respectively) and these were on par with thiourea spray at 500 ppm at 20-25 DAS and at 50-55 DAS (43.53, 2535 kg/ha, 4061 kg/ha, 54861 □/ha, 2.45 respectively) as shown in Table 1.

Thiourea sprayed at 750 ppm on three different varieties at 20-25 DAS and at 50-55 DAS recorded significantly higher pods/plant (DSb 21: T_{12}-47.33, MACS 1188: T_8-46.67, JS 93-05: T_4-45.48), seed yield (DSb 21: T_{12}-2587, MACS 1188: T_8-2584, JS 93-05: T_4-2574 kg/ha), haulm yield (DSb 21: T_{12}-4199, MACS 1188: T_8-4196, JS 93-05: T_4-4182 kg/ha) with net returns (DSb 21: T_{12}-56579, MACS 1188: T_8-56471, JS 93-05: T_4-56107 □/ha) and B:C ratio (DSb 21: T_{12}-2.48, MACS 1188: T_8-2.48, JS 93-05: T_4-2.47) and was on par with thiourea sprayed at 500 ppm but significantly higher than rest of the interactions and control. This might be due to increased crop photosynthesis favoured by both improved photosynthetic efficiency and source to sink relationship and cumulative effect in favouring growth contributing characters which ultimately contributes to dry matter accumulation. These results are in conformity with findings of Premaradhya *et al.,* (2018) and Zain *et al.,* (2017).

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Table 1 Effect and economics of foliar application of thiourea on soybean yield attributes

Treatment details	No of pods/plant	Seed yield (kg ha$^{-1)}$	Haulm yield (kg ha$^{-1)}$	Gross return (□/ha)	Net return (□/ha)	B:C ratio
FACTOR A (varieties)						
A$_1$: JS 93-05	38.75^{a}	2386^{a}	3687^{a}	87206^{a}	49383^{a}	2.30^{a}
A$_2$: MACS 1188	40.46^{a}	2401^{a}	3702^{a}	87720^{a}	49897^{a}	2.32^{a}
A$_3$: DSb-21	41.63^{a}	2423^{a}	3721^{a}	88535^{a}	50712^{a}	2.34^{a}
S.Em. ±	0.88	48.3	73.5	1763	1763	0.05
FACTOR B (Thiourea levels)						
B$_1$: water spray	33.16^{bc}	2157^{b}	3035^{c}	78530^{b}	41049^{b}	2.10^{b}
B$_2$: 250 ppm	37.93^{b}	2339^{ab}	3526^{b}	85402^{ab}	47693^{ab}	2.26^{ab}
B$_3$: 500 ppm	43.53^{a}	2535^{a}	4061^{a}	92798^{a}	54861^{a}	2.45^{a}
B$_4$: 750 ppm	46.50^{a}	2582^{a}	4192^{a}	94551^{a}	56386^{a}	2.48^{a}
S.Em. ±	1.01	55.8	84.9	2036	2036	0.05
INTERACTION						
T$_1$: A1B1	31.44^{bc}	2146^{b}	3024^{c}	78134^{b}	40653^{b}	2.08^{b}
T$_2$: A1B2	35.64^{ab}	2323^{ab}	3510^{b}	84815^{ab}	47106^{ab}	2.25^{ab}
T$_3$: A1B3	42.43^{a}	2502^{a}	4033^{a}	91603^{a}	53666^{a}	2.41^{a}
T$_4$: A1B4	45.48^{a}	2574^{a}	4182^{a}	94272^{a}	56107^{a}	2.47^{a}
T$_5$: A2B1	33.26^{b}	2158^{b}	3036^{bc}	78566^{b}	41085^{b}	2.10^{b}
T$_6$: A2B2	38.56^{ab}	2328^{ab}	3514^{b}	84994^{ab}	47285^{ab}	2.25^{ab}
T$_7$: A2B3	43.32^{a}	2532^{a}	4063^{a}	92683^{a}	54746^{a}	2.44^{a}
T$_8$: A2B4	46.67^{a}	2584^{a}	4196^{a}	94636^{a}	56471^{a}	2.48^{a}
T$_9$: A3B1	34.78^{b}	2167^{b}	3045^{bc}	78890^{b}	41409^{b}	2.10^{b}
T$_{10}$: A3B2	39.60^{ab}	2367^{ab}	3553^{b}	86398^{ab}	48689^{ab}	2.29^{ab}
T$_{11}$: A3B3	44.82^{a}	2572^{a}	4088^{a}	94108^{a}	56171^{a}	2.48^{a}
T$_{12}$: A3B4	47.33^{a}	2587^{a}	4199^{a}	94744^{a}	56579^{a}	2.48^{a}
Control	35.37^{c}	1752^{c}	2292^{d}	63612^{c}	26859^{c}	1.73^{c}
S.Em. ±	5.07	100.4	149.9	3662	3662	0.10

Present status, production constraints and future research strategies in oilseed *brassica*

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The oleiferous *Brassica* species, commonly known as rapeseed-mustard, are one of the economically important agricultural commodities. Rapeseed-mustard comprising eight different species viz., Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan rai, black mustard and taramira, are being cultivated in 53 countries spreading all over the globe. The oil and protein content varies from 37 to 49% and 22-28%, respectively. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for human consumption throughout the northern India in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. It is used in soap making, in mixtures with mineral oils for lubrication. Rapeseed oil is used in the manufacture of grease. The oil cake is used as feed and manure. Green stem and leaves are a good source of green fodder for cattle. The leaves of young plants are used as green vegetable as they supply enough sulphur and minerals in the diet. In the tanning industry, mustard oil is used for softening leather. Rapeseed-mustard oil contains lowest level of saturated fatty acids among all vegetable oil, which is quite desirable for good health. Both the essential fatty acids (EFA) such as linoleic acid (C18:2) and linolenic (C18:3) are present in rapeseed-mustard oil. Rapeseed-mustard oil has high level of antioxidant, which retards growth of free radicals mainly responsible for disease like cancer and ageing. Glucosinolates present in seed meal has shown anticancer properties. *Brassica* species are very rich in phenolic compounds and glucosinolates. Rapeseed-mustard crops in India comprise traditionally grown indigenous species, namely toria (*Brassica campestris* L.

var. toria), brown sarson (*Brassica campestris* L. var. brown sarson), yellow sarson (*Brassica campestris* L. var. yellow sarson), Indian mustard [*Brassica juncea* (L.) Czern & Coss], black mustard (*Brassica nigra*) and taramira (*Eruca sativa*/*vesicaria* Mill.), which have been grown since about 3,500 BC along with non-traditional species like gobhi sarson (*Brassica napus* L.) and Ethiopian mustard or karanrai (*Brassica carinata* A. Braun).

Rapeseed–mustard crops in India are grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late sown, saline soils and mixed cropping. Indian mustard accounts for about 75-80% of the 5.8 million hectare (mha) under these crops in the country during 2009-10. The cultivation of brown sarson which once dominated the entire rapeseed- mustard growing region is now shadowed by Indian mustard. There are two different ecotypes of brown sarson: lotni (self-incompatible) and tora (self-compatible). The 'lotni' is predominantly cultivated in colder regions of the country particularly in Kashmir and Himachal valley.The'tora'on the other hand is cultivated in limited areas of eastern Uttar Pradesh. Yellow sarson is now mainly grown in Assam, Bihar, north- eastern states, Orissa, eastern Uttar Pradesh and West Bengal. Toria is a short duration crop cultivated largely in Assam, Bihar, Orissa and West Bengal in the east mainly as winter crop. In Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Uttarakhand and western Uttar Pradesh, it is grown as a catch crop. Taramira is grown in the drier parts of north-west India comprising the states of Rajasthan, Haryana and Uttar Pradesh. Gobhi sarson and karan rai are the new emerging oilseed crops having limited area of cultivation. Gobhi sarson is a long duration crop confined to Haryana, Himachal Pradesh and Punjab. Rapeseed-mustard crops because of their low water requirement fit well in the rainfed cropping system of resource poor farmers.

Important oil seed crop grown in cool season sub tropics, higher elevations and winter crops. Rapeseed oil was produced in the 19th century as a source of a lubricant for steam engines. It was less useful as food for animals or humans because it has a bitter taste due to high levels of glucosinolates. Varieties have now been bred to reduce the content of glucosinolates, yielding a more palatable oil. This has had the side effect that the oil contains much less erucic acid.

The oil and protein content varies from 37 to 49% and 22-28%, respectively. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for human consumption throughout the northern India in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. It is used in soap making, in mixtures with mineral oils for lubrication. Rapeseed oil is used in the manufacture of grease. The oil cake is used as feed and manure. Green stem and leaves are a good source of green fodder for cattle. The leaves of young plants are used as green vegetable as they supply enough sulphur and minerals in the diet. In the tanning industry, mustard oil is used for softening leather.

Rapeseed oil is one of the oldest vegetable oils, but historically was used in limited quantities due to high levels of erucic acid, which is damaging to cardiac muscle of animals, and glucosinolates, which made it less nutritious in animal feed (Sahasrabudhe, 1977). Rapeseed oilcan contain up to 54% erucic acid (CFR, 2010). Food-grade canola oil derived from rapeseed cultivars, also known as rapeseed 00 oil, low erucic acid rapeseed oil, LEAR oil, and rapeseed canola-equivalent oil, has been generally recognized as safe by the United States Food and Drug Administration (The Commission of the European Communities, 1980). Canola oil is limited by government regulation to a maximum of 2% erucic acid by weight in the USA and 5% in the EU (Humbert *et al*., 2001), with special regulations for infant food. These low levels of erucic acid are not believed to cause harm in human neonates.

Rapeseed-mustard oil contains lowest level of saturated fatty acids among all vegetable oil, which is quite desirable for good health. Both the essential fatty acids (EFA) such as linoleic acid (C18:2) and linolenic (C18:3) are present in rapeseed-mustard oil. Rapeseed-mustard oil has high level of antioxidant, which retards growth of free radicals mainly responsible for disease like cancerand ageing. Glucosinolates present in seed meal has shown anticancer properties. *Brassica* species are very rich in phenolic compounds and glucosinolates.

Area and Distribution: The Important Rapeseed Mustard growing countries of the world are India, Canada, China, Germany, France & Poland. India ranks third (after China & Canada) In the world in respect of acreage and Production.

CONSTRAINTS IN PRODUCTION

The rapeseed-mustard, which contributes nearly 80% of the total rabi oilseed production, is a vital component in edible oil sector. The rapeseed- mustard crops are diverse in their agro-climatic requirements and crop management practices. The production constraints facing each of the crops are also diverse in nature. The objective of raising domestic availability of edible oil can be realized only by increasing the productivity of these oilseed crops. Enhancing the production and productivity of the crop assumes significance; not only from the farmers' viewpoint but also for the edible oil industry and other vertically and horizontally linked enterprises. The major constraints faced by these crops are:

- Uncertainty of acreage of the crops due to several factors: climatic, biological, natural resources and policy decisions.
- Low and erratic rainfall leading to continuous moisture stress/ drought over the years. Seedling stage is most sensitive to moisture stress followed

by flowering. Farmers are also not well versed with the moisture conservation techniques.

- Irrigation with saline and alkali-blended water in most of the areas of Rajasthan and parts of UP, Haryana and Punjab resulting in salinity builds up.
- Mono cropping in most of the major areas has led to soil deficiency for nutrients and built-up of soil borne pathogens.
- Stress caused by insect, nematodes, fungal, bacterial and viral pathogens, Orobanche and weeds collectively result in approximately 45% yield loss annually.
- High temperature during crop establishment (mid-September to early- November), cold spell, fog and intermittent rains during crop growth causeconsiderableyieldlossesbyphysiologicaldiso rderandappearance and proliferation of white rust, downy mildew and Sclerotinia stem rot diseases and aphid pest.
- Farmer's reluctance in using balanced dose of fertilizers, poor adoption of plant protection measures to control pest, diseases and weeds and harvesting at improper time.

Table 1: Major Rapeseed & Mustard growing countries in the world

Country	Area (m ha)	Production (m tonnes)	Yield (Kg/hectare)
Bangladesh	0.24	0.22	916
Canada	6.51	11.86	1821
China	7.37	13.08	1775
Denmark	0.17	0.58	3486
France	1.46	4.81	3286
Germany	1.46	5.70	3899
India	5.59	6.61	1181
Pakistan	0.41	0.16	852
Poland	0.32	2.07	2700
Swedan	0.17	0.28	2553
World	31.68	59.07	1864

Table 2: Major Rapeseed & Mustard growing States in India area, Production and Productivity of Rapeseed & Mustard in India duringlast five year (2015-16 to 2020-21).

State	Area (m ha)	Production (mt)	Yield (Kg/ha)
Andhra Pradesh	2.0	4.0	500
Assam	170.4	279.5	610
Bihar	98.3	86.8	1132
Chhattisgarh	25.8	50.2	514
Gujarat	361.0	213.0	1695
Haryana	962.0	559.0	1721
Himachal Pradesh	4.7	9.0	520
Jammu & Kashmir	48.9	59.9	817
Jharkhand	145.7	186.0	783
Karnataka	1.0	2.0	500
Madhya Pradesh	919.2	784.6	1172
Maharashtra	2.0	9.0	222
Orissa	4.0	14.6	275
Punjab	41.0	32.0	1281
Rajasthan	3814.6	2834.7	1346
Tamil Nadu	0.1	0.6	230
Uttar Pradesh	836.0	662.0	1263
Uttarakhand	16.9	18.1	933
West Bengal	474.8	446.9	1062
Others	100.6	110.6	909
All India	8028.9	6362.6	1262

Future challenges: The following future breeding challenges are targeted for improvement of oilseed Brassica:

- There is a need to broaden the genetic base; the regions of higher diversity should be explored. The exploration and collection from unexplored areas / hotspots are extensively needed.
- Exploration from the countries like Australia, Canada, China, Japan, Russia, Spain, Sweden; especially for quality, high heterosis (oil content, yield), biotic, abiotic stress and wild species.
- Introduction of germplasm of wild / weedy relatives as well as cultivated species of rapeseed-mustard from the centers / areas of rich generic diversity.
- Multi-location evaluation and characterization of germplasm, and subsequently their proper documentation is required to be strengthened.
- Molecular characterization of germplasm.
- Maintenance of gene pool for various traits such as quality, biotic and abiotic stresses.
- Participation of farmers during collection of germplasm and indigenous knowledge.
- Development of a core set of the germplasm for different traits for efficient handling and utilization of germplasm.
- Development of varieties for specific area and purposes.
- Development of CMS based hybrids.
- Development of nutrionally superior varieties etc.

Future Research Plans: It would concentrate on the following key researchable areas to achieve quantum jump in production and productivity of rapeseed-mustard:

- Efficient utilization of rapeseed-mustard genetic resources.
- Exploitation of available heterosis in mustard and toria for further enhancing the yield potential.
- Developing high yielding varieties/hybrids with improved oil and seed meal quality for food, feed and industrial uses using conventional as well as biotechnological approaches.
- Development of thermo and photo in sensitive genotypes for diverse cropping systems under varied agro-ecological situations.
- Development of cultivars with high water and nutrient use and photosynthetic efficiency for different situations.
- DevelopmentofdesignerBrassicafordifferentfattyacidsprofile&value-added product.
- Development of rapeseed mustard genotypes tolerant to various biotic (Alternaria blight, Sclerotinia rot, white rust, Orobanche, mustard aphid, painted bug) and abiotic stresses (drought, temperature and salinity).
- Productiontechnologiesformustardbasedcropping systemsunderclimate change scenario.
- Bio-molecules, bio-remediation and bio-fertilization for environmental safety.
- Survey and surveillance of insect-pests, diseases and weeds under climate change.
- Remote sensing for energy-water balance, disease and insect-pest surveillance, forewarning and crop modelling.
- Bio-intensive integrated pest management (IPM) module development for major insect pests and diseases.
- Host-pathogen interaction and induced resistance for management of diseases.
- Impact of pesticide residues on the dynamics of soil flora fauna and environment.
- Socio-economic operational and institutional constraints in the transfer of technology, yield gap analysis and farmer’s perceptions.
- Development of information technology (IT) based decision support systems, innovations in knowledge management and technology dissemination.
- Impact of policies (procurement, price, export-import, storage, incentives etc.) and development programmes on area and production of rapeseed-mustard.

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Influence of weather parameters on foliar diseases of sesame

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ABSTRACT

Three years field experiment was conducted on sesame during *Kharif* 2015 to 2017 to find out the effect of *climate* factor and management for foliar disease in sesame. In this experiment, i.e. three sesame varieties, JTS-8, TKG-21 and GT-10 were sown with two treatments protected and unprotected. The severity of powdery mildew and *Alternaria* and *Cercospora* was recorded at weekly intervals using 0 - 5 grade scale. The disease severity was correlated with the weather parameters. Correlation of diseases with the weather parameters indicated that *Alternaria* and *Cercospora* severity was positively correlated with Relative humidity observed during morning and evening. Similarly, the powdery mildew was also positively correlated with relative humidity.

Keywords: Foliar diseases, Sesame, Weather parameters

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop. It plays an important role in the oilseed economy throughout the world. The fungal foliar diseases, *Alternaria*, *Cercospora*, and Powdery mildew of sesame are important in Jabalpur area, disease incidence in field resulting in heavy yield losses (Gupta *et al*., 2018). The pathogen attack plant at all growth stages. An attempt was made to find out the weather parameters responsible for the development of the diseases.

MATERIALS AND METHODS

Three years field experiment was conducted on sesame during *Kharif*, 2015 to 2017 to find out the effect of *climate* factor and management for foliar disease in sesame (Fig.1). In this experiment, three sesame varieties, JTS-8, TKG-21 and GT-10 were sown with two treatments, protected and unprotected. Under protected treatment; Seed treatment with Carbendazim 50 WP, 2g/kg of seed. Soil Application of *Tricoderma viridae* 2.5 kg/ha; and two spraying with Sulphex (3g/lit of water), (0.1% Carbendazim50WP + 0.2% Mancozeb) at early growth stage of crop and under unprotected treatment no spraying was taken up. The severity of powdery mildew, *Alternaria* and *Cercospora* was recorded at 15 days interval of disease appearance using 0 - 5 grade scale (Anonymous, 2014). The disease severity was correlated with the weather parameters. The average of weather parameters *viz*., Maximum temp., Minimum Temp., Relative humidity (morning), Relative humidity (evening), wind speed and total rainfall prior to seven days of disease appearance was subjected to correlation and regression analysis.

RESULTS AND DISCUSSION

The results indicate that Correlation of *Alternaria* and *Cercospora* disease severity with the weather parameter was positive with relative humidity observed during morning and evening. Similarly, powdery mildew was also positively correlated with relative humidity (evening). JTS-8 and TKG-21 recorded maximum intensity of powdery mildew, alternaria and *Cercospora* leaf spot in unprotected as compare to protected. However, TKG-55 was found moderately resistant for all the foliar diseases. Step wise multiple regression analysis showed that the mean disease intensity of *Alternaria*, *Cercospora* and *powdery mildew* by the variable maximum temperature (X1), minimum temperature (X2), relative humidity (X4) and rain fall (X5) and wind speed (X6). The R^2 value of the function ranged from 0.88 to o.98.

The liner prediction equation for

Powdery mildew = -48.39+0.009 RF+0.23 T (maxi) + 0.97 T (mini) + 0.20 Rh (m) + 0.51 Rh (ev) - 0.43(Ws)
Alternaria leaf spot =-38.74+0.001RF + 0.35 T (max) + 0.60 T (mini) 0.006 Rh (m) + 0.21Rh(e) + 0.32Ws
Cercospora leaf spot: Y= -63.43 + 0.00RF + 0.49 T (maxi) +1.09 T (mini) + 0.08 Rh (m) + 0.43Rh (e) + 0.25Ws

Were selected as the best fit for predicating the powdery mildew, Alternaria leaf spot and Cercospora leaf spot disease of sesame under normal epiphytotic condition. The present findings are similar with the results Patel and Patel (1990) who reported higher temperature (35°C) and low relative humidity to be favorable for maximum disease incidence for blight of green gram.

It was concluded that *Alternaria* and *Cercospora* severity was positively correlated with relative humidity observed during morning and evening. Powdery mildew was also positively correlated with relative humidity (evening). Influence of weather parameters on foliar disease of sesame indicated that, the crop sown in the month of June recorded tolerant reaction and higher yield as compared to the late sown crop.

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Efficacy of seed soaking in different phytoextracts for the management of charcoal rot (*Macrophomina phaseolina* (tasi) Goid) of sesame

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ABSTRACT

The effect of sixteen plant extracts were evaluated for the management of root & stem rot of sesame by seed soaking method under *in-vivo* (sick plot condition) at 20 percent of concentrations in two sesame varieties. In variety RT-346 garlic extract was found most effective as a seed treatment among all the tested plant extract against *M. phaseolina* by 78.44 percent of healthy plant followed by the onion 77.28 percent. In VRI-1 variety, garlic extract was found most effective as a seed treatment among all the tested plant extract against *M. phaseolina* by 79.66 per cent of healthy plant followed by the onion 75.81 per cent.

Keywords: Macrophomina, Management, Plant extract, Sesame

Sesame (*Sesamum indicum* L.) is one of the world's oldest oilseed crops and has been cultivated in Asia since ancient times and largely produced for its oil and is also used as a flavoring agent. The seeds of sesame contain 40 to 63 percent oil, which contains significant amount of oleic and linoleic acids. Sesame phyllody is the most destructive disease in India. Among the fungal diseases, *Macrophomina* root and stem rot *Alternaria* leaf blights, *Phytophthora* leaf spot, *Cercospora* leaf spot, Powdery Mildew are important diseases of sesame. *Macrophomina phaseolina* earlier reported by Aly *et al.*, (2001) & Gupta *et al.*, (2018) *M. phaseolina* is a seed and soil borne fungal plant pathogen that causes charcoal rot disease in more than 500 different monocotyledonous and dicotyledonous plant species including. The fungus exists in two forms, one is saprophytic named *Rhizoctonia bataticola* which mainly produce microsclerotia and another is pathogenic i.e., *Macrophomina phaseolina* where the pathogen mainly produces pycnidia. Present investigation was undertaken to evaluate the effect of sixteen plant extracts for the management of root and stem rot of sesame by seed soaking method under *in-vivo* (sick plot condition) at various concentrations in two sesame varieties

MATERIALS AND METHODS

The clean and fresh plant parts such as leaves, cloves, bulbs and flowers were collected and washed them with the help of the running tap water and dried at room temperature for removal of excess amount of moisture and water content for 10-15 days. After that, roughly crushed them with the help of a hand or mixer grinder and makes the powder form of it. The 1:1 w/v each plant powder and sterilized distilled water were mixed and heated at 80°C for 10 minutes. This aqueous extract is sterilized with the help of autoclave. The soil was sterilized with the help of an autoclave at 121.6°C temperature and 1.05 kg/cm^2 for 20 minutes and clay pots of 20 cm diameter were sterilized by the 5 per cent of formalin solution for 15 minutes and left to dry out for two weeks. Mass media of *M. phaseolina* were added to the soil at the rate of 10% per pot of soil weight and mixed thoroughly. The sterilized pots were filled with sterilized soil (each pot contained 500 gm of soil mixed with inoculum) mixed with the inoculum of *M. phaseolina* as described before by 10% of soil weight then watered and left for two weeks to ensure establishment and distribution of the inoculum in the soil. Surface sterilized sesame seeds of two varieties RT-351 and VRI-1 were soaked in autoclaved plant extract (20% concentration) for 15 minutes and then left to air dry for 24 hours before sowing in *M. phaseolina* infected potted soil. Seed treated with water soaked only was used in control pots. Three pots each planted with 10 sesame seeds were used for each treatment. The percentage of pre and post-emergence and root & stem rot has been observed for disease development after 15-20 and 25-30 days of sowing sesame.

RESULTS AND DISCUSSION

In variety RT-346, garlic extract was found most effective as a seed treatment among all the tested plant extract against *M. phaseolina* by 78.44 per cent of healthy plant followed by the onion 77.28 per cent while in VRI 1 variety, garlic extract was found most effective as a seed treatment among all the tested plant extract against *M. phaseolina* by 79.66 per cent of healthy plant followed by the onion 75.81 per cent. Similar result was found by Hoda *et al*., (2010) who evaluated aqueous plant extract by soaking sesame seed before sowing in sick pot under greenhouse conditions by providing 80-90 per cent of healthy plants. The present investigation was also supported by El-Fiki *et al*., (2004) who evaluated filtered and autoclaved plant extract of Cumin, Ginger, Marjoram, Garlic, Rhubarb, Eucalyptus, Thyme, Anise, Rosselle, Fennel, Azhdarchid and Clove by soaking sesame seed and found that the filtered extract of garlic significantly better than the autoclaved extracts for decreasing disease incidence and increasing the healthy plant percent

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Identification on seed associated mycoflora of sesame genotypes

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ABSTRACT

Seed mycoflora of 165 genotypes of sesame in (AVTs & IVTs) were detected using seed health testing methods *viz.*, paper towel method, standard blotter method, and standard agar plate method and six distinct fungi *viz.,Alternaria, Macrophomina, Fusarium, Aspergillus, Penicillium, and Rhizopus* spp. were detected. In the three methods employed to identify seed mycoflora the standard blotter method has identified the maximum number of seeds infected by fungi compared to paper towel method and standard agar plate method. After a few days of germination, it was observed that the majority of the seeds were infected with disease, which hampered normal seedling growth and resulted in abnormal and rotted seedlings.

Keywords: Sesame, Seed mycoflora

Sesame crop is attacked by many phytopathogens like where most of them are seed borne, seed borne mycoflora are carried over by infected seeds and they cause deterioration of seed in soil-affecting germination, causing seedling mortality and further infection of foliage is observed at growth stage. Different fungi *viz.*, *Alternaria sesami, Curvularia species, Macrophomina phaseolina, Cercospora sesami, Fusarium oxysporum f. sp. sesami, Helminthosporium, Penicillium* and *Rhizopus* spp. were associated with sesame seed (ISTA, 1999). Some other fungus like *Aspergillus niger, A. nidulans, A. alba and A. flavus* (that produce a toxic secondary metabolite called Aflatoxin) were also isolated from the seeds of sesame. These mycoflora are causing qualitative and quantitative losses in sesame. Among them *M. phaseolina, A. sesami, Cercospora sesami and Curvularia* spp. were the most prevalent fungi ranging from 23.9 to 35.4% (Rana singh *et al.*, 2019). Early identification of seed mycoflora is very important to ensure the production, quality and health. Therefore, to plan the management practices, identification of these pathogens is very important (Nayyar *et al*., 2013).

MATERIALS AND METHODS

The Research work was conducted during the year 2014 to 2018 and sesame seeds of 165 genotypes (AVTs &IVTs) were taken from All India Coordinated Research Project on Sesame and Niger, College of Agriculture, JNKVV, Jabalpur. Seed samples of sesame were tested by using Paper towel, Standard blotter. In paper towel method 50 seeds are taken from each genotype and in blotter paper method 25 seeds were taken from each and kept in seed germinator at 25 °C and relative humidity was 89.4 % and 10 seeds were taken from each genotype for standard agar plate method and kept in BOD incubator. After seven days the mycoflora associated with sesame seed samples were observed under the microscope and the number of infected seeds and seedlings were noted. Also, the fungal incidence in each genotype and germination percentage were calculated using paper towel method.

RESULTS AND DISCUSSION

Six distinct fungi *Alternaria, Macrophomina, Fusarium, Aspergillus, Penicilium, and Rhizopus* spp. were detected using the two seed health testing methods. Data revealed that maximum fungi were observed in the genotype RT-346 and followed by TKG-22 Maximum number of seed infected with fungi were observed in the blotter method and it was observed that *Macrophomina phaseolina* was the predominant fungi identified through paper towel method and *Alternaria* spp. through standard blotter method and *Aspergillus* spp. was seen more in standard agar plate method.The Current studies are similar with the findings of Pravallika *et al.,* (2018) who evaluated 28 seed samples of sesame to detect the seed borne mycoflora and isolated seven fungal species belonging to six genera associated with the seed of sesame indicating their seed borne nature and concluded that the standard blotter method as the best, simple and sensitive method for the detection of mycoflora associated with sesame seed.

The fungal incidence on each genotype calculated based on number of infected seeds and seedlings ranged from 6 to 30 % seeds of sesame under paper towel method and 8 to 44 % in standard blotter methodand from 10 to 40 % in standard agar plate method.

Among the thirteen genotypes, germination percentage ranged from 82 to 96 % with minimum noticed in RT-346 with 82 % followed by RT-389 with 84 % and maximum germination percentage was found in TKG-22(NC) with 96 % followed by GT-10(NC) and RT-390 with 94 %.

It could be concluded that from different seed testing methods sesame seeds were associated with six fungi *viz.*, *Macrophomina phaseolina*, *Cercospora sesamicola*, *Alternaria sesami*, *Aspergillus* sp., and *Rhizopus* spp. and presence of these mycoflora affected the normal growth of sesame seedling and resulted in abnormal and infected growth of seedlings. Standard blotter method was found to be the best method for the identification of seed mycoflora as a greater number of the seeds infected with fungi were identified in this method and it was a simpler method compared to the paper towel method.

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A correlation and path analysis of seed yield and yield contributing characters in safflower (*Carthamus tinctorius* L.)

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ABSTRACT

Correlation and path analysis were carried out to determine the effect of various traits as components of seed yield in 34 safflower genotypes. The genotypes were evaluated in RBD with three replications during Rabi 2021, at the central research farm of the Department of Genetics and Plant breeding at Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj. The analysis of variance exhibited significant difference for all the characters suggesting the presence of inherent genetic variations among the genotypes. Correlations among the traits revealed that the Harvest index and seed yield/plant had a positive and substantial correlation. Harvest index, seed index, number of seeds/capitulum, and number of capitula/plant were discovered by path analysis at the phenotypic level as essential direct components for seed yield/plant.

Keywords: Correlation and path analysis, GCV, Genetic Advance, PCV, Heritability, Variability

An essential oilseed crop, safflower (*Carthamus tinctorius* L.), is able to endure climate change because of its low water and input requirements, as well as its wide range of soil type adaptability. Safflower is a significant oilseed crop because it contains 78% PUFA (Linoleic Acid), which is advantageous for those with heart disease because it lowers blood cholesterol levels (Nimbkar 2002). Correlation and path analysis gives the relation between direct and indirect effect of yield attributing characters with each other. Correlation and path analysis were carried out to determine the effect of various traits as components of seed yield in 34 safflower genotypes.

MATERIALS AND METHODS

The experiment was carried out during *rabi* 2021–22 with 34 genotypes of safflower including one check in RBD with . with three replications. Each genotype was raised in five rows of three meters each, with a spacing of 45 x 20 cm. To guarantee good crop stand, recommended agronomic and plant protection techniques were carried out. By selecting five randomly chosen plants from each plot, the mean data were collected on twelve yield-contributing characteristics, including days to 50% flowering, plant height, number of primary branches, number of secondary branches, number of capitula per plant, capitulum diameter, number of seeds per capitulum, days to maturity, 100 seed weight, biological yield, and seed yield per plant. The computation of phenotypic correlations followed Weber and Moorthy's recommendations (1952). To determine the direct and indirect effects, path coefficient analysis was done for variables that had strong phenotypic correlation coefficients with seed yield, as recommended by Wright (1921) and demonstrated by Dewey and Lu (1959). The statistical data analyze by using 'R software v 4.2.1'(R Core Team 2021., R: A language and environment for statistical computing. R foundation for statistical computing, Vienna, Austria. URL https://www.R-project.org/.

RESULTS AND DISCUSSIONS

Correlation and Path analysis: At both the phenotypic and genotypic levels, there was a positive and significant correlation for the number of capitulum/plant, secondary branches/plant, seeds/capitulum, harvest index, and biological yield/plant. As a result, these traits became the most significant correlates of safflower seed output/plant. The number of effective capitula/plant was significantly positively correlated with seed yield, according to Nair et al. (2006). The traits, number of primary branches/plant, the number of seeds/capitulum, and the number of capitulum/plant each had greatest direct influence. The indirect impact of the quantity of capitula/plant resulted in the direct impact of 100-seed weight on seed output. These characteristics, which are essential parts of seed output, may help to boost safflower seed yield. Seed index, plant height, and capitulum diameter all had less of an impact on plant seed yield directly than did the number of capitula/plant (Malleshappa *et al*. 1989, Pandya *et al*. 1996). The relationship between the number of seeds/capsule and the weight of 100 seeds for each plant showed a positive and significant association. Additionally, route coefficient analysis showed that 100-seed weight had the greatest direct effect, followed by number of seeds/capsules (Pushpavalli *et al*. 2016). Between seed yield/plant, number of seeds/capitulum, and 100-seed weight, a significant and favorable association was found. The breeding program will be more effective in increasing yield by selecting for these features. As a result, these characteristics could be regarded as the most crucial determinants of safflower seed yield.

According to a correlation coefficient study, there was a substantial and positive correlation between the number of capitulum/plant, secondary branches/plant, seeds/ capitulum, harvest index, and biological yield/plant at both the phenotypic and genotypic levels. The number of capitulum/plant demonstrated the largest direct effect.

The path coefficient analysis was used to calculate the direct and indirect contributions of various characters to the seed

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Table 1 Phenotypic & genotypic correlation coefficients among different characters in safflower

Genotypes	DF 50%	PH	NPB PP	NSB PP	NC PP	DC	NS PC	100 SW	DM	BY PP	HI	SY PP
DF50%	1 **	0.0859	-0.1113	-0.1032	-0.03	0.1714	-0.3373	0.143	0.926 **	-0.19	0.0828	-0.1259
	1 **	0.0817	-0.1165	-0.0955	-0.022	-0.022	-0.2982 **	0.1105	0.8461 **	-0.1805	0.081	-0.1194
PH		1 **	-0.1257	-0.1534	-0.346 *	-0.5679 **	-0.0184	-0.216	0.1172	-0.4547 **	-0.1998	-0.4188 *
		1 **	-0.1164	-0.1485	-0.3407 **	-0.1373	-0.0151	-0.2023 *	0.1118	-0.4507 **	-0.1964 *	-0.4148 **
NPBPP			1 **	0.9303 **	0.6894 **	0.453 **	0.0741	-0.4021 *	0.0123	0.5461 **	0.668 **	0.599 **
			1 **	0.8853 **	0.6698 **	0.1516	0.0779	-0.3659 **	0.01	0.5323 **	0.6499 **	0.5851 **
NSBPP				1 **	0.7752 **	0.3078	0.0152	-0.3591 *	0.0434	0.5823 **	0.6761 **	0.636 **
				1 **	0.7606 **	0.0465	0.0094	-0.3296 **	0.0319	0.573 **	0.662 **	0.6252 **
NCPP					1 **	0.8402 **	-0.049	-0.2236	0.1434	0.8792 **	0.7916 **	0.9128 **
					1 **	0.2116 *	-0.047	-0.2073 *	0.1337	0.8744 **	0.7865 **	0.908 **
DC						1 **	0.6911 **	0.0818	0.0883	1.1668 **	0.9622 **	1.1148 **
						1 **	0.209 *	0.0608	0.0261	0.308 **	0.2538 *	0.3015 **
NSPC							1 **	-0.2446	-0.2118	0.239	0.096	0.2008
							1 **	-0.2055 *	-0.2021 *	0.2318 *	0.0968	0.1966 *
100SW								1 **	-0.0485	0.0144	-0.1336	-0.022
								1 **	-0.0387	0.0146	-0.1216	-0.0172
DM									1 **	-0.0275	0.1762	0.0267
									1 **	-0.0261	0.1691	0.0259
BYPP										1 **	0.7132 **	0.9826 **
										1 **	0.7109 **	0.9818 **
HI											1 **	0.8079 **
											1 **	0.8066 **
SYPP												1 **
												1 **

**,* significant 1% and 5% level of significance respectively

Table 2 Path coefficient analysis showing direct and indirect effect of different characters on seed yield in safflower genotypes

Genotypes	DF50%	PH	NPBPP	NSBPP	NCPP	DC	NSPC	100SW	DM	BYPP	HI	SYPP
DF50%	**-0.512**	0.000	-0.003	0.004	-0.008	0.005	-0.012	0.009	0.056	-0.112	0.013	**-0.512**
	0.010	0.000	-0.002	0.003	-0.003	0.000	-0.007	0.003	-0.007	-0.132	0.015	**0.010**
PH	-0.007	**0.324**	-0.004	0.006	-0.088	-0.017	-0.001	-0.014	0.007	-0.269	-0.033	-0.007
	0.001	**0.093**	-0.002	0.005	-0.049	0.001	0.000	-0.005	-0.001	-0.329	-0.037	0.001
NPBPP	0.009	0.000	**0.378**	-0.039	0.175	0.014	0.003	-0.027	0.001	0.323	0.110	0.009
	-0.001	0.000	**0.656**	-0.028	0.097	-0.001	0.002	-0.009	0.000	0.389	0.122	-0.001
NSBPP	0.008	0.000	0.028	**-0.663**	0.196	0.009	0.001	-0.024	0.003	0.344	0.112	0.008
	-0.001	0.000	0.012	**-0.479**	0.110	0.000	0.000	-0.008	0.000	0.419	0.125	-0.001
NCPP	0.002	0.000	0.021	-0.033	**1.198**	0.026	-0.002	-0.015	0.009	0.519	0.131	0.002
	0.000	-0.001	0.009	-0.024	**1.055**	-0.002	-0.001	-0.005	-0.001	0.639	0.148	0.000
DC	-0.014	0.000	0.014	-0.013	0.213	**-0.787**	0.024	0.005	0.005	0.688	0.159	-0.014
	0.000	0.000	0.002	-0.001	0.031	**-0.181**	0.005	0.001	0.000	0.225	0.048	0.000
NSPC	0.027	0.000	0.002	-0.001	-0.012	0.021	**1.122**	-0.016	-0.013	0.141	0.015	0.027
	-0.003	0.000	0.001	0.000	-0.007	-0.002	**0.650**	-0.005	0.002	0.169	0.018	-0.003
100SW	-0.011	0.000	-0.012	0.015	-0.057	0.003	-0.009	**0.218**	-0.003	0.009	-0.022	-0.011
	0.001	0.000	-0.005	0.010	-0.030	0.000	-0.005	**-0.200**	0.000	0.011	-0.023	0.001
DM	-0.074	0.000	0.000	-0.002	0.036	0.003	-0.007	-0.003	**0.224**	-0.016	0.029	-0.074
	0.008	0.000	0.000	-0.001	0.019	0.000	-0.005	-0.001	**0.411**	-0.019	0.032	0.008
BYPP	0.015	0.000	0.017	-0.025	0.223	0.036	0.008	0.001	-0.002	**-0.294**	0.118	0.015
	-0.002	-0.001	0.007	-0.018	0.127	-0.002	0.005	0.000	0.000	**0.588**	0.134	-0.002
HI	-0.007	0.000	0.020	-0.029	0.201	0.030	0.003	-0.009	0.011	0.421	**0.398**	-0.007
	0.001	0.000	0.009	-0.021	0.114	-0.002	0.002	-0.003	-0.001	0.520	**-0.835**	0.001
SYPP	**-0.512**	0.000	-0.003	0.004	-0.008	0.005	-0.012	0.009	0.056	-0.112	0.013	**-0.512**
	0.010	0.000	-0.002	0.003	-0.003	0.000	-0.007	0.003	-0.007	-0.132	0.015	**0.010**

DF50% = Days to 50% flowering, PH = Plant height, NPBPP = Number of primary branches per plant, NSBPP = Number of secondary branches per plant, NCPP = Number of capitulum per plant, DC = Capitulum diameter, NSPC = Number of seeds per capitulum, 100SW = 100 Seed weight, DM = Days to maturity, BYPP = Biological yield per plant, HI = Harvest index, SYPP = Seed yield per plant

Genetic variability and heritability of seed yield and yield contributing characters in safflower (*Carthamus tinctorius* L.)

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ABSTRACT

In the present study, genotypic and phenotypic variability were worked out on 34 genotypes of safflower for yield and yield contributing characters at Department of Genetics and Plant breeding at Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj during *rabi* 2021. The experiment was conducted by using RBD design with three replications. The information was compiled using 12 characters to examine the genotypes of safflower with regard to genetic variability, heritability, the connection of yield contributing components with yield The highest percentage of PCV (64.93), GCV (65.26) and heritability (99%) were found for number of Capitulum per plant. Low heritability estimates were found for the seed index and capitulum diameter whereas moderate genetic gain was seen for capitulum diameter, days to maturity, days to 50% flowering, and plant height. When a trait is highly heritable and genetic progress as a percentage of the mean, it is likely that additive gene action, with equal contributions from non-additive and additive gene action, is responsible for the trait.

Keywords: Genotypic variability, Phenotypic variability, Safflower

Safflower (*Carthamus tinctorius* L.), can endure climate change because to its low water and input requirements, as well as its wide range of soil type adaptability. Safflower is produced in 500000 mt annually across 60 different nations. India, the world's top producer, accounts for about half of global production and a majority of global consumption. The tap root system of a safflower plant contributes to the enhancement of soil structure and aids in the absorption of soil moisture. Since it can produce linoleic and oleic acid, it can be a wonderful replacement for present oilseed crops. Safflower is a significant oilseed crop because it contains 78% PUFA (Linoleic Acid), which is advantageous for those with heart disease because it lowers blood cholesterol levels (Nimbkar 2002). Safflower is crucial for making medications from plants and is also used as animal feed in addition to being beneficial as an oilseed crop. Studying genetic variability can help identify parents who are genetically varied because hybrids resulting from parents of different origins exhibit more heterosis. Correlation and path analysis gives the relation between direct and indirect effect of yield attributing characters with each other. The genetic base will be widened, genetic resources will be conserved, and there will be practical applications in plant breeding thanks to the examination of genetic diversity and path analysis that follows.

MATERIALS AND METHODS

The experiment was conducted at the Department of Genetics and Plant breeding at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj for component relationship and genetic variability of seed yield and its contributing attributes during *rabi* 2021–2022. One check of safflower was among the experimental material's 34 genotypes. Based on the randomized block design with three replications, these genotypes were planted in the field. Each genotype was cultivated in five rows of three meters each, with a spacing of 45x20 cm To guarantee good crop stand, recommended agronomic and plant protection techniques were carried out. By selecting five randomly chosen plants from each plot, the mean data were collected on twelve yield-contributing characteristics, including days to 50% flowering, plant height, number of primary branches, number of secondary branches, number of capitula per plant, capitulum diameter, number of seeds per capitulum, days to maturity, 100 seed weight, biological yield, and seed yield per plant. The computation of phenotypic correlations followed Weber and Moorthy's recommendations (1952).

RESULTS AND DISCUSSIONS

The analysis of variance showed that there were substantial differences between the genotypes for all traits. The data for all 12 characters that displayed significant differences were then subjected to additional statistical analysis.

GENETIC VARIABILITY

Thirteen genotypes were found to have higher seed/plant than Check variety SSF 12-40 out of 34 genotypes that were examined for 12 distinct traits. SSF-1870, SSF-708, SSF 18-123, SSF 2021-27, SSF 2021-4, SSF-1871, SSF 2021-18, SSF-1855, SSF 2021-2, SSF-1833, SSF 2021-6, SSF-1883, and SSF-1708 were among the varieties that made up these genotypes. Therefore, by generating variety through hybridization and selection, these genotypes may be utilized in next breeding programs to generate superior varieties with advantageous economic qualities for mankind. For seed output/plant, which came in second to capitulum count/plant, significant GCV and PCV were noted. While low GCV and PCV were recorded for days to maturity, days to 50% flowering, and capitulum diameter, both moderate GCV and PCV were recorded for the number of primary and secondary branches/plant, Seed Index, the number of seeds/ capitulum, and the biological yield/plant, suggesting that improvement in these characters may be possible to some extent.

HERITABILITY AND GENETIC ADVANCE

Number of primary and secondary branches/plant, number of capitula/plant, biological yield/plant (g), and seed production/plant (g) all had high genetic advance estimates as a percentage of the mean. For seed index, plant height, and the number of seeds/capitulum, high estimates of heritability were combined with moderate genetic advance as% of mean; on the other hand, low estimates of heritability were combined with minimal genetic advance as % of mean for days to 50% flowering, capitulum diameter, and days to maturity. Since these qualities are controlled by additive gene action, direct selection can be used to enhance them. In terms of biological yield/plant, number of secondary branches, number of capitulum/plant and seed yield/plant (g), GCV and high heredity were noted. This demonstrated that these qualities are advantageous for selection in breeding programs because they are relatively less influenced by the environment.

According to the results of the current investigation, 13 safflower genotypes viz; SSF-1870, SSF-708, SSF18-123, SSF2021-27, SSF2021-4, SSF-1871, SSF2021-18, SSF-1855, SSF2021-2, SSF-1833, SSF2021-6, SSF-1883, and SSF-1708 possessed the highest seed yield per plant relative to the control variety SSF-12-40. The results of the analysis of variance also support the conclusion that all the investigated features exhibit significant variation among genotypes. For seed output/plant, which came in second to Capitulum count/plant, significant GCV and PCV were noted. In contrast, characters with reasonable estimations of GCV and PCV both included the number of primary and secondary branches/plant, the Seed Index, the number of seeds/Capitulum, and the biological yield/plant. Additionally, genetic data showed that all features, with the exception of Capitulum diameter and seed index, showed substantial heritability (in the broad sense).

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Table 1 Analysis of Variance for 12 different characters in Safflower

Characters	Mean Sum of Square		
	Replication(df=2)	Genotypes(df=33)	Error(df=66)
Days to 50% flowering	0.14	42.96**	1.60
Plant Height (cm)	1.04	317.44**	1.86
No. of primary Branches	0.41	43.5**	0.76
No. of secondary Branches	0.38	348.17**	4.20
No. of Capitulum per plant	1.96**	713.43**	2.41
Diameter of Capitulum (cm)	0.06	0.03	0.02
No. of seeds per capitulum	0.67	84.82**	1.88
100 seed weight (gm)	0.13	3.22*	0.20
Days require to maturity	9.21	38.60	0.60
Biological yield per plant (gm)	1.98**	2236.815**	0.44
Harvest Index	3.71	546.92**	0.80
Seed yield per plant (gm)	0.53	1922.653**	0.61

**,* significant 5% and 1% level of significance respectively

Table 2 Genetic parameters for 12 characters in Safflower

Characters	GV	PV	GCV	PCV	H^2(bs)	GA	GA %Mean
Days to 50% Flowering	13.78	15.39	3.48	3.68	90.00	7.24	6.79
Plant Height (cm)	105.19	107.05	7.89	7.96	98.00	20.94	16.10
No. of Primary Branches / Plant	14.24	14.97	35.57	36.48	95.00	7.58	71.44
No. of Secondary Branches / Plant	114.66	118.85	46.99	47.84	96.00	21.67	95.07
No. of Capitulum / Plant	237.01	239.42	64.93	65.26	99.00	31.55	133.08
Diameter of Capitulum	0.00	0.02	1.90	7.13	70.00	0.02	1.05
No. of Seeds / capitulum	27.65	29.53	17.09	17.66	94.00	10.48	34.07
100 Seed Weight (Seed Index)	1.01	1.20	17.51	19.16	84.00	1.89	32.96
Days Required to Maturity	12.67	13.27	2.59	2.65	95.00	7.16	5.20
Biological Yield per Plant (g)	745.46	745.90	43.79	43.80	100.00	56.23	90.18
Harvest index	182.04	182.84	23.12	23.17	100.00	27.73	47.52
Seed Yield per Plant (g)	640.68	641.29	65.16	65.19	100.00	52.12	134.16

GV= Genotypic variance, PV= Phenotypic variance, GCV= Genotypic coefficient of variance, PCV= Phenotypic coefficient of variance, GA= Genetic advance, H^2(bs)= Heritability (broad sense).

Standardization of screening technique for root rot disease (*Macrophomina phaseolina*) of castor

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ABSTRACT

Root rot caused by *Macrophomina phaseolina* is a major disease of castor in endemic areas and under water stress conditions. Sick pot method was found better artificial inoculation method for screening of castor genotypes than stem tape inoculation method and sorghum grown inoculum of *M. phaseolina* @ 35 g/kg soil standardized for sick pot method. In both inoculation methods, parental lines ICS-303, ICS-304, ICS-305, ICS-319, DPC-22, and IPC-46 recorded <10% root rot incidence, while ICS-298, ICS-312, and ICS-321 recorded <20% root rot incidence.

Keywords: Castor, Macrophomina phaseolina, Root rot, Screening technique

The castor crop (*Ricinus communis* L.) is affected by major diseases *ie* gray mold, Fusarium wilt and root rot. Among these, root rot caused by *M. phaseolina* is a major disease in endemic areas and under water stress conditions (Rajani and Parakhia, 2009). The root rot appeared in Andhra Pradesh, Maharashtra, Gujarat, Bihar, Karnataka and Tamil Nadu and disease incidence ranged from 5 to 60% especially in Gujarat region. The different symptoms *viz*., seedling blight / die-back, spike blight, stem blight, collar rot, root rot and twig blight were observed (Maiti and Raoof, 1984). The sources of resistance to root rot in castor lines needs to be explored; hence studies were initiated to standardize the screening technique and evaluating the castor parental lines.

MATERIALS AND METHODS

M. phaseolina was isolated from root rot infected castor roots and pure culture was maintained on PDA at 25 ± 2 °C. The culture discs from the seven-day old culture inoculated to boiled and autoclaved sorghum grains for mass multiplication and incubated for 10 days at a temperature of 25 ± 2 °C. The different levels of inoculum load of sorghum grown *M. phaseolina* at 25, 30, 35, 40, 45, 50 g each per kg of soil was mixed and kept for 2 days. The castor genotypes GCH-4 (Susceptible check), JI-357 (Resistant check) were sown in these pots in 3 replications (10 pl/pot).

The parental lines *ie* ICS-298, ICS-299, ICS-303, ICS-304, ICS-305, ICS-312, ICS-314, ICS-316, ICS-318, ICS-319, ICS-321, DPC-22, IPC-46 along with susceptible check GCH-4 and resistant checks - JI 357 (2019-20); JI-449 (2021-22) were evaluated against root rot both by stem tape inoculation method and sick pot method. In sick pot method, seeds were sown in the pots containing sterilized soil mixed with sorghum grown pathogen inoculum at 35 g/kg soil and the seeds sown in sterilized soil without adding pathogen inoculum served as control. The root rot incidence was recorded at intervals upto 40 days after sowing by assessing the percentage of dead plants. In stem tape inoculation method, the hypocotyl region of the 25-30 days old plants was superficially wounded at 2-3 cm above the soil surface and the mycelial disc of *M. phaseolina* placed against the wound and covered with cellophane tape. The control plants were inoculated with a sterile PDA disc. The root rot incidence recorded at intervals upto 20 days after inoculation by assessing the percentage of dead plants and length of lesion on the stems.

RESULTS AND DISCUSSION

Optimization of inoculum load for sick pot method: In GCH-4, the root rot incidence varied from 45.8 to 100 % while in JI-357, the root rot incidence ranged from 5.0 to 20.0% in different inoculum levels of 25 to 50 g/kg soil, respectively. Among them, sorghum inoculum of 35 g/kg soil recorded 100% root rot incidence in GCH-4; while 20.0% root rot incidence in JI-357. Hence, sorghum inoculum of *M. phaseolina* @ 35 g/kg soil has been standardized for sick pot method.

Parental lines were tested by both stem tape inoculation method and sick pot method along with GCH-4 (susc. check) and resistant checks JI-357 (2020-21) & JI 449 (2021-22). The root rot incidence (%) ranged from 0.0 to 55.2% in the entries in sick pot method, while 0.0 to 26.7 % in stem tape inoculation method. In both inoculation methods, parental lines ICS-303, ICS-304, ICS-305, ICS-319, DPC-22, IPC-46 recorded <10 % root rot incidence and ICS-298, ICS-312, ICS-321 showed < 20 % root rot incidence during both years of testing. GCH-4 (Susc. check) recorded 65.2 and 93.3% root rot, while JI-357 (resistant check) recorded 5.6 and 8.3 % root rot incidence in stem tape inoculation and sick pot methods, respectively (Fig. 1) during 2020-21. The susc. check GCH-4 recorded 96.6 % root rot and JI-449 (resistant check) recorded 6.9 % root rot incidence in sick pot method during 2021-22. In stem tape inoculation method, the progress of root rot disease after inoculation was very slow and late in the appearance of symptoms, while it was fast with early appearance of root rot symptoms in sick pot method. Hence sick pot method is being followed in screening of castor genotypes against root rot under pot culture conditions. Identification of root rot resistant parental lines will be useful to researchers working on castor crop improvement for developing multiple resistant cultivars.

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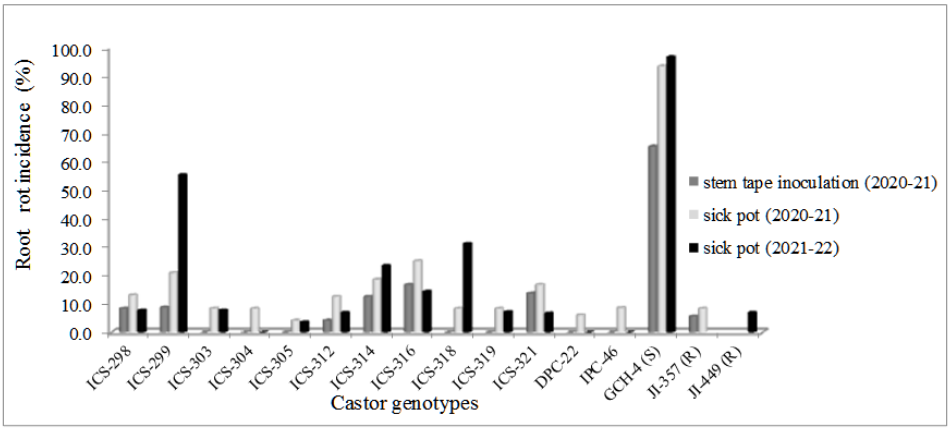

Fig.1. Screening of selected parental lines of castor against root rot disease under pot culture conditions

Nutraceutical potential of traditional fermented soybean (*Hawaijar*)

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ABSTRACT

Fermentation not only reduces the toxins but also it is an excellent processing method for improving nutritional and functional properties of soybean due to the increased content of small bioactive compounds. The NEH region of India also has similar traditional fermented soy products. ACE inhibitory activity was found to increase during fermentation and exhibited higher ACE inhibition percent in starter culture strain (H) than starter culture strain (S) of both the soybean used (local small variety and JS-335). Fermentation of soybean with different micro-organisms improve the bio-functional properties due to the increase in free isoflavones and peptides.

Keywords: Fermented soybean, Nutraceutical potential, Traditional

Soybean is the most acknowledged source of plant protein, which also contributes to a wide range of health benefits. Soybean is consumed in two forms, unfermented and fermented. Soybean is considered a good substrate for functional foods, since fermentation by probiotics has the potential to (1) reduce the levels of some carbohydrates possibly responsible for gas production in the intestinal system, (2) increase free isoflavone levels and (3) favour desirable changes in bacterial populations in the gastro intestinal tract. Various processing activity reduces or removes this harmful elements. Fermentation can reduce anti-nutritional factors and objectionable flavour. This can be achieved by using microbial cultures in the form of mono and multi cultures. In India, people of North Eastern states traditionally prepare and consume fermented soybean.

MATERIALS AND METHODS

The seeds of JS-335 soybean variety were procured from Andro Research Farm, CAU, Imphal and local small variety were purchased from local farmers of Manipur. The seeds were cleaned manually, dried in sun and stored in plastic containers for further use. Soybean seeds were soaked in water. It is difficult to maintain consistent quality control when making traditional fermented soybean-*hawaijar*. So a scientific method for production of quality fermented soybean- *hawaijar* is established by inoculation with different starter culture strain S and H.

BIOCHEMICAL ANALYSIS

Fatty acid composition analysis using gas chromatography

The fatty acid profilling of the sample were done at Department of Biochemistry, ICAR-Indian Institute of Soybean Research (IISR), Indore.

ACE inhibition assay: The ACE inhibitory activity was assayed by using the modified method of Lieberman.

RESULTS AND DISCUSSION

Fatty acid profiling: The soybean samples were then fermented with different starter culture strain S and strain H. As part of a programme to improve the fermentation process of different soybean using starter culture of different strain, this study was focused on fatty acid profiles, which would be useful as food compositional data. As shown in table 1, the fermentation by different starter cultures seemed to affect the fatty acid contents. Five fatty acids were identified in the fermented samples (palmitic, stearic, oleic, linoleic and α-linolenic acid). Interestingly, our data showed that starter culture strain H inoculation in soybean fermentation contributed to an increase in concentration of unsaturated fatty acids (oleic, linoleic and α-linolenic) in both the soybean variety.

ACE inhibition assay: Angiotensin Converting Enzyme (ACE) converts angiotensin I to angiotensin II and inactivates bradykinin a potent vasodilator, thereby increasing the blood pressure and risk of cardiovascular disease. ACE inhibitory peptides derived from protein rich foods can be used for treating high blood pressure and hypertension. During soybean fermentation, the ACE inhibitory peptides are generated by proteolytic degradation of soybean protein fractions (glycinin and β-conglycinin). Fermentation of soybean with different micro-organisms improves the bio-functional properties due to the increase in free isoflavones and peptides

ACE inhibitory activity was found to increase during fermentation and exhibited higher ACE inhibition percent in starter culture strain (H) than starter culture strain (S) of both the soybean used (local small variety and JS-335) as shown in the fig. 1.

Soybean has a great potential as a source of important nutrients and nutraceutical of implication to human health. With further research and development and management efforts fermented soybean of NEH region could be exploited for the ever expanding nutraceutical and functional food industries.

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Table 1 Fatty acid profiles of fermented soybean – *Hawaijar* using different starter culture strain

Fatty acid	Sample No. 1 (S)	Sample No. 2 (H)	Sample No. 3 (S)	Sample No. 4 (H)
Palmitic acid	11.24	9.90	13.82	12.20
Stearic acid	2.24	1.81	1.50	1.91
Oleic acid	14.06	13.31	20.61	20.77
Linoleic acid	67.33	69.21	58.20	58.32
α Linolenic acid	5.10	5.75	5.80	6.78

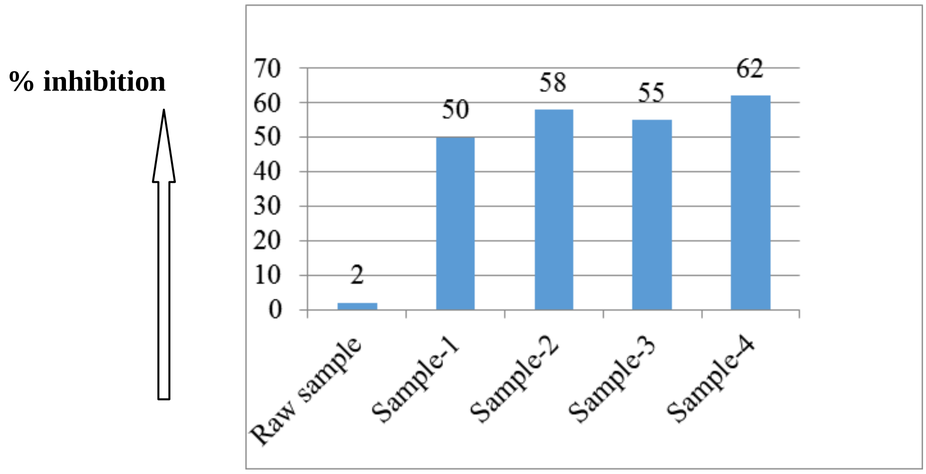

Fig.1: ACE inhibitory effect of fermented soybean

Novel approach to assess seed viability and vigour in Soybean genotypes through Q2 scanning technology

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ABSTRACT

The objective of the study was to establish relationship between seed germination and vigour parameters with an intension to predict the planting value of seed lots of soybean. The variation among genotypes was assessed for quality parameters. Different seed lots of variety JS 335 were analysed for seed quality in Q2 scanner. The vigour parameters estimated through Q2 scanning and conventional methods corresponded with each other. The correlation and regression analysis among germination and vigour parameters were worked out, which indicated significant values with respect to final count of germination and field emergence.

Keywords: Q2 Scanning Technology, Soybean genotypes, Viability, Vigour

Soybean is categorized as the most sensitive crop with reference to seed longevity owing inherent seed structure. In seed deterioration vigour loss precedes the germination loss. Quantifiable relationship between these two parameters may help in predicting the planting value of seed lots based on germination performance in the laboratory. The objectives of the study were to evaluate soybean genotypes for seed quality (germination and vigour) following accelerated ageing, to evaluate seed quality of samples from different seed lots of variety JS 335 by Q2 scanner and to establish benchmark among seed germination, vigour and field emergence under ambient storage.

MATERIAL AND METHODS

The experiment was carried out during 2019 and 2020 at the Department of Seed Science and Technology, PJTSAU, Rajendranagar and Division of Seed Science and Technology, University of Hoheinhom, Germany. The completely randomized design was followed for lab studies. Seed samples of eleven genotypes were subjected for accelerated ageing at 0, 24, 48 and 72 h and were assessed for seed quality parameters *viz.*, germination and field emergence eighteen seed lots of JS 335 were assessed for seed quality parameters viz., seed moisture, germination, seedling vigour indices and field emergence. Based on the germination percentage, the eight seed lots had shown above 70% germination according to IMSCS were selected and assessed through Q2 seed scanner and other conventional methods viz., Germination, Seedling vigour index I, Seedling vigour index II and Accelerated ageing. Q2 seed scanner provides a fast and accurate measurement of oxygen consumption i.e metabolic activity of individual seeds and correlates the respiration rate to the germination and vigour characteristics of the seed. As the soybean seed lots had showed linear slope and negative values for q2 ASTEC values viz., Increased metabolism time (IMT), Critical oxygen pressure (COP), Relative germination time (RGT) and Oxygen metabolism rate (OMR), the curves cannot fit in to the software. So, based on the raw data (excel) obtained from oxygen consumption curves, the seed lots were analyzed for alternate methods i.e., area above the curve and Oxygen percentage.

The seed of variety JS 335 harvested during monsoon season of 2018 and 2019 was assessed for seed quality parameters under ambient storage conditions for establishing association among germination and seedling vigour parameters.

RESULTS AND DISCUSSION

Seed samples of eleven genotypes were subjected for accelerated ageing at 0, 24,48 and 72 h and were assessed for seed quality parameters *viz.*, germination and field emergence. Significant variation was observed among the genotypes, among which Asb 15 showed highest seed germination and field emergence with least seed deterioration when compared with other genotypes. Eighteen seed lots of JS 335 were assessed for seed quality parameters *viz.*, seed moisture, germination, seedling vigour indices and field emergence. Based on the germination percentage, the eight seed lots had shown above 70% germination according to IMSCS were selected and assessed through Q2 seed scanner. Q2 seed scanner provides a fast and accurate measurement of oxygen consumption i.e., metabolic activity of individual seeds and correlates the respiration rate to the germination and vigour characteristics of the seed (Zhao *et. al*., 2013). As the soybean seed lots had showed linear slope and negative values for q2 ASTEC values viz., Increased MetabolismTime (IMT), Critical Oxygen Pressure (COP), Relative Germination Time (RGT) and Oxygen Metabolism Rate (OMR), the oxygen consumption curves cannot fit in to the software. So, based on the excel data obtained from oxygen consumption curves, the seed lots were analyzed for seedling vigour through other alternate methods i.e., Area above the curve and Oxygen percentage. Seed lot of Adilabad had showed high area above the curve and low oxygen percentage because the seed lot was active and consumption of the oxygen was more with high metabolic activity (Fig1). Similar results were obtained when data obtained from Q2 scanner compared with the conventional method i.e field emergence which are in line with findings of (Zhong, and Zhao, G. 2017). The variety JS 335 *(Kharif*, harvested seed of 2018 and 2019) were assessed for seed quality parameters viz., first count of germination, final count of germination, seedling dry weight, seedling vigour index, electrical conductivity, field emergence at 5thday and field emergence at 8th day under ambient conditions. The fall in germination corresponded with fall in vigour and field emergence over the months. There was a drasticreduction in vigour after 4th month of storage compared to fall in germination and trend continued up to 7th month of storage. All the seed quality parameters showed significant and positive correlation with final count of germination whereas electrical conductivity showed negative correlation and significant in JS 335 (*Kharif*, harvested seed 2018) and non-significant in JS 335 (*Kharif*, harvested seed 2019). The regression curves were fit for the pattern fall in germination and vigour. The seed germination had showed significant and strong relation with the seed quality parameters from the linear regression analysis. Significant variation was observed in germination and vigour when both seed lots were compared till five months of storage.

The results of the study indicated that the quantifiable relationship between germination and vigour over storage intervals gives an indication to the seed producers to predict planting value of the seed lots based on the germination data, without going for vigour tests. And also it is useful for the seed industry in deciding the field planting value for making decision regarding the marketing of seed lots. The standards for Q2 scanning for soybean seed vigour estimation are to be still established for estimation of ASTEC values.

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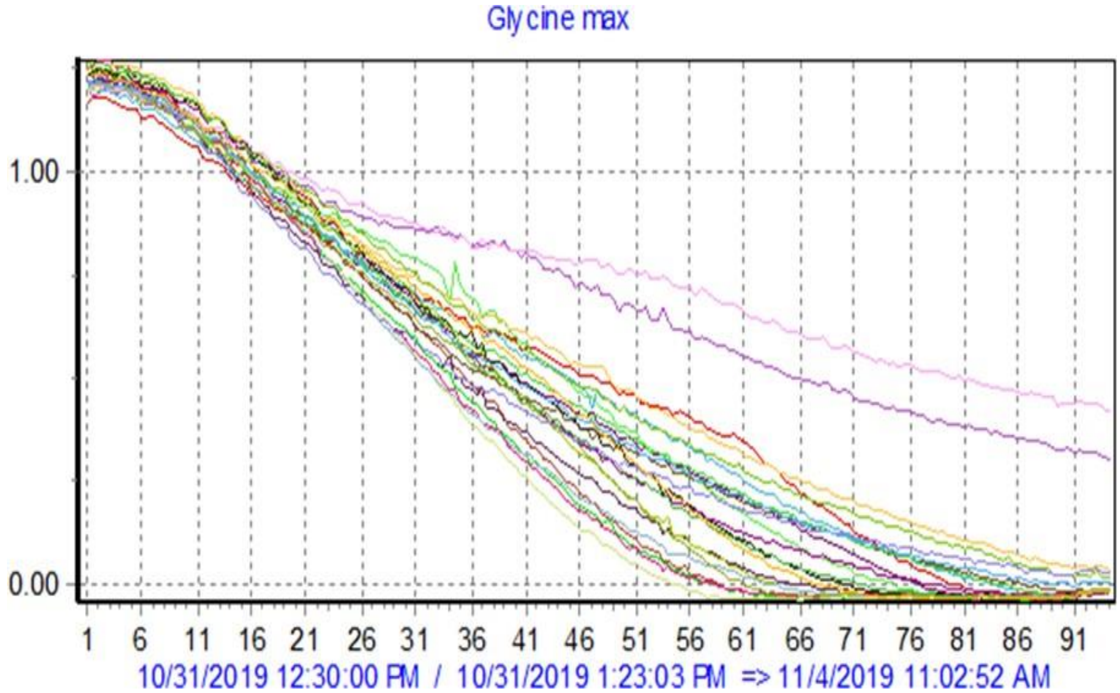

Fig. 1 Oxygen Consumption curves of different seed lots of variety JS 335(Adilabad) lot through Q2 Seed Scanner

Efficacies of new age fungicides against charcoal rot of sesame

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ABSTRACT

Six systemic fungicides were evaluated under *in vitro* condition by using poison food techniques at three different concentrations 500 ppm, 1000 ppm and 1500 ppm against root and stem rot pathogen of sesame (*Macrophomina phaseolina*) Tassi Goid. all the treatments were found to be superior over control in which T1 (Tebuconazole 50% + Trifloxystrobin 25%), gave 100% inhibition against test fungus (*M. phaseolina*) at all the concentrations (500, 1000 and 1500 ppm) followed by T6 (Carbendazim + Mencozeb), which gave 94.43% of average inhibition, followed by T5 (Captan + Hexaconazole), that gave 92.59% of average inhibition, followed by T4 (Cymoxanil + mencozeb) gave 83.15% average inhibition, followed by T5 (Pyraclostrobin + Metiram) with 57.28% of average inhibition. Least mycelial inhibition was given by T2 (Azoxystrobin) with only 41.66%.

Keywords: Charcoal, Fungicides, Sesame

Sesame (*Sesamum indicum* L.) is one of the most ancient and traditional oilseed crops. Sesamin also contain bactericide potential, besides this it has wide application against liver skin oral and dental ailments because of its antioxidant nature. Area and production of sesame is declining day by day in the traditional sesame growing areas due to severe biotic stresses such as Bacterial blight, Macrophomina stem rot, Phyllody, Fusarium wilt, Powdery mildew, Alternaria leaf spot and Cercospora leaf spot. *Macrophomina phaseolina* may cause heavy yield losses in sesame, if management is not proper. Root rot/stem rot caused by *Macrophomina phaseolina* (Tassi.) Goid (= *Rhizoctonia bataticola*) is one of the most important diseases of sesame in India (Chattopadhyay and Sastry, 1998). Charcoal rot disease has diminished the production of sesame at about 27 million bushels per year in USA (Chattopadhyay and Sastry, 2002). Yield losses owing to *M. phaseolina* infection have been estimated up to 57% in sesame (*Sesamum indicum* L.) at 40% disease severity (Maiti *et al*., 1988). On object of finding the suitable fungicide for management of the Root and Stem rot disease of sesame the following research work has been carried out.

MATERIALS AND METHODS

Diseased plants with characteristic symptoms of Charcoal rot disease were collected from field and brought in pathology laboratory for isolation of pathogen. Infected roots were washed thoroughly with tap water and cut into small pieces of 4- 6 mm and surface sterilized with 1% NaOCl. At least 2-3 pieces of infected roots were placed in petri plate containing Potato Dextrose Agar (PDA) medium. The plates were incubated at 25^0C for 48-72 hours for fungal growth (Sarwar *et al.,* 2005). The poisoned food techniques (Nene and Thapliyal, 1982) was followed to evaluate the efficacy of fungicides. Six fungicides (Tebuconazole + Trifloxystrobin, Azoxystrobin, Pyraclostrobin + Metiram, Cymoxanil + Mencozeb, Captan + Hexaconazole and Carbendazim + Mencozeb) were tested in laboratory against *M. phaseolina* at a concentration of 500 ppm, 1000 ppm and 1500 ppm respectively with three replications were kept for each fungicide. Molten sterilized potato dextrose agar was used as medium and required quantity of each fungicide was added separately so as to get a requisite concentration of that fungicide. The fungicides were thoroughly mixed by stirring and about 20 ml poisoned medium was poured to each of the 90 mm petri dishes and allowed for solidification. The actively growing periphery of the seven days old culture of *M. phaseolina* was carefully cut using a cork borer and transferred aseptically to the centre of each petridish containing the poisoned solid medium. Suitable control was maintained by growing the cultures on PDA without fungicides. The plates were then incubated at 28 ± 1ºC in BOD incubator and observations were recorded after 5 days of inoculation. The per cent growth inhibitions under the influences of different fungicides were calculated on the basis of control.

RESULT AND DISCUSSION

At 500 ppm, no growth was observed in Tebuconazole 50% +Trifloxystrobin 25%. Comparatively less growth was observed at Carbendazim + Mencozeb (15.16 mm). Maximum growth was observed at Azoxystrobin (56.33 mm) at 500 ppm.At 1000 ppm, no growth was observed in Tebuconazole 50% +Trifloxystrobin 25%. The growth of *M. phaseolina* was completely inhibited by Captan + Hexaconazole and Carbendazim + Mencozeb at 1000 and 1500 ppm. Maximum growth was observed into Azoxystrobin (53.33 mm) at 1000 ppm. At 1500 ppm, the maximum growth was seen into Azoxystrobin (47.83 mm), followed by Pyraclostrobin + Metiram (25.33 mm) growth. The maximum growth of *M. phaseolina* was recorded into control (90.00 mm). All fungicides were superior over control at 500 ppm, 1000 ppm and 1500 ppm. Complete inhibition of mycelial growth was recorded by T1 (Tebuconazole 50% +Trifloxystrobin 25%) at all the three concentrations taken. However, T6 (Carbendazim + Mencozeb) and T5 (Captan+ Hexaconazole) exhibited complete inhibition at 1000 ppm. At 1500 ppm T3 (Pyraclostrobin + Metiram) and T4 (Cymoxanil + Mencozeb) inhibited more than 50% growth of *M. phaseolina* while T2 (Azoxystrobin) showed less than 50% inhibition of growth at all used concentrations. The results indicated that all fungicides were superior over control at 500 ppm, 1000 ppm and 1500 ppm and complete inhibition of mycelial growth was recorded by Tebuconazole 50% + Trifloxystrobin 25 % at all the three concentrations taken (100% inhibition).These results satisfy the findings of Bashir *et al*., (2017) who evaluated six fungicides against *M. phaseolina* causing root & stem rot of sesame and the mean colony growth of all treatments expressed that Nativo (Tebuconazole 50% + Trifloxystrobin 25 %) exhibited minimum colony growth of pathogen.

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Variability of *M. phaseolina* Sesame isolates obtained from different geographical region

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ABSTRACT

The cultural characteristics of the three isolates were studied, the cultural characters of the isolates colony growth, colony texture, colony colour type studied. Into which all the isolates show variability into the characters of the isolates. In case of colony colour isolate Mp 1 (Jabalpur, M.P.) and Isolate Mp 2 (Mandor, R.J.) show grey coloured colony was observed but isolate Mp 3 (Vridhachalam, T.N.) show dark black colour colony. In case of colony texture two type of colony texture was seen, Appressed and fluffy growth and suppressed and dense growth. In case of Mp 1 (Jabalpur) and Mp 2 (Mandor) isolate , appressed and fluffy growth types of growth was observed while in case of isolate Mp 3 (Vridhachalam) suppressed and dense growth was seen. All the isolates of *M. phaseolina* do not show any kind of significant difference in colony growth. Maximum radial growth (90.00 mm) was observed in all three isolates of *M. phaseolina*.

Keywords: Isolates, *Macrophomina phaseolina*, Root rot, Sesame

Sesame is under constant threat by many diseases *viz.*, charcoal rot/stem rot/root rot, powdery mildew, leaf blight, wilt, leaf spot, stem blight,, bacterial leaf spot and phyllody. Among these root rot/stem rot caused by *Macrophomina phaseolina* (Tassi.) Goid (= *Rhizcotonia bataticola*) is the most important disease of sesame in India (Chattopadhyay and Sastry, 1998). Root rot / charcoal rot / stem rot caused by *Macrophomina phaseolina* (Tassi.) Goid., is one of the most devastating fungal disease, affecting the crop at all stages of crop growth and causing 5-100% yield losses (Vyas, 1981) and sometimes 42-45% yield losses in India (Usha Rani *et al.,* 2009). Distributed worldwide and *M. phaseolina* attacks crop plants at different stages of plant growth and causes complex disease syndromes like root rot, seedling blight, charcoal rot, ashy stem blight, wilt, collar rot, dry rot, pod rot and seed rot in several crops. *Macrophomina phaseolina* is infect the sesame plant in any stage of growth when temperature varies from 28^0C to 32^0C and germination of microsclerotia showed maximal growth at 30-33C the stem rupturing upward and becomes blackish in colour. The roots will become brittle and black colour dots appear on stem. The present studiesprovide information on the variability of *M. phaseolina* in major sesame growing state *viz*., Madhya Pradesh, Tamil Nadu and Rajasthan.

MATERIAL AND METHODS

Collection of root rot samples: The representative disease samples bearing micro sclerotia of the fungus and characteristic symptoms of root rot were collected from. Madhya Pradesh, Tamil Nadu and Rajasthan. The diseased specimens were packed in paper bags and properly labeled, brought to the laboratory and stored at 4ºC until processed for identification.

Isolation and purification of the pathogen:-The root rot infected root samples collected from the field were used for isolation of the pathogen. The pathogen was isolated from the infected root and purified by adopting hyphal tip method (Rangaswami, 1972).These isolates were further used in variability studies. The mycelial discs of 5 mm diameter were cut from the edge of a three days old culture and transferred aseptically to 90 mm Petridish containing 15ml PDA. These plates were incubated at 28±1 °C into BOD incubator. Each treatment was replicated thrice. The colonies of isolates were characterized for various cultural characters at 72 h after incubation. Seven day old culture were used to record texture, colour, type of margins and presence or absence of aerial mycelium into the cultures.

RESULTS AND DISCUSSION

Cultural variability in *Macrophomina phaseolina (Rhizoctonia bataticola)* isolates: Variability in the cultural characteristics of three isolates of *M. phaseolina* was studied on potato dextrose agar medium. The colony growth rate, colony colour, colony texture and type of margin of the colony were studied. Three isolates of *M. phaseolina* (*Rhizoctonia bataticola*) were studied for colony growth. There was no significant difference in the colony growth rate of all isolates at 72 hours after inoculation at 28 ± 1ºC. The maximum colony growth of 90 mm was observed in all the isolates.The results are in agreement Karibassappa *et al*.,(2020) who collected ten isolates of *Macrophomina phaseolina* (Tassi) Goid of sesame and found colony colour varied from black, grey and light grey colour in PDA medium. With respect to the colony colour, three isolates of *M. phaseolina* (*Rhizoctonia bataticola),* showed 2 types. The isolate Mp 3 was gave dark black colour colony, while isolate Mp 1 and Mp 2 gave blackish grey colour colony. Mohanapriya *et al*., (2017) reported that in all the 10 isolates of *M. phaseolina* different types of colony colours on Potato Dextrose Agar (PDA) medium. Same results were also observed by Lakhran and Ahir (2020) who found whitish, grayish and blackish colour colony appearance of *M. phaseolina* of sesame on PDA. The three isolates of *M. phaseolina* (*Rhizoctonia bataticola)* showed 2 types of colony texture *viz.*, appressed and fluffy growth and suppressed and dense growth. Isolate Mp 1 and Mp 2 were observed appressed with fluffy growth while the isolate Mp 3 showed suppressed and dense growth into the culture medium. The findings are in line with the earlier reports(Satpathi and Gohel,2018). They found that isolates *M. phaseolina* of different geographical regions had different topography of colonies *viz*., Fluffy, Dense uniform and circular and Flat and dense.

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Seed production technology of sunflower (*Helianthus annuus*): An update

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ABSTRACT

Sunflower (*Helianthus annuus*) belonging to the family Asteraceae was introduced in India in 1969 and became one of the important oilseed crops. The oil is used for culinary purpose, preparation of cosmetics etc. Seed production can be taken up in all the three seasons like *kharif, rabi* and summer. For rainfed conditions June – July and October – November and for irrigated conditions April – May and December – January is suitable for seed production. Sunflower oil is light yellow in colour and possesses good odour, which can be used for a variety of cooking purposes like any other edible oil. Sunflower oil is a rich source of linoleic acid (64%), which helps in washing out of cholesterol deposition in the coronary arteries of theheart, and thus it is good for heart patients. The oil is used for manufacturing hydrogenated oil.Its oil is also used in manufacture of soaps and cosmetics. The sunflower cake contains 40-44% high quality protein. It is ideally suited for poultry and livestock rations. The sunflower kernels can be eaten raw or roasted. It can also be used for manufacturing baby foods.

Keywords: Seed production, Seed selection, Sunflower

Sunflower is a cross pollinated crop. Anthesis takes place between 5 – 8 am and the pollen grains are viable for 12 hours. Honey bees are the pollinating agents. During pollination if the insect activity is low, it will result in poor seed setting and poorly filled seeds. The isolation distance maintained between varieties is 200 metres for certified and 400 metres for foundation seed production. The potential of the seed storage depends on the oil content of the seeds. Sowing in September - October result in seeds with low oil content. Hence the storage potential of the seed is very high. If sowing took place in March – April, the resulting seeds will be high in oil content with less storage potential.

Seed production involves three stages, breeder seed, foundation seed, and certified seed. The common crop growing conditions and the practices to be followed for scientific method of producing the seeds include the following.

Land: The land selected should not be cultivated with sunflower in the previous season. The soil should be fertile with neutral pH and good drainage facility.

Seed selection and sowing: Seeds should be obtained from the appropriate source approved by the seed certification agency. Fresh seeds possess 45 – 60 days of dormancy. To break the dormancy, the selected seeds should be soaked in water for 12 – 16 hours and seeds can also be leached in running water. Seed rate is 3 – 4 kg/acre (8 - 10 kg/ha). Treated seeds are sown in the field with a spacing of 45 x 30 cm.

Nutrient management: FYM or compost @ 4 tonnes/acre (10 tonnes/ ha) is thoroughly incorporated into the soil before the last plough. This will improve the texture as well as the nutrient content of the soil. NPK @ 16: 8: 8 kg/acre (40: 20: 20 kg/ha) is recommended for better seed yield. Nitrogen supply can be split into two halves and applied as basal dose at the time of sowing and as top dressing after 30 – 35 DAS just after weeding.

Weed management: Maintaining the seed field free from weeds and unwanted plants is very important for successful seed production. A total of two hand hoeing and a weeding should be done. First weeding is done 30 – 35 days after sowing.

Disease management:Alternaria blight may assume serious proportions in the rainy season and may reduce yields drastically. The dark brown and black coloured spots, if seen on any plant part, should be immediately sprayed with 0.25 per cent spray of dithane M-45 or dithane Z-78 at one to two weeks intervals.Sclerotium wilt affected plants should be uprooted and burnt. Growing of sunflower in longer duration rotational cycles is recommended.

Insect management: No serious pest of sunflower has been noticed. The crop should be watched against attack by cut worms during the seedling stage, for head borer damage at the bloom stage and for jassid attack all the time. Mixing of 5 per cent heptachlor dust in soil at 15 kg per hectare will control cut worms and one to two sprays of 0.025 per cent metasystox (25 E.C.) will take care of the other two insects.

Irrigation: First irrigation is done soon after the seed sowing. On the third day after sowing field should be again irrigated. After this depending on the nature of the soil field should be irrigated once in a week. Irrigation is very critical during flowering and seed maturation stages.

Water scarcity at these stages result in ill-filled seeds. Proper irrigation will result in high yield of seeds.

Roguing: Roguing should be done from vegetative phase up to harvest. Off-types should be removed based on the plant height, head size, branching habit, number of heads and colour of seeds. Maximum percentage of off-types permitted at and after flowering stage is 0.10% for foundation seed production and 0.20% for certified seed production. The percentage of plants affected by downy mildew allowed in foundation stage of seed production is 0.05% and 0.50% for certified stage of seed production.

Field inspection: A minimum of three inspections will be done from vegetative to harvesting stage by the Seed Certification Officer. Normally first inspection is done at the stage when 6 – 7 pairs of leaves are present to check the isolation, presence of volunteer plants and designated diseases. Second inspection will be made during flowering stage to check isolation, off-types and other factors. Sometimes third inspection will be scheduled prior to harvest to verify the designated disease, true nature of plant, flower head and seed and also to estimate the yield of seed crop.

Supplementary pollination:Supplementary pollination is done when the insect activity is low. Palm covered with muslin cloth is used to rub the flower heads to make sure all the flowers are fertilized and increase seed setting.

Harvesting: Sunflowers should be harvested when the backside of the flower heads turn lemon yellow from green. After anthesis in about 40 to 45 days the heads will mature. Heads are harvested in one picking.

Threshing and drying: The harvested heads are dried under the sun for a couple of days to reduce the moisture content to 15 to 18%. After this the seeds are removed from the heads by hand threshing or mechanically using sunflower thresher. After threshing seeds are dried under the sun to obtain the moisture content of 10 to 12%.

Processing: Seeds dried to an optimum moisture content are graded using 9/64" round perforated sieve as middle sieve using OSAW cleaner cum grader.

Seed storage: Seeds can be stored in gunny bags for up to 10 months and in 700 gauge polyethylene bags for about 15 to 18 months.

Seed standards: The percentage of physical purity of foundation and certified seeds should be 98% with 70% of germination capacity and 9% of moisture content.

Principle of hybrid seed production in sunflower: Hybrid sunflower is produced by using cytoplasmic male sterility and genetic fertility restoration system. The male sterile line (A line) contains sterile cytoplasm and recessive genes for fertility restoration. This is maintained by a male fertile counterpart (B line) which also contains recessive genes, but has fertile cytoplasm.

For production of hybrid seed male sterile line (A line) is crossed with a fertility restorating line (R line) which has the dominant genes for fertility restoration, but may have either sterile or fertile cytoplasm. The restorer line (R line) should nick well A line to produce F1 hybrid seed.

The practices followed for A line, R line and Hybrid are well standadised and the crop management is similar to what has been described above.

Stability analysis of different sunflower hybrids (*Helianthus annuus* L.)

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ABSTRACT

In present study eleven hybrids along with two check hybrids were evaluated for seed yield/plot (g), head diameter (cm), plant height (cm) and 100 seed weight (g) over three environments. The Genotype x environment interaction was found significant for all the characters suggesting the presence of genetic variability in the hybrid population. The environment indices revealed that E_1 was the favorable environment for seed yield/plot (g), $E_2$for 100 seed weight (g), and for plant height (cm) and head diameter environment E_3 was favorable. With respect to stability parameter, the hybrids SVSH-488, SVSH-514, SVSH-517 and check Phule Raviraj were stable for seed yield/plot (g); SVSH-520 for head diameter (cm); SVSH-488, SVSH-512, SVSH-517, SVSH-519 and check Phule Raviraj stable for 100 seed weight (g) with high mean, bi value nearer to unity (bi=1) and non-significant S^2di. For plant height (cm) SVSH-512, SVSH-513, SVSH-514 and SVSH-517 showed stable performance.

Keywords: Genotype and parameters, Stability, Regression coefficient

Information leads to successful evaluation of stable genotype, which could be used for general cultivation. Yield is a complex quantitative character and highly influenced by environmental fluctuation; hence selection for superior genotype based on yield at single location may not be very effective. Thus, evaluation of genotype in different environment condition for yield is important aspect of any breeding programme. Breeding efforts are directed towards increase the yield levels through the development of high yielding varieties and hybrids for different seasons. Hence, there is a need for the development of season specific hybrids in addition to the identification of stable hybrids over environments.

MATERIALS AND METHODS

In the present study 9 hybrids along with two checks *viz*; (Phule Raviraj and MDSFH-411) were evaluated in randomized block design with three replication and evaluated in three different centers of Mahatma Phule Krushi Vidyapeeth, Rahuri, Maharashtra *viz.*, Savalvihir (E1), Rahuri (E2) and Solapur (E3) in during *kharif* 2021. The performance of different hybrids studied for four characters studied and estimating the stability and significance of G X E interactions. Each hybrid was represented by five rows of 4.5 m length with 60 x 30 cm spacing between and within rows, respectively. Observations were recorded in each entry on per plot basis for seed yield, for 100 seed weight randomly selected 100 seeds and for head diameter and plant height on five plant basis. The analysis was carried as per standard method of Eberhart and Russell (1966) by using INDOSTAT software in order to estimate the three parameters of stability *viz*., mean, regression coefficient (bi), and mean squared deviation (S^2di) for each genotype.

RESULTS AND DISCUSSION

In the present investigation the genotypes x environments interaction were found to be highly significant for all the characters studied when tested against pooled deviation indicating significant difference among them. The Environment + (G x E) and Environment (linear) were found non significant for all the characters under studied when tested against pooled deviation. Estimates of environmental indices (Ij) suggested that Savalvihir was the most favorable environment for seed yield per plot; Solapur for 100 seed weight as well as plant height and Rahuri for 100 seed weight. The significance of G x E interactions has also been reported by Bhoite *et al*. (2018).

The stability parameters for seed yield per plot (g) four out of eleven hybrids have non linear portion of G x E interaction as only S^2di values non significant for seed yield per plot (g). Among the hybrids, hybrid SVSH-514, SVSH-517 and check Phule Raviraj were with high mean than hybrid mean (1.08 g) along with mean squared deviation (S^2di) non significant and regression coefficient (bi) were more than unity (bi>1), hence this hybrids found highly responsive suitable for favorable environments showed below average stability. Hybrid SVSH-488 found high mean value with non significant S^2di and bi less than unity showed above average stability suitable for unfavourable environment. Similar results were also reported by Bhoite *et al*. (2018).

The result for head diameter, three hybrids were with high mean values than hybrid mean (14.5 cm) and mean squared deviation (S^2di) non significant. Hybrid SVSH-520 and check Phule Raviraj exhibited high mean values coupled with regression coefficient less than unity (bi<1) and non significant S^2di indicating it's highly responsive suitable for unfavourable environment i.e. above average stability (bi<1). Hybrid SVSH-488 with high mean, non significant S^2di and bi value more than unity showed below average stability and suitable for favourable environment. These findings are in conformity with Tyagi *et al*. (2018). Not clear

The hybrid namely SVSH-512, 514 and 517 recorded significantly lower values for plant height than hybrid mean (167 cm) with regression coefficient less than unity (bi□1) and non significant deviation from regression (S^2di), thus found stable above average stability and suitable for poor environment also reported by Chandra *et al*. (2018).

For 100 seed weight five hybrids found high mean values than hybrid mean (5.3 g). Hybrids SVSH-488,512 and check Phule Raviraj exhibited high mean values coupled with regression coefficient more than unity and non significant S^2di indicating its highly responsive suitable for favourable environments i.e. below average stability (bi>1). SVSH-519 found high mean S^2di non significant and bi less than unity showed above average stability suitable for unfavourable environments. Hybrid SVSH-517 found stable for all type of environment (bi=1). These findings are in conformity with Tyagi *et al*. (2018).

From the above findings, it could be summarized that none of the hybrids were stable for all the characters under study. Similar results were also reported by Bhoite *et al.* (2018). Based on mean performance for seed yield/plot, 100 seed weight and head diameter the hybrid SVSH-488 was found superior. For plant height hybrid SVSH-513 was found stable for poor environment.

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Table: Analysis of variance for stability (Eberhart and Russell, 1966) for seed yield per plot, Head diameter Plant height (cm) and 100 seed weight in sunflower hybrids

Characters	Genotype	E + (G x E)	Environment	G x E	E (L)	G x E (L)	Pooled deviation	Pooled Error
	10	22	2	20	1	10	11	60
Seed yield per plot (g)	0.06**	0.08	0.05**	0.04**	0.93	0.06*	0.02**	0.01
Head diameter (cm)	0.88**	4.10	30**	1.48**	61	1.25	1.55**	0.31
Plant height (cm)	254**	232	2066**	49**	4132	31	60**	22
100 seed weight (g)	0.38**	0.49	3.54**	0.18*	7.07	0.23	0.13	0.10

*, ** Significant at 5 and 1 per cent, respectively; SVSH=Savalvihir Sunflower Hybrid.

Genome-wide association study (GWAS) reveals key loci associated with rhizoctonia aerial blight resistance in soybean

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ABSTRACT

Rhizoctonia Aerial Blight (RAB) is caused by *Rhizoctonia solani* is one of the most worldwide devastating diseases in soybean. In present study, a GWAS was conducted for rhizoctonia aerial blight (RAB) resistance by using 269 diverse soybean genotypes for two consecutive year 2020 & 2021. GWAS analysis revealed two most significant SNPs, located very close each other on chromosome 12 (3193687 & 3193885) and 16 (6074131 & 6076330). Some candidate genes such as related to leucine-rich repeats containing (LRRNT; Glyma.16g064200), protein ubiquitination (F-box-like) and amino acid transmembrane transport (Trp_Tyr_perm; Glyma.16g062500 & Glyma.16g062600) were identified near the significant SNP positions. Our findings may be relevant for future studies and provide insights into the genetic basis for RAB resistance in soybean.

Keywords: GWAS, RAB resistance, Rhizoctonia Arial blight

Rhizoctonia Aerial Blight (RAB), also known as Rhizoctonia foliar blight and web blight, is caused by the fungus *Rhizoctonia solani*. The development and use of disease-resistant cultivars have been the most effective strategy to control RAB. Identifying the genes mediating RAB resistance is a prerequisite for breeding cultivars with broad-spectrum and durable resistance (Surbhi *et al*., 2021). In the present study, a genome-wide association study (GWAS) was conducted for RAB resistance in 269 genotypes of soybean to dissect allelic diversity and potential genes responsible for RAB resistance.

MATERIAL AND METHODS

Phenotypic evaluation was done for RAB resistance in two consecutive years 2021 and 2022. AUDPC (Area Under Disease Progress Curve) and DSS (Disease severity score) was calculated for 2021 and 2022. Genotyping was done for 254 soybean accessions with the help of GBS platform. GWAS panel exhibit a total of 570139 SNPs distributed on all over 20 chromosomes. After removing SNPs with 70% missing data, 56568 SNPs were left for analysis. Imputations were performed to fill missing data and finally a total of 66300 SNPs were used for association analysis. The LD analysis was performed in using SNPs that had MAF > 0.05. The association analysis was conducted by employing mixed linear model (MLM) in TASSEL 5.2.

RESULTS AND DISCUSSION

RAB infection ranges from 13.5 to 87.3%. GWAS analysis showed a total of 66300 SNPs distributed all over 20 chromosomes. GWAS analysis revealed two most significant SNPs, located very close each other on chromosome 12 (3193687 & 3193885) and 16 (6074131 & 6076330). Flanking regions of these significant SNPs were searched for candidate genes. Some candidate genes such as leucine-rich repeats containing (LRRNT_2; LRR_1; LRR_8; Pkinase; Glyma.16g064200), protein ubiquitination; negative regulation of defense response (FBA_1; F-box-like; Glyma.16g063500) and amino acid transmembrane transport; response to karrikin (Trp_Tyr_perm; Glyma.16g062500 & Glyma.16g062600) were identified near significant SNPs positions. These genes may have direct or indirect role in RAB resistance in soybean (Zhou et al., 2016). Our findings may be relevant for future studies provide insights into the genetic basis for RAB resistance in soybean.

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Sustainable intensification of oilseed brassica based production systems under semi-arid climates

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ABSTRACT

Technologies to decrease non-renewable energy use in agriculture production may recuperate the energy balance and C emission in the atmosphere. Conservation Agriculture (CA) practices are getting pace world-wide to answer declining factor productivity, deteriorating soil health, climate change, farm profitability and sustainability. Permanent beds with residue retention (PB+R) improved mustard seed yield (15.4%), system grain yield (10.6%), consumed less C input (-17%) and C foot prints (-25%), and recorded more C output (12%), C net (21%), C efficiency (47%) and C sustainability (47%) compared to conventional tillage without residues (CT-R). Diversification of traditional fallow-mustard (F-M) system with maize-mustard rotation (Mz-M) increased system grain yield (142.9%), sustainable yield index (376.5%), production efficiency (177.2%), economic efficiency (94%) and irrigation water productivity (66%) compared with F-M under CT-R.

Keywords: Carbon foot prints, Conservation agriculture, Intensification, Mustard, Sustainable production

Indian mustard, a dominant and versatile oilseed crop of the semi-arid tropics, needs incessant system-based approaches at appropriate scale to exploit the metabolic potential of cultivars while enduring the growing climatic stresses. CA-based sustainable intensification of the traditional fallow-mustard system in the rainfed ecology holds promises to address the shortfall of oilseed and edible oil in the country and reduce the import burden. The present study was taken up to provide insights of (i) CA-based system intensification of Indian mustard production under rainfed ecologies, (ii) enhanced inputs and output efficiencies, and (iii) Sustainability and economic viability in CA-based Indian mustard systems.

MATERIAL AND METHODS

In the present investigation, two factors (tillage practice and cropping systems with and without residues) were studied for three years in the split plot design. Three tillage practices were taken as main-plot factors [Permanent beds with residue (PB+R) and zero tillage with residue (ZT+R)] and compared with conventional tillage without residue (CT-R). Six cropping systems in rotation of rainy season crops with Indian mustard [fallow-mustard (F-M); cluster bean (*Cyamopsis tetragonoloba* L.)-mustard (CB-M); green gram (*Vigna radiate* L.)-mustard (GG-M); maize (*Zea mays* L.)-mustard (Mz-M); Pearl millet (*Pennisetum glaucum* (L.) R. Br.)-mustard (PM-M); and sesame (*Sesamum indicum* L.)-mustard (S-M)] were taken as sub-plot factors.

RESULTS AND DISCUSSION

Results showed that conservation tillage practice (PB+R) recorded markedly higher mustard seed yield (3.0 Mg/ha), system grain yield (4.3 Mg/ha), sustainable yield index (SYI) (0.41), production efficiency (PE) (15.7 kg grain / day), economic efficiency (EE) (6.4 US$/day) and irrigation water productivity (IWP) (3.14 kg grain/M^3). Intensification of traditional cropping systems with maize-mustard increased mustard seed yield (3.1 Mg/ha), system grain yield (6.8 Mg/ha), SYI (0.75), PE (24.6 kg grain/day), EE (7.3 US$/day) and IWP (2.94 kg grain/M^3).

Field operation-wise C emissions were estimated for carbon budgeting and foot prints of different tillage and cropping systems showed that PB+R consumed less C input and C foot print, however, produced maximum C output, C net, C efficiency and C sustainability index compared to CT-R. Diversification of traditional fallow-mustard system with GG-M recorded maximum total C output and C net, and lowest C foot print followed by Mz-M system.

Thus, CA-based Mz-M system produced more biomass yield at less energy and C inputs found sustainable and regenerative for oilseeds security and to mitigate climate change in the semi-arid climate. Conservation tillage practices and system diversification response to production efficiencies of Indian mustard based systems.

Table 1 ……………………………….

Treatments	Mustard seed yield (Mg ha^{-1})	System grain yield (Mg ha^{-1})	SYI	PE (kg grain day^{-1})	EE (US$ day^{-1})	IWP (kg grain M^{-3})
Tillage practices						
PB+R	3.0^{a}	4.3^{a}	0.41^{a}	15.7^{a}	6.4^{a}	3.14^{a}
ZT+R	2.8^{ab}	4.0^{b}	0.36^{b}	14.4^{b}	5.6^{b}	2.32^{b}
CT-R	2.6^{b}	3.9^{b}	0.36^{b}	14.1^{b}	5.3^{b}	2.25^{b}
Cropping systems						
F-M	2.8^{c}	2.8^{e}	0.20^{f}	10.2^{e}	4.8^{d}	2.49^{c}
CB-M	2.9^{b}	3.9^{b}	0.36^{c}	14.3^{b}	6.6^{c}	2.86^{a}
GG-M	2.9^{b}	3.8^{c}	0.34^{d}	13.7^{c}	6.9^{b}	2.75^{b}
Mz-M	3.1^{a}	6.8^{a}	0.75^{a}	24.6^{a}	7.3^{a}	2.94^{a}
PM-M	2.6^{d}	4.1^{b}	0.38^{b}	14.8^{b}	4.6^{de}	2.2^{d}
S-M	2.4^{e}	3.0^{d}	0.23^{e}	10.9^{d}	4.4^{e}	2.17^{d}

A New Report: Niger (*Guizotia abyssinica*), a new host of Phytoplasma in Madhya Pradesh India

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ABSTRACT

Niger (*Guizotia abyssinica*) is one of the important minor oilseed crops in India. Phyllody disease on niger was noticed for the first time at Research Farm of Project Co-ordinating Unit, Sesame and Niger, JNKVV, Jabalpur (M.P.) during the year *kharif* 202021 and noticed again in 2021-22.

Keywords: Niger, phyllody, phytoplasma

Niger (*Guizotia abyssinica (L.F.*) Cass) *is* a one of the nine important oilseed crops in India. It is commonly known as Ramtil. It is cultivated to a limited extent in Ethiopia, South Africa, East Africa, WestIndies, Zimbabve and India. India ranks first in area, production and export of Niger in the world. In India, it is mainly cultivated in tribal areas of Madhya Pradesh, Odisha, Karnataka, Maharashtra and Andhra Pradesh and it is planted in both '*kharif*' and' *rabi'* seasons.

METHOD AND MATERIALS

Phyllody disease on Niger was noticed for the first time at Research Farm of Project Co-ordinating Unit, Sesame and Niger, JNKVV, Jabalpur (M.P.) during the year *kharif* 2020-21 and 2021-22. Samples of Niger showing severe and typical little leaf symptoms and phyllody were collected and the twig was grafted to healthy plant grown under insectary.

RESULTS AND DISCUSSION

The natural occurrence of little leaf/virescence and witches' broom was observed on Niger field. The infected plants showed excessive green branches, narrow leaves, shorting, of internodes, reduced plant height and leaf size as well as modification petals in to leaf like structure that led to phyllody/little leaf/ witches and broom like symptoms. The diseased plants were characterized by the transformation of floral organs into leaf like structures. Production of phyllody flowers was seen on secondary shoots in diseased plants. Early infected plants were very much stunted in their growth. The plants infected at later stages had some branches showing typical phyllody symptoms, while rest of branches remained apparently with normal development of flowers. The disease was successfully transmitted by the leafhopper vector *Orosius albicinctus* and the association of phyllody measuring 100-800 nm size was also confirmed by electron microscope in ultrathin section of the phloem sieve tubes of diseased Niger (Rangaswamy and Muniyappa, 1993). Phyllody and witches broom caused by Phytoplasma, *Candidatus phytoplasma asters* (16SrI), has been previously reported from Uttar Pradesh by Chaturvedi *et al*., (2009). The present finding is in accordance with Ayman *et al*., (2008).The observed symptomatology clearly revealed the phyllody disease caused by phytoplasma, based on the similar symptoms recorded by Ayman *et al*.(2008) in Egypt, Chaturvedi *et al*., (2009) and Mahalingappa *et al*., (2019) in India.

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Efficacy of various compatible insecticides for management of Sesame phyllody

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ABSTRACT

A field experiment was conducted during 2018 at research area of AICRP on Sesame and Niger for the effective management of phyllody in sesame. The experiment comprising eight treatments (T_1- Seed treatment with Imidacloprid 17.8 SL@ 5ml/kg seed; T_2- T1+ Spray of Imidacloprid 17.8% SL @ 0.25ml/l; T_3- T_1 + Spray of Acetamaiprid @ 0.3g/l; T_4- T_1 + Spray of Thiocloprid @ 1ml/l; T_5- T_1 + Spray of Thiomethaxam @ 0.25 g/l; T_6- T_1 + Spray of Lambda cyhalothrin@ 1ml/l; T_7- T_1 + Spray of Azadirachtin @ 0.03%;T_8- Control was laid out in Randomized Block Design with three replications. Among the eight treatments tested a positive and significant response was found with the seed treatment of imidacloprid 17.8 SL @ 5 ml/kg + spray of Acetamaiprid 20% SP @ 0.3 g/L recorded the least disease incidence (7.05 per cent) and maximum seed yield (5.21 q/ha). The results on benefit cost ratio revealed that highest benefit cost ratio was recorded in treatment T_3 (4.39). All the treatments are superior over the control.

Keywords: Compatible insecticides, Phyllody, Management

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop. It plays an important role in the oilseed economy of the world. The export of sesame is increasing day to day and having bright future for its export potential. In Madhya Pradesh it is grown during *kharif* and *rabi* and the crop is affected by many pests and diseases. One of the important pests is leafhopper *Orosius albiacinctus* Dissent which transmits phyllody diseases caused by phytoplasma. As much as 10-100% incidence had been reported (Brar and Ahuja 1979). The yield loss due to phyllody in India is estimated to be about 39-74% (Saharan et al., 2005). The poor crop management and exposure of the crop to the multiple biotic and a biotic stress. Phyllody an important disease of sesame is caused by a Pleomorphic mycoplasma-like organism (Phytoplasma) and transmitted by leaf hopper (Vasudeva and Sahambi, 1955). The affected plants become stunted and the floral parts being modified in to leafy structure which results in non bearing of fruits and seeds causing yield loss up to 33.9 percent (Abraham *et al*., 1977). Hence, in the present investigation was planned and undertaken to manage of phyllody disease in sesame.

MATERIALS AND METHOD

A field experiment was conducted to find out efficacy of some insecticides against phyllody diseases of sesame at Research Farm of Project Co-ordinating Unit, Sesame and Niger, JNKVV., Jabalpur (M.P.) during the year, *kharif* 2014-15 & 2015-16. The sesame cultivar JTS-8 was sown. The experiment was conducted with seven treatments *viz*., (T_1) Seed treatment with Imidacloprid 70 WG 7.5gl/kg seed ; $(T_2)_1$ + Spray of Imidacloprid 17.8 % SL @ 0.25ml/l (T_3) T_1 + Spray of Acetamaiprid @ 0.3g/l (T_4) T_1 + Spray of Thiocloprid @ 1ml/l (T_5) T_1+ Spray of Thiomethaxam @ 0.25 g/l (T_6) T_1+ Spray of Lambda cyhalothrin 1ml/l (T_7) T_1+ Spray of Azadirachtin 0.03% (T_8) control in Randomized block design replicated thrice. Efficacy of foliar spray on the incidence of diseases was compared with the control. The incidence of Phyllody was recorded individually by counting the number of infected and healthy plants at random by quadrate selection in each plot and percent disease incidence was calculated. Observations on disease incidence, test weight and yield kg/plot/ha was recorded. The economic device was also calculated.

RESULTS AND DISCUSSION

All the six insecticidal treatments were significantly superior over control in reducing the vector and minimizing the disease. The results indicated that seed treatment with Imidacloprid (70 WG @ 7.5 g/kg seed) followed by foliar spray of Thiomethaxam @ 0.25 g/l was found effective in reducing the vector population and significant reduction in incidence over phyllody disease over control and recoding highest yield (4.95 q/ha). Effectiveness of Imadacloprid against potato leaf hopper has been reported by Akbar *et al*., 2012. It could be concluded that either seed treatment with Imidacloprid (70 WG @ 7.5 g/kg seed) and two foliar spray of Thiomethaxam @ 0.25 g/l were effective in reducing the vector population and significantly decreasingthe incidence of phyllody disease over control.

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Identification of soybean (*Glycine max* (L.) Merrill) varieties suitable for different dates of sowing

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ABSTRACT

Seven soybean genotypes were evaluated across three seasons to identify genotypes suitable for different seasons and dates of sowing. Percent variance contributed by genotypes main effects was more to total genotypic variability than that contributed by seasons, dates of sowing genotypes × seasons interactions and genotypes × dates of sowing interactions for 50% flowering, number of branches and 100 seed weight. Seasons and dates of sowing main effects contributed more to total genotypic variability than genotypes, GSI and GDOSI for plant height, number of pods and grain yield. DSb 21, DSb 23 and KBS 23 showed lowest estimates of AMMI Stability Value and Stability Index for grain yield are widely adopted genotypes.

Keywords: AMMI Stability Value (ASV), GSI, Soybean, Stability Index (SI)

Soybean is the world's most important seed legume which contributes about 25 % of the global edible oil production and demand for soybean increasing rapidly. It has been valued for its excellent nutritional content, hence it is known as the 'golden bean' and 'miracle crop' for its several uses. In India the total area, production and productivity of soybeans were 12.19 million hectares, 11.22 million tonnes and 0.921 t ha^{-1} respectively (Anon., 2019). The climate change is a challenge to Soybean production. We need to identify varieties which are suitable for different seasons and different dates of sowing.

The effects of sowing date and growing season on seed yield vary depending on the genotypes of soybean crop. Understanding genotype ×environment interaction has become critical to identify genotypes that are stable when subjected to grow-under different environments. We hypothesized that available varieties/elite genotypes interact significantly with temporal environments representing different dates of sowing and seasons; hence, it is possible to exploit such interaction by identifying varieties suitable for each date of sowing and season.

MATERIALS AND METHODS

Seven soybean genotypes namely, KBS 23, Karune, DSb 21, DSb 23, KB 79, JS 335, and MAUS 2were evaluated on fifteen different dates of sowing, from 19^{th} June to 6^{th} November 2020, with an interval of 10 days covered three seasons, namely *Kharif*, late *Kharif* and *Rabi*. Seeds were sown in a randomized complete block design (RCBD) with three replications, at University of Agricultural Sciences, GKVK), Bengaluru. In two rows of 3m length with spacing of 40 x 10cm. Data on 50% flowering, plant height (cm), no. of branches, number of pods, grain yield (g) and 100 seed weight (g) were recorded. The quantitative trait means of each genotype were also subjected to ANOVA following additive main effects and multiplicative interaction (AMMI) model (Gauch and Zobel, 1988), Genotype + Genotype ×Environment (GGE) bi-plot (Yan *et al.,* 2000), AMMI stability value (ASV) (Purchase *et al*., 2000) and Stability Index (SI) (Farshadfar, 2011).

RESULTS AND DISCUSSION

The estimate of ASV is a useful parameter for the objective assessment of genotype stability. The genotypes are more stable when ASV is lower in magnitude. In the present study, soybean varieties were evaluated across seasons. The estimates of ASV were lower in DSb 23, DSb 21 and Karune for days to 50% flowering; DSb 21, KB 79 and DSb 23 for plant height; JS 335, KB 79 and KBS 23 for the number of branches $plant^{-1}$; KB 79, JS 335 and KBS 23 for the number of pods $plant^{-1}$; KB 79, DSb 21 and JS 335 for grain yield $plant^{-1}$; KBS 23, DSb 21 and JS 335 for 100 seed weight.

Apart from evaluation of soybean varieties across seasons, they were evaluated across the dates of sowing too. For days to 50% flowering, the ASV estimates for the soybean varieties Karune, DSb21 and DSb23 were lower in magnitude than those for other genotypes. DSb21, KB79 and DSb23 for plant height; JS 335, KB 79 and KBS 23 for the number of branches $plant^{-1}$; KB 79, JS 335 and DSb 21 for the number of pods $plant^{-1}$; DSb 21, KB 79 and KBS 23 for grain yield plant^{-1}; JS 335, MAUS 2 and DSb 21 for 100 seed weight.

The estimates of SI were lower in magnitude for the DSb 21, DSb 23 and MAUS 2 for days to 50% flowering; MAUS 2, DSb 21 and DSb 23 for plant height; KBS 23, DSb 21 and KB 79 for the number of branches plant^{-1}; KBS 23, DSb 21 and DSb 23 for the number of pods plant^{-1}; KBS 23, DSb 21 and DSb 23 for grain yield plant^{-1}; MAUS 2, JS 335 and Karune for 100 seed weight.

The AMMI ANOVA indicated significant variability attributable to GEI for all six quantitative traits across seasons and dates of sowing. The genotypes DSb 23, DSb 21 and KB 79 with the lowest estimate of ASV and SI were widely stable across seasons for grain yield/plant. The genotypes KBS 23, DSb 21 and DSb 23 with the lowest estimate of ASV and SI were widely stable across dates of sowing for grain yield plant^{-1}

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Genetic variability studies among thirty three vegetable soybean genotypes under Manipur condition

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ABSTRACT

The present study was carried out at Central Agricultural University Research Farm, Andro, Imphal East, Manipur, during *kharif* 2021 to estimate genetic variability parameters of thirty three vegetable soybean genotypes for ten characters. Statistical analysis showed significant differences between the tested genotypes. Maximum phenotypic coefficient of variation value (66.54) and genotypic coefficient of variation value (66.53) was recorded for character fresh pod yield/plant. Heritability (in broad sense) value ranged from 99.99 to 86.53. The estimates of genetic advance expressed as percentage ranged from 137.24 to 118.09. Highest GA over its mean was recorded for fresh pod yield/plant (137.24), followed by number of pods/plant (118.09). The correlation study showed a positive and significant correlation between fresh pod yield/plant and the number of pods/plant, 100 fresh pod weight and 100 fresh seed weight.

Keywords: Correlation coefficient, Genetic variability, Genetic advance, Heritability, Vegetable Soybean

Vegetable Soybean (Edamame) is one of the most nutritious leguminous crops. It is also known as the "miracle crop" because of its exceptional qualities. Vegetable soybean (Edamame) was first used as a medicinal herb in China around 200 B.C. and remains broadly used today (Jian, 1984). Despite being a minor crop, it is quite popular throughout East Asia, particularly in Japan, China, Korea, and Taiwan. It has gained popularity in India in recent years as a result of its nutritious value.

The current challenge in vegetable soybean breeding is to develop improved cultivars that outperform existing cultivars in terms of yield by increasing productivity directly. A fundamental stage in any crop improvement effort is the collection of germplasm and the evaluation of variability and its magnitude. Yield is a complicated feature that is influenced by a variety of yield-contributing characters that are controlled by polygenes, as well as the environment. Certain genetic characteristics must be understood and manipulated in order for any crop improvement programme to be successful. Keeping in view of the above information the present study was carried out to assess the performance of thirty three vegetable soybean genotypes under Manipur condition, and study the extent of inheritance and their relationship between yield component characters.

MATERIAL AND METHOD

The research study was conducted during *kharif*, 2021 at the CAU Research farm, Andro. The experiment was laid out in augmented design in three blocks. Thirty vegetable genotypes with three checks were used. Row to row and plant to plant spacing was kept at 45 and 10 cm respectively. At two weeks after emergence of seedlings, thinning was done to one seedling/hole. Normal cultural practices were adopted. The observations were recorded from five randomly selected plants in each plot in each replication on, plant height (cm), pod length (cm), number of seeds/plant, number of pods/ plant, fresh pod yield/plant, 100 fresh pod weight (g), 100 Fresh seed weight (g), 100 Dry seed weight (g). Data on days to 50% flowering and days to harvest were recorded on plot basis through visual observation. The recorded data for different parameters were assembled and organized properly for statistical analysis using R studio with R software version 4.2.1.

RESULTS AND DISCUSSION

The mean sum of squares based on ANOVA of 33 genotypes for 10 characters revealed a high level of variability among the genotypes. Basavaraja *et al*. (2005) and Reni and Rao (2013) both reported significant genetic variation in soybean germplasm. Maximum phenotypic coefficient of variation value (66.54) and genotypic coefficient of variation value (66.53) was recorded for characters fresh pod yield/plant. Heritability (in broad sense) value ranged from 99.99 to 86.53. The estimates of genetic advance expressed as percentage ranged from 137.24 to 118.09. Highest GA over its mean was recorded for fresh pod yield/plant (137.24), followed by number of pods/plant (118.09). Similar results were reported by Reni and Rao (2013). The correlation study show a positive and significant correlation between fresh pod yield/plant and the number of pods/plant, 100 fresh pod weight and 100 fresh seed weight. Similar finding had been reported by Pawar *et al.* (2020). The genotypes studied showed wide range of variability for most of the characters. Moreover, the high positive relation between the characters could be effectively exploited in vegetable soybean yield improvement program.

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Table1. Genetic variability parameters for ten different characters in thirty three vegetable soybean genotypes

Characters	Range	Mean	GCV	PCV	ECV	hBS	GA	GAM
Days to 50% flowering	29 – 46.67	37.27	11.7	12.39	4.1	89.07	8.49	22.78
Plant height (cm)	20.53 - 77.25	42.9	33.61	33.73	2.85	99.29	29.63	69.08
Days to maturity	70.83 - 87.67	81.21	5.96	6.4	2.33	86.73	9.3	11.45
Pod length (cm)	3.5 - 6.19	4.83	10.42	10.69	2.42	94.88	1.01	20.93
Number of seeds per pod	1.88 - 3.1	2.36	16.87	18.14	6.66	86.53	0.76	32.38
Number of pods per plant	9.45 - 109.48	42.69	57.32	57.4	3.03	99.72	50.42	118.09
Fresh pod yield per plant (g)	7.88 - 204.18	64.5	66.53	66.54	1.13	99.97	88.52	137.24
100 Fresh pod weight (g)	61.93 - 223.62	148.47	32.96	32.96	0.71	99.95	100.92	67.97
100 Fresh seed weight (g)	22.25 - 99.32	52.71	31.62	31.62	0.33	99.99	34.38	65.22
100 Dry seed weight (g)	31.5 - 11.96	20.63	26.45	26.97	5.3	96.13	11.03	53.49

GCV=Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, ECV= Environmental coefficient of variation, hBS= Heritability broad sense, GA= Genetic Advance, GAM= Genetic advance as percent of mean value.

Shelf-life and persistence of biopolymer-based *Trichoderma* formulations for biological control of oilseed seed and soil-borne diseases

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ABSTRACT

In the present study, the biological control agent (BCA) *Trichoderma harzianum* strain Th4d was entrapped in biopolymeric compositions applied as film forming seed coat on oil seed crops viz., soybean, groundnut and safflower. Results revealed that high entrapment efficiency of 89- 92% with viability for 24 months without much reduction and persistence of Trichoderma in soil was studied which is having minimum spore count of $1X10^6$ CFUs till 90 days of application in biopolymer-based *Trichoderma* seed coating treatment. Field evaluation of biopolymer-based Trichoderma seed coatings was done in soybean, ground nut and safflower exhibited higher productivity in biopolymer-based Trichoderma formulations over control.

Keywords: Bio-polymer based formulations, Oilseed crops, Trichoderma

The diverse agro-ecological conditions in the country are favorable for growing 9 annual oilseed crops. Unfortunately, many crops suffer from fungal and viral diseases during the initial stage of the crop due to soil and seed borne diseases. In the present-day context, in view of the growing stress for edible and biofuel purpose, a lot needs to be done for disease management by several approaches. An efficient disease management includes multiple chemical treatments leading to serious environmental concerns. In view of the environmental implications of the use of chemicals, alternative strategies for the control of plant disease are being sought. Biological control of plant diseases using antagonistic microbes offers a powerful and eco-friendly alternative to the use of synthetic chemicals. However, the serious bottlenecks for using the bio-control agents are the high temperature and limited moisture in the soil for activity and efficacy of these bioagents (Rini *et al.*, 2006).

Tailor made biopolymers derived from biomacromolecules such as polysaccharides have emerged as promising materials for multifarious applications owing to their three-dimensional structure, bio-degradability and bio-compatibility, ability to imbibe water, and good mechanical integrity. Tailor made biopolymers (cellulose and chitosan) are cross-linked polymers which possess network properties and provide favourable environment to the crop inputs and also serve as controlled release systems for regulated release of the agrochemicals. These materials are finding extensive applications in dry land agriculture and carriers in delivery systems etc (Chandrika *et al.*, 2019; Prasad *et al.*, 2020). These can be used as drug delivery carriers for crop inputs like pesticides and beneficial microbes for seed coating purpose. Quality of seed is an important entity for better crop productivity and yield. The most critical phases in the growth and development of any crop are those of germination and establishment.

MATERIALS AND METHODS

At ICAR-IIOR, we synthesized tailor-made bio-polymer compositions. The developed seed coating biopolymeric compositions were utilized for entrapment of beneficial microbes like *Trichoderma* to target for soil and seed borne diseases. Detailed protocol of the preparation is under IPR protection process. Structural characterization through FTIR, SEM, TGA etc.

RESULTS AND DISCUSSION

Structural characterization of optimized polymers showed the polymerization of blend ingredients and formation of matrix structure facilitating proper entrapment of biocontrol agent suggesting the suitability of polymers as seed coating agent. Shelf life of *Trichoderma* after entrapping in biopolymers is being maintained till 24 months (Table 1) without much reduction from initial entrapment efficiency of 89-92%. Under pathogenic conditions, the efficacy was evaluated both in laboratory and pot experiment which is performing on par with commercial check of vitavax. The persistence of *Trichoderma* was studied which is having minimum spore count of $1X10^6$ CFUs till 90 days of application in soil of bio-polymer entrapped *Trichoderma* compared to *Trichoderma* spores alone (till 45 days of application). The antioxidative enzyme activity in oilseed crops was studied under pathogenic conditions at four different intervals (5, 7, 9, 11) in treated seeds. The increase of enzyme activity was more pronounce in treated plants, observed maximum in biopolymer and *Trichoderma* combination even under pathogenic conditions. Field evaluation of biopolymer-based *Trichoderma* seed coatings was done in soybean, ground nut and safflower exhibited maximum germination percentage (84.7), disease inhibition (88.8%) and yield (792 kg/ha) in chitosan polymer+ *T. harzianum* Th4d in safflower crop, where as in groundnut crop maximum germination percentage (90.05) in cellulose polymer + *T. harzianum* Th4d, disease inhibition percentage (95.5) and yield (3040 kg/ha) in chitosan polymer + *T. harzianum* Th4d and in soybean crop maximum germination (83.4%), disease inhibition (95.8%) in chitosan polymer+ *T. harzianum* Th4d and yield (1251 kg/ha) in cellulose polymer+ *T. harzianum* Th4d was observed.

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Table 1: Shelf life of Trichoderma (Th4d) spores after entrapping in cross-linked polymers (Unit: $X10^{11}$ cfu/ g of cross-linked polymer film)

Treatment	Cellulose polymer	Chitosan polymer	Synthetic polymer
0 day	23.67	21.66	20
30 day	22	17.33	15.33
60 day	17	12.33	10.66
120 day	10	10.33	4.33
240 day	4	3.66	0.01
480 day	2.67	2	0.00005
540 day	1.67	1.33	0.0000003
730 day	1.8	1.11	0

Table 2: Entrapment efficiency of *Trichoderma* spores Th4d in cross-linked polymer films

Treatment	10^{12} cfu/g	Entrapment efficiency (%)
Th4d spores	2.53	-
Cellulose polymer entrapped with Th4d	2.38	94
Chitosan polymer entrapped with Th4d	2.16	87

Evaluation of soybean genotypes for high temperature tolerance during reproductive stages

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ABSTRACT

High temperature is one of the major abiotic factors restricting plant growth and development. In this investigation, twenty soybean accessions were evaluated for different morpho-physiological and yield traits at two different day/night temperatures (30°C/20°C & 40°C/28°C) under green house conditions in year 2018-19 and 2019-20 where high temperature stress was induced at onset of reproductive stage to till the maturity of the crop. Same panel of genotypes was also evaluated for delayed leaf senescence and related traits during summer 2019 and summer 2020. The experimental results revealed that genotypes NRC 146, 6A-58-5 and JS 20-98 performed better consistently in high temperature conditions while genotypes ICS 84/86-85B-4, JS 95-60, JS 90-41 were found to be highly sensitive.

Keywords: Evaluation, High temperature tolerance, Reproductive stages, Soybean

Soybean contributes 25% to the global edible oil and about two-third of the world's protein concentrate for livestock feeding. The current temperatures in major soybean growing regions in country are reported to be at the doorstep of upper limit and the occurrence of very high temperatures beyond 35°C, particularly at late reproductive stages (Jumrani *et al.,* 2018). Lobell and Asner (2003) reported about average 17% decrease in soybean seed yield for every 1°C rise in temperature. Therefore, exploration for soybean genotypes that are more tolerant to high temperature stress is immediately required for sustainable soybean production.

MATERIAL AND METHODS

Twenty soybean genotypes including six germplasm accessions, eleven varieties and three elite breeding lines were evaluated under controlled environment conditions in year 2018-19 & year 2019-20 as well as in summer 2019 & 2020 with ambient hot weather conditions. High temperature stress was induced during reproductive stages in green house experiment and elevated temperature conditions were also matched at reproductive stages by sowing soybean in summer season. Several morpho-physiological traits viz., specific leaf weight(SLW), canopy temperature depression(CTD/δ°C), SCMR(SPAD chlorophyll meter readings), yield and yield attributing traits were recorded in controlled day/night temperatures [control – (30°C/20°C) and stress – (40°C/28°C)] conditions. Delayed leaf senescence score (1-5), SCMR and CTD/ δ°C were recorded during summer screening.

RESULTS AND DISCUSSION

In green house experiment, high temperature stress significantly decreased chlorophyll content, CTD, SLW, seed yield and yield related traits (Table 1). Percentage reduction in seed yield was significantly correlated with percentage reduction in SLW (r~0.8) and SCMR (r~0.68). During summer season, delayed leaf senescence score was significantly correlated with SCMR (r~0.67). Tolerant genotypes i.e. JS 20-98 (variety), JS 20-38 (breeding line) and advance breeding lines (NRC 146 and 6A-58-5) derived from heat tolerant genotype EC 538828 showed less reduction in yield and other related physiological traits in comprasion to tolerant check JS 97-52 (Table 2) while genotypes CAT 2065, JS 95-60, JS 90-41 found to be sensitive to high temperature stress. Identified genotypes from the present study will serve as donor to develop high temperature tolerant soybean varieties.

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Table 1: Variation for yield and morpho-physiological parameters in the study

Particulars of green house experiment	**Range (2018-19)**	**Range (2019-20)**
Percentage reduction in SCMR	3.2% - 12.89%	5.10% - 17.33%
Percentage reduction in specific leaf weight (SLW)	3.81% - 25.70%	6.55% - 29.85%
Reduction in CTD (Stress) in relation to CTD (Control)	0.41°C – 4.21°C	0.53°C – 5.11°C
Percentage reduction in seed yield per plant	11.47% - 56.56%	14.25% - 79.53%
Percentage reduction in 100 seed weight	7.02% - 36.24%	15.23% - 53.94%
Percentage reduction in numbers of pods	7.95% - 47.43%	4.85% - 49.47%
Particulars of summer screening	**Range (2019)**	**Range (2020)**
Delayed leaf senescence score/rating	1 – 5	1 – 51 to 5
SPAD chlorophyll meter reading (SCMR)	37.8 – 46.2	29.20 – 48.238.23
Canopy temperature	28.84 °C – 36.2 °C	29.33 °C – 35.1°C 1 °
Canopy temperature depression (CTD/ δ°C)	-3.57 °C to 3.79 °C	-2.37 °C to 4.19 °C

Performance evaluation of Oxadiargyl for effective weed management in sunflower

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ABSTRACT

A field experiments with the objective to determine the performance evaluation of Oxadiargyl for effective weed management in sunflower was conducted under irrigated condition. The experiment was laid out in randomized block design consisting of nine treatments and replicated thrice. Weed free environment produced higher growth and yield parameters, however it's on par with the other treatments T_2 and T_3 which are having combination of herbicide followed by hand weeding. Pre emergence application of Oxadiargyl @ 125g ai/ha fb hand weeding gave excellent control of all the weeds at all the stages of the crop and it recorded higher weed control efficiency and the lowest weed index. Highest net returns of Rs. 26,151/ha and benefit cost ratio of 1.47 was observed in Pre emergence application of Oxadiargyl @ 125g ai/ha fb hand weeding at 30 DAS.

Keywords: Effective weed management, Oxadiargyl, Performance evaluation, Sunflower

Sunflower (*Helianthus annuus* L.) is one of the important vegetable oilseeds crops in India. Weed infestation is a major constraint causing lower sunflower yield. Weed infestation occurs heavily in sunflower mainly due to adoption of wider spacing, slower crop growth at initial stages, higher amount of fertilizers application and frequent irrigation. Manual weeding is difficult as it is highly labour intensive and time consuming. Uncontrolled weeds in sunflower caused yield loss of up to 62% (Sumathi *et al*., 2009). Manual weeding alone in sunflower cultivation is difficult as it is highly labour intensive and time consuming. Herbicides are effective and viable option for better weed management in sunflower (Shylaja and Sundari 2008). By considering above scenario, the present investigation was carried out with the objective to determine the performance evaluation of Oxadiargyl for effective weed management in sunflower.

MATERIALS AND METHODS

Field experiments were conducted at Department of Oilseeds, TNAU, Coimbatore on Integrated weed management in Sunflower during *Kharif* 2020. The experiment comprised of nine treatments *viz*., T_1 - Oxadiargyl @ 75g a.i./ha as pre-emergence spray + one HW at 30 DAS, T_2 - Oxadiargyl @ 100 g a.i./ha as pre-emergence spray + one HW at 30 DAS, T_3 - Oxadiargyl @ 125ga.i./ha as pre-emergence spray + one HW at 30 DAS, T_4 - Oxadiargyl @ 75g ai/ha as pre-emergence spray + Quizalofop Ethyl 10 EC (Turga super) @ 37.5 g a.i/ha at 15 – 20 DAS directed post-emergence spray on weeds, T_5 - Oxadiargyl @ 100g ai/ha as pre-emergence spray + Quizalofop Ethyl 10 EC (Turga super) @ 37.5 g a.i/ha at 15 – 20 DAS directed post-emergence spray on weeds, T_6 - Oxadiargyl @ 125g ai/ha as pre-emergence spray + Quizalofop Ethyl 10 EC (Turga super) @ 37.5 g a.i/ha at 15 – 20 DAS directed post-emergence spray on weeds, T_7 – Farmers' practice (Two HW at 20 & 40 DAS), T_8 - Weed free control (Three HW at 15, 30 and 45 DAS), T_9 - Unweeded control.

RESULTS AND DISCUSSION

Weeds in the field experiment were predominant by grassy weeds like *Cynodon dactylon*, *Dacteloctenium aegypticum*, *Echinochloa colona*, *Chloris barbata* and *Brachiaria reptans*, Sedges like *Cyperus rotundus* and broad-leaved weeds like *Trianthema portulacastrum*, *Amaranthes viridis*, *Parthenium hysterophorus*, *Digera arvensis*, *Euphorbia prostrata* and *Acalypha indica* were the dominant ones.

Weed free environment produced higher growth and yield parameters, however it's on par with the other treatments T_2 and T_3 which are having combination of herbicide followed by hand weeding. Pre emergence application of Oxadiargyl @ 125g ai/ha *fb* hand weeding gave excellent control of all the weeds at all the stages of the crop and it recorded higher weed control efficiency and the lowest weed index. This combination also resulted in significant increase in growth and yield attributes of sunflower (2281 kg/ha) and it was comparable with weed free environment (T8) resulted in producing significantly higher seed yield of 2345 kg/ha and Oxadiargyl @ 100 g a.i./ha + one HW at 30 DAS (2266 kg/ha). It might be due to management of weeds in sunflower at early growth stages in effective manner, which helped for sunflower growth resulting in significant seed yield increase. This finding was in accordance with findings of Selvakumar *et al*., 2018.

Highest net returns of Rs. 26,151/ha and benefit cost ratio of 1.47 was observed in Pre emergence application of Oxadiargyl @ 125g ai/ha as pre-emergence spray *fb* hand weeding at 30 DAS. Hence, application of Oxadiargyl @ 125g ai/ha as pre-emergence spray fb hand weeding at 30 DAS in sunflower will control the weeds effectively and economically. The higher net return and B:C ratio were also reported by Mohapatra *et al*., 2020 due to the reduction of cost of cultivation.

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Table 1. Response of sunflower to Integrated weed management with Oxadiargyl

Treatment	Plant height at harvest (cm)	Number of grains / Capitulum	Yield (Kg/ha)	WCE	Net Return Rs./ha	B:C ratio
T_1	188.7	884	2048	90.1	18325	1.33
T_2	191.4	963	2266	97.0	25892	1.46
T_3	193.5	959	2281	99.5	26151	1.47
T_4	173.9	575	1275	54.2	-4413	0.91
T_5	178.4	600	1364	65.0	-1490	0.97
T_6	180.7	728	1641	69.0	8201	1.16
T_7	182.7	861	1953	96.6	8909	1.15
T_8	193.6	975	2345	99.5	15421	1.22
T_9	165.8	391	855	0.0	-15419	0.67
SEd	7.7	52.7	109			
CD (P=0.05)	16.3	112	231			

Effect of different land configurations and crop geometry with levels of fertilizer on sunflower productivity under rainfed condition

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ABSTRACT

A field experiment with the objective to determine the response of sunflower to varying planting geometry and fertilizer levels under different land configurations was conducted under rainfed condition. The experiment was laid out in split plot design consisting of twelve treatments (Four main and three sub treatments) and replicated thrice. The entire period of cropping period received the adequate rainfall for the growth and development. The economics revealed that the land configuration ridges and furrow sowing with 100 % RDF recorded higher net return (Rs. 8,517/ha) and BCR (1.25). Hence, it concluded that under red loamy soil, sowing of sunflower with a spacing of 60 cm x 30 cm in ridges and furrow land configuration with application of 100 % RDF is highly suitable under rain fed condition to attain maximum yield with more profit.

Keywords: Crop geometry, Land configuration, Rainfed condition, Sunflower

Sunflower (*Helianthus annuus* L.) is one of the important vegetable oilseeds crop which always play a role in global vegetable oil production, contributing up to 12 per cent. In India, cultivation of sunflower is done mainly under rainfed ecosystem. The establishment of crop under rainfed ecosystem, maintaining of optimum population and addition of crop nutrients at optimal doses is essential for safe and affordable food security for the developing population. Mortvedt *et al*. (2003) observed that fertilizing soil is an essential component for the effective commercial production of sunflower. Application of complete fertilizers *i.e*., having nutrients like nitrogen, phosphorous and potash will improve sunflower growth and sustain the yield (Cechin and Fumis, 2004 and Sadras, 2006). By considering the above scenario, the present investigation was carried out with the objective of determining the response of sunflower to varying planting geometry and fertilizer levels under different land configurations under rainfed conditions.

MATERIALS AND METHODS

The experiment was laid out in split plot design with main plot consisting of different land configurations and altered crop geometry M_1 - Flat bed sowing at 60 cm x 30 cm, M_2 - Ridge and furrow sowing at 60 cm x 30 cm, M_3 - Flat bed with paired row sowing at 45 cm x 40 cm (90/40 cm), and M_4 - Broad bed and furrow with paired row sowing at 45 cm x 40cm (90/40cm) in subplot levels of fertilizer *viz*., S_1 - 75 % RDF, S_2 - 100 % RDF (60:90:60 N, P2O5 and K2O kg/ha), and S_3 -125% RDF were included. The entire experiment was replicated thrice and laid out at the Department of Oilseeds, Tamil Nadu Agricultural University Coimbatore, during *Kharif* season, 2019. Sunflower CoSFV5 was sown on 13.09.2019 in the red loam soil field and the crop was harvested on 11.12.2019. The experiment was conducted under rainfed ecosystem.

RESULTS AND DISCUSSION

The entire period of cropping period received the adequate rainfall for the growth and development. The rainfall received during the cropping period was 475.1 mm with 30 rainy days. The results revealed that the growth parameters, yield attributes and yield parameters of sunflower were significantly influenced by land configurations and graded level of fertilizers. Growth parameters performed better in the land configuration ridges and furrow sowing and it was followed by flatbed sowing. Among the land configuration, ridges and furrow sowing recorded significantly higher yield attributes (number of grains/plant, volume weight (g/100 ml) and 100 grain weight and yield (1259 kg/ha)) and it was followed by flat bed. Under ridges and furrow planting could be attributed to the adequate availability of soil moisture over other treatments. Among the fertilizer levels, 125 % RDF recorded significantly higher growth parameters, yield attributes and yield (1159 kg/ha) over 75 % RDF but 125% RDF was comparable with 100% RDF. The effect of improved growth parameters and yield parameters might be due to efficient metabolic activities and efficient source sink relationship under 125 % RDF and it was accordance with the findings of Kokila *et al*., (2018). However, quality of sunflower was not significantly influenced by the different land configure-tions and fertilizer levels.

The economics revealed that among the land configuration, ridges and furrow sowing with 100 % RDF recorded higher net return (Rs. 8,517/ha) and BCR (1.25). Hence, it was concluded that under red loamy soil, sowing of sunflower with spacing of 60 cm x 30 cm in ridges and furrow land configuration with application of 100 % RDF is highly suitable under rain fed condition to attain maximum yield with more profit.

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Table 1. Response of sunflower to varying planting geometry and fertilizer levels under different land configurations

Treatment	Plant Height (cm)	Seed yield (kg/ha)	Oil content (%)	Net Return (Rs/ha)	B:C ratio
M_1	160	1066	35.0	1506	1.04
M_2	190	1259	35.1	8517	1.25
M_3	140	1033	34.9	382	1.01
M_4	157	1053	34.8	1061	1.03
S.Ed.	6	58	0.4		
C.D.(P=0.05)	15	143	NS		
S_1	153	1047	35.2	2552	1.08
S_2	162	1101	34.8	3033	1.09
S_3	170	1159	34.9	3015	1.08
S.Ed.	7	28	0.3		
C.D.(P=0.05)	14	59	NS		
M at S S.Ed.	12	74	0.6		
C.D.(P=0.05)	NS	NS	NS		

Stability analysis for yield and yield contributing characters in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Twenty two genotypes including two checks were evaluated in randomized block design with three replications for yield and yield components under different environments. Estimates of stability parameters revealed that none of the genotypes were stable for all characters; however the genotype ICGV-07296 possesses average stability for days to maturity and pod yield per plant, where as the genotype ICGV-98170 recorded early flowering, where as the genotype ICGV-07273 for number of mature pod per plant, ICGV-07235 and ICGV-00187 for kernel yield per plant, ICGV-07273 for oil content exhibited average stability so they were adapted to all the environments. ICGV-07296 for days to maturity, ICGV-07273 for shelling percentage, ICGV-06151 for sound mature kernel, ICGV-06150 and ICGV-07217 for pod yield per plant and ICGV-0076 for pod yield per plot showed below average stability so they were better adapted to favorable environment. Whereas the genotypes ICGV-0211, ICGV-07270 and JL-24 were found especially adapted to better environment, while the genotypes ICGV-07106 and ICGV-06138 were adapted to unfavorable or poor environment.

Keywords: Groundnut, Stability analysis, Yield and yield contributing characters

The groundnut (*Arachis hypogaea* L.) is a valuable food and oilseed crop. It is commonly called as the king of vegetable oil, poor man’s nut, peanut or monkey-nut. Groundnut is self pollinated (with an average cross pollination of about 2 %), auto tetraploid with chromosome number 2n = 4 x = 40. Groundnut is originated in the Brazil. The secondary centre origin is Africa. Flowers usually open at sunrise and anther may dehisce for 7-8 hours before flower opening the stigma become receptive about 24 hours after anthesis. It is an important oil, food and feed legume, where kernels are rich in oil (48-50 %) and protein (25-28%). Groundnut is some nutrient-dense food rich in digestible protein, unsaturated fatty acids minerals, fibre and polyphenolic antioxidants. Groundnut is widely cultivated throughout warm temperature, tropical and sub tropical countries. Groundnut is the 13^{th} most important food crop of the world. It is the world’s 4^{th} important source of edible oil and 3rd most important source of vegetable protein. Globally, 50 percent of groundnut produce is used for oil extraction, 37 percent for confectionary use and 12 percent for seed purpose. In India 80 percent of the total produce is used for oil extraction, 11 percent as seed, 8 percent for direct food uses and 1 percent is exported (www.icrisat.org).

MATERIAL AND METHODS

Twenty two groundnut genotypes ICGV-0211, ICGV-0076, ICGV-98170, ICGV-187, ICGV-00189, ICGV-07408, ICGV-07235, ICGV-07273, ICGV-07270, ICGV-07296, ICGV-07286, ICGV-06138, ICGV-06139, ICGV-06150, ICGV-06151, ICGV-07106, ICGV-07120, ICGV-06175, ICGV-07217 and ICGV-07214 with two checks [LGN-1 and LGN-2] obtained from Oilseeds Research Station, Latur and were sown in randomized block design with 3 replications at Oilseeds Research Station, Latur, Oilseeds Research Sub-Station, Ambajogai and Agricultural Research Station, Badn apur. The sowing was carried out at the spacing of 30 cm and 10 cm between the rows and plants, respectively. The method of sowing followed was dibbling. The gross plot size was 5.0 x 0.90 m^2, while net plot size was 4.8 x 0.90 m^2. The recommended fertilizer dose of 25 kg N + 50 kg P_20_5 per hectare was applied at the time of sowing. All other cultural practices and plant protection measures were undertaken to maintain healthy crop. Observation recorded *Viz.* days to 50% flowering, days to maturity, number of mature pods per plant, pod yield per plant (g), kernel yield per plant (g), shelling percentage (%), 100 kernel weight (g), sound mature kernel (%), pod yield per plot (g) and oil content (%). The stability analysis was performed for the characters under study using Eberhart and Russell model.

RESULT AND DISCUSSION

The result of pooled analysis of variances over environments revealed that the variances due to genotypes were highly significant for all characters studied. Variance due to environment were highly significant for all characters except no. of mature pods/plant and oil content, where as for genotype x environment interaction variances were also highly significant for days to maturity, shelling percentage, 100-kernel weight kernel yield/plant and pod yield /plant. Analysis of variances for stability parameters revealed that the variances due to environment + (genotype x environment) were highly significant for Days to maturity, shelling percentage, 100-kernel weight, kernel yield/plant and pod yield/plant. While the environment (linear) was significant for all characters except no of mature pods/plant and oil content indicating that a major part of variation could be attributed to linear regression.

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Genetic variability and association studies in Sunflower Inbreds

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ABSTRACT

Genetic variability, heritability, genetic advance and association studies were carried out in 87 sunflower inbreds shared by different AICRP centres for six yield and its contributing traits. Results of ANOVA showed highly significant mean sum of squares for all the traits indicating presence of sufficient variability in the experimental material. Wide range of variation was noticed in plant height followed by seed yield and days to 50 % flowering. High phenotypic and genotypic coefficient of variation were recorded for head diameter, seed yield per plant and 100 seed weight. High heritability coupled with high genetic advance as per cent of mean was exhibited for seed yield indicated directional selection could be effective. Head diameter recorded strong correlation with seed yield followed by plant height and 100 seed weight and in turn these traits were also strongly intercorrelated.

Keywords: Association analysis, Genetic variability, Heritability, Inbreds, Sunflower

Sunflower (*Helianthus annuus* L.) is regaining its importance in the state of Andhra Pradesh due to its enhanced Minimum Support Price (Rs. 6400/q) during 2022 declared by Govt. of India and support to Oilseeds sector. At, present in Andhra Pradesh it is cultivated in an area of 17,257 ha and the major districts cultivating sunflower are Ananthapuramu, YSR Kadapa and Kurnool districts. Therefore, public and private sector are concentrating in developing stable, high yielding and high vigour hybrids and strengthening their seed production programmes to supply quality seed to the consumers. The first step in development of hybrids is identification of inbreds for the valid traits and these inbrdes can be utilized in development of new CMS lines or as restorers based on their maintainer / restorer behaviour with the corresponding promising CMS lines. Hence, the present study is concentrated to evaluate different inbreds for yield and its contributing traits, genetic variability studies and the association of different traits with seed yield.

MATERIALS AND METHODS

Eighty seven inbred lines shared by different AICRP centres of sunflower were tested during Rabi 2019-20 at Regional Agricultural Research Station, Nandyal in Augmented Block Design using three checks (NDSI3, LTRR 341 and NDCMS 30B), wherein only checks were replicated. The genotypes were sown with a spacing of 60 cm between rows and 30 cm within a row. Recommended agronomic practices were followed to raise a good crop. Data was recorded for six characters *viz.*, days to 50% flowering, plant height (cm), head diameter (cm), 100 seed weight (g), seed yield per plant and oil content (%). To test the difference among the genotypes, the analysis of variance was performed individually for each character as per method suggested by Federer (1956). Phenotypic and genotypic coefficients of variation (PCV and GCV) were computed according to Burton, 1952. Heritability (h^2) in broad sense was calculated according to the formula given by Allard, 1960. Genotypic correlation coefficients were calculated using the method given by Johnson *et al.* 1955.

RESULTS AND DISCUSSION

The results of ANOVA (Table 1) carried out in the present study showed highly significant mean sum of squares for all the traits indicating presence of sufficient variability in the experimental material. Wide range of variation was observed for plant height (61-139 cm) followed by days to 50% flowering (44 - 60), seed yield per plant (13 – 48 g/Pl), head diameter (6.0 – 18 cm), oil content (29 – 41%) and 100 seed weight (3.50 – 6.10 g). These results are in agreement with Neelima *et al.*, 2016 and Varalaskhmi *et al*., 2019.

The PCV values were higher than GCV for all the traits studied which implies effect of environment on variability of these traits. High PCV and GCV were noted for head diameter followed by seed yield per plant, plant height, and seed weight. Low PCV and GCV values were recorded for oil content and days to 50 % flowering indicated that the variation in the material was low, therefore, search for variation in other material may be required.

In this study, heritability estimates were high for head diameter (94.98%) followed by days to 50 % flowering (92.92%), seed weight (85.74%), oil content (85.36%), seed yield per plant (82.35%) indicating that these traits were less influenced by the environment and selection based on phenotypic observations would be effective. Low heritability was noticed for plant height (65.22%).

High heritability coupled with high genetic advance as percent of mean (GAM) was noticed for head diameter, seed weight and seed yield per plant which indicated that these traits are governed by additive gene action and directional selection could be more effective. High heritability coupled with low GAM was observed for days to 50 % flowering and oil content suggesting the role of favourable environment rather than genotype and therefore, selection may not be not rewarding. Low heritability coupled with high GAM was observed for plant height indicating it is governed by additive gene effects and is highly influenced by environments and therefore, selection would be effective. These results are in line with Madhavi Latha *et al.*, 2017.

In association analysis (Table 3) all the traits recorded positive correlation with seed yield. Head diameter (0.372**) recorded strong correlation with seed yield followed by plant height (0.353 **) and 100 seed weight (0.350**). Similar results were reported by Varalaskshmi *et al*., 2019. In turn, these traits were also strongly intercorrelated. This clearly implied that improvement for seed yield can be achieved if directional selection is practiced for these traits. Among yield contributing characters, head diameter and plant height showed strong association (0.725**) followed by seed weight and head diameter (0.565**).

In conclusion, the present study has shown wider range of variability, high PCV and GCV, high heritability and high GAM for seed yield indicating variability in the material, high influence of environment and directional selection could be effective. This direction selection for seed yield in sunflower can be achieved if selection is practiced for head diameter, plant height and 100 seed weight.

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Table 1 Genetic variability parameters in sunflower Inbreds

	Mean	Range		PCV (%)	GCV (%)	Heritability (%)	GAM
		Min.	Max.				
Days to 50 % flowering	51	44	60	3.894	3.62	92.93	7.40
Plant height (cm)	99	61	139	19.34	15.62	65.23	25.98
Head diameter (cm)	10	6.0	18	24.73	24.09	94.90	48.38
100 seed weight (g)	5	3.5	6.10	18.12	16.78	85.74	40.98
Seed yield/plant (g)	23	13	48	24.16	21.93	82.35	31.98
Oil content (%)	34	29	41	7.36	6.80	85.36	12.93

Table 2 Analysis of variance for yield and its contributing traits in sunflower Inbreds

Trait	Blocks (2)	Treatments (89)	Checks (2)	Inbreds (86)	Check Vs. Inbred (1)	Error (4)
Days to 50% flowering	0.114	3.85*	3.444*	3.894*	0.927	0.276
Plant height (cm)	71.28	400.81	1194.0*	366.0*	1768.0*	509.0
Head diameter (cm)	0.529	8.052*	39.36*	6.36*	90.83*	0.32
100 seed weight (g)	0.098	0.893*	4.023*	0.82*	0.879	0.118
Seed yield/plant (g)	4.33	50.90*	732.33*	32.10*	304.98*	5.67
Oil content (%)	1.242	6.746*	30.72*	6.27*	0.499	0.92

* Significant at 5% level

Table 3 Genotypic correlations among seed yield and its attributes in Sunflower Inbreds

	Days to 50 % flowering	Plant height (cm)	Head diameter (cm)	100 seed weight (g)	Seed yield/pant (g)	Oil content (%)
Days to 50 % flowering	1.000					
Plant height (cm)	0.177	1.000				
Head diameter (cm)	0.179	0.725**	1.000			
100 Seed weight (g)	0.251*	0.392**	0.565**	1.000		
Seed yield/plant (g)	0.249*	0.353**	0.372**	0.350**	1.000	
Oil content	0.120	0.178	0.177	0.138	0.202*	1.000

*,** Significant at 5% and 1% levels, respectively

An Institutional Regulatory Analysis for Genetically Modified Products with special reference to Bt Mustard

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ABSTRACT

Rules for the Manufacture, Use/Import/Export, and Storage of Hazardous Micro Organisms/Genetically Engineered Organisms or Cells, 1989 has laid down several guidelines to ensure environmental safety in the use of genetically modified organisms (GMOs) and to provide regulatory approvals for dealing with genetically engineered (GE) entities.A few committees have been constituted under the 1989 rules and the Recombinant DNA (rDNA) safety guidelines, 1990 at the institutional level, including Genetic Engineering Approval Committee (GEAC). The

Paper intends to analyze policy initiatives in the direction of biotechnology regulation in India, especially after the petition was filed opposing the government's approval of field trials for GM crops. The petitioner has sought Supreme Court's intervention in the matter with a clear direction to the government for not pushing and going ahead with the approval of field trials of GM crops.

Keywords: Genetically modified, Mustard, Regulatory analysis

INTRODUCTION AND DISCUSSION

The introduction of the Rules for the Manufacture, Use/Import/Export, and Storage of Hazardous Micro Organisms/Genetically Engineered Organisms or Cells by the Government of India in 1989 provided a regulatory mechanism for biotechnology in India.Indeed, Genetically Modified organisms (GMOs) have not been specifically dealt with under the domestic laws of India. However, there are several struggles to meet the amenability by including guidelines, regulations, legislations, and measures to establish an institutional mechanism. Rules for the Manufacture, Use/Import/Export, and Storage of Hazardous Microorganisms/ Genetically Engineered Organisms or Cells, 1989 guidelines were notified by the Ministry of Environment, Forest and Climate Change(MOEFCC), Government of India on 5th December 1989, under the provisions of the Environment Protection Act, 1986. Section 3 of the rules defines the terms "biotechnology," "cell hybridization," "gene technology," "genetic engineering," and "microorganism." Under Section 3 of the rules, the following competent authorities have been established under the rules for implementation and monitoring of the process: Recombinant DNA Advisory Committee (RDAC), Institutional Bio-safety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM),Genetic Engineering Approval Committee (GEAC).

Under the Revised Guidelines for Research in Transgenic Plants and Guidelines for Toxicity and Allergenicity Evaluation of Transgenic Seeds, Plants and Plant Parts, 1998, The institutional mechanism was created for the regulation of biotechnology under the 1989 rules on microorganisms has been acknowledged and further empowered.

Guidelines and Standard Operating Procedures for the Conduct of Confined Field Trials of Transgenic Plants, 2008 the guidelines and the standard operating procedures (SOPs) for confined field trials of regulated, GE, and transgenic plants were issued by the Department of Biotechnology, Ministry of Science and Technology, Government of India in 2008. These guidelines summarize the information, requirements, and procedures used by the two regulatory committees, Review Committee on Genetic Manipulation (RCGM) and Genetic Engineering Approval Committee (GEAC)

The Genetic Engineered Approval Committee, Review Committee on Genetic Manipulation, Institutional Bio-safety Committee, Recombinant DNA Advisory Committee, State Biotechnology Coordination /Committee, and the District-Level Committees constitute the institutional mechanism for the regulation of biotechnology in India, have been recognized and mentioned under these guidelines.

The SOPs have been prepared to guide for conducting of confined field trials of regulated and GE crops in India. These procedures provide guidelines for the transport of regulated and GE plant material; storage of regulated and GE plant material; management of confined field trials; management of harvest or termination of confined field trials; post-harvest management of confined field trials.

The parliamentary standing committee on the cultivation of GM crops has suggested stopping all field trials on GM crops and a complete overhaul of regulatory norms. The standing committee on agriculture deliberated for three years—from 2009 to 2012—studying and considering the international norms and regional and domestic laws. Moratorium on GM crops, in particular BT brinjal in 2012, took place in the background of the parliamentary committee's findings.

In Aruna Rodrigues & Ors. V. Union Ministry of Environment, Forest and Climate Change & Ors. [WP (C) No. 260/2015] "Is there a compelling reason for the environmental release of the genetically modified herbicide-tolerant mustard crop at this stage, and will such release have an irreversible adverse effect on the environment, the Supreme Court of India asked the Centre on the First week of December

Field trials of the transgenic mustard variety, DMH-11 (Dhara Mustard Hybrid-11), revealed them to be higher yielding, and they did not deter the pollination habits of honey bees, Union Science Minister Jitendra Singh said in Rajya Sabha in a written response to a query on 8th December 2022. The matter stands sub judiced.

Effect of foliar nutrition on soybean [*Glycine max* (L.) Merrill] productivity under rainfed condition of Manipur

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ABSTRACT

A field experiment was conducted during *kharif* 2017 to find out the response of soybean yield to application of foliar nutrition under rainfed condition of Manipur. The experiment was laid out in randomized block design with nine treatments which were replicated thrice. Treatments consist of application of foliar nutrient with recommended dose of fertilizer. Results showed that application of foliar nutrients significantly influenced the yield of soybean. Application of RDF + MOP 0.5% at pod initiation produced maximum seed yield of 2096 kg/ha followed by application of RDF + Urea 2% spray at pod initiation (1988 kg/ha) and RDF + 19:19:19 (NPK) 2% at pod initiation (1964 kg/ha).

Keywords: Foliar nutrition, Soybean, yield.

Soybean enjoy the status of being the prime legume crop among the world's important agricultural commodities that contributes significantly (~25%) to the globe's edible oil production. Among the major soybean growing countries, India ranks fourth in terms of area and fifth in terms of production as per AMIS, FAO estimates. Soybean production in India during 2021-22 is estimated to be 13.12 million tons from an area of 12.18 million ha and a productivity of 1077 kg/ha as per 2nd advance estimates of DAC&FW (Anonymous 2022). Foliar nutrition should be a component of a complete crop nutrition program. Accurate identification and treatment of nutrient deficiencies with foliar fertilizers will minimize the loss of yield. Foliar application allows the nutrients to enter the plant during dry conditions, when soil moisture may be too low to move towards the plants. Foliar spray of nutrients is the fastest way to boost up crop growth because the nutrients are available to plants quickly in the initial and critical stages of crop (Jamal *et al*., 2006). Foliar application of 2% diammonium phosphate (DAP) resulted in significantly higher number of pods per plant, number of seeds per pod, seed index and higher yield of soybean (Kumar *et al*., 2013). Foliar spray of 0.1% borax significantly increased germination percentage, 1000 seed weight of soybean (Crak *et al*., 2006). Keeping the above point in view, the experiment was taken up to study the effect of application of foliar nutrient on soybean productivity.

MATERIAL AND METHODS

The experimental trial was conducted at CAU Research Farm, Andro, Imphal, Manipur during the *kharif* 2017. The area is located at 24^{o}45.89´ N latitude, 94^{o}03.45´ E longitude with an elevation of 800 m above mean sea level. The soil was clay loam in texture containing 240 kg per ha available nitrogen, 15 kg per ha available phosphorus and 52 kg per ha available potassium with an organic carbon content of 0.9 per cent. The experiment was laid out in randomized block design with nine treatments which were replicated thrice. The treatment comprises of RDF (recommended dose of fertilizer) + water spray at pod initiation, RDF + Urea 2% spray at pod initiation, RDF + DAP 2% spray at pod initiation, RDF + MOP 0.5% at pod initiation, RDF + 19:19:19 (NPK) 2% at pod initiation, RDF + Molybdenum 0.5% at pod initiation, RDF + Boron 0.5% at pod initiation, RDF +Zinc chillated 0.5% at pod initiation and RDF only. The recommended dose of fertilizers was applied as basal @ 20:60:40 kg per ha of N, P_2O_5 and K_2O in the form urea, single super phosphate and muriate of potash, respectively. The genotype used in the experiment was JS 97 52 with a spacing of 45 cm x 10 cm. No irrigation was applied and the total rainfall received was 1159 mm during cropping period.

RESULTS AND DISCUSSION

The results showed that the application of foliar nutrition significantly influenced the seed yield of soybean. Among the treatments, application of RDF + MOP 0.5% at pod initiation produced maximum seed yield of 2096 kg/ha followed by application of RDF + Urea 2% spray at pod initiation (1988 kg/ha) and RDF + 19:19:19 (NPK) 2% at pod initiation (1964 kg/ha) which were at par. Higher seed yield might be due increased uptake of nutrient by the crop. Application of RDF + MOP 0.5% at pod initiation also recorded yield attributes, number of branches per plant and maximum B: C ratio of 2.74. Yield increased with the increase in the number of branches per plant, pods per plant and 100 seed weight due to 19:19:19 (N:P:K) has a profound effect on plant reproductive development and seed yield (Kaiser *et al*., 2005).

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Effect of foliar nutrition on yield and yield attributes of soybean.

Treatment	Branches/ plant	Pods/ plant	Seed index (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	HI (%)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
RDF + water spray at pod initiation	3.6	54	9.24	1511	2047	43.31	33546	90688	57142	1.70
RDF + Urea 2% spray at pod initiation	3.8	80	10.22	1988	3104	39.58	33628	119263	85635	2.55
RDF + DAP 2% spray at pod initiation	3.6	70	10.35	1885	2486	43.39	33886	113125	79239	2.34
RDF + MOP 0.5% at pod initiation	4.0	84	10.59	2096	2176	51.30	33604	125750	92146	2.74
RDF + 19:19:19 (NPK) 2% at pod initiation	3.7	74	10.36	1964	2652	42.86	35246	117863	82617	2.34
RDF + Molybdenum 0.5% at pod initiation	3.7	65	10.11	1781	2134	45.58	46918	106875	59957	1.28
RDF + Boron 0.5% at pod initiation	3.5	68	9.95	1816	2843	39.76	34676	108938	74262	2.14
RDF +Zinc chillated 0.5% at pod initiation	3.6	69	10.04	1824	2401	43.27	36046	109450	73404	2.04
RDF only	3.4	58	9.57	1541	2194	41.86	33546	92488	58942	1.76
SEm	0.156	4.64	0.26	106.6	173.2	2.40	-	6394	6394	0.183
CD (P=0.05)	NS	13.91	NS	319.5	519.2	7.20	-	19170	19170	0.548

Genetic analysis of yield and yield component traits in exotic soybean germplasm (*Glycine max* (L.) Merrill) for vegetable type under Indian Conditions

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ABSTRACT

The present investigation was carried out at ICAR-Indian Institute of Soybean Research, Indore during kharif, 2019 to evaluate 105 soybean germplasm accessions received from World Vegetable center (AVRDC), Taiwan for vegetable type under Indian Conditions. Genetic parameters such as genetic variability, heritability and genetic advance were estimated for 11 quantitative characters. High estimates of PCV and GCV were recorded for row yield, grain yield per plant, number of primary branches per plant, 100 seed weight, number of pods per plant, number of pod clusters per plant and plant height. This indicates considerable variability and provide scope for genetic improvement through selection. High heritability coupled with high genetic advance as percent of mean was found for row yield, grain yield per plant, 100 seed weight, and number of pods per plant, plant height and days to 50 per cent flowering. This designates careful selection leads to improvement of traits and provides better opportunities for selecting plant material for these traits in soybean breeding program for vegetable type.

Keyword: AVRDC, Broad sense heritability, GCV, Genetic advance, PCV, Soybean, Variability

Soybean (*Glycine max* (L.) Merrill) is considered as the most valuable oilseed crop which is known as Miracle crop and Golden bean due to its diversified uses. It is a self pollinated crop and has chromosome number of 2n=2x=40 belongs to the family Fabaceae. Soybean has high protein (40%) and oil content (20%) as well as seeds are rich in unsaturated fatty acids, minerals (Ca, P) and vitamins (A,B,C & D) which caters needs of humans and animals (Asmammaw, 2022).The vegetable soybean is known as grren soybean or edible soybean in north America, edmame in japan and madau in china which is consumed mainly as snack or salad (Nagaraju Shilpa shree *et al.*, 2021). Genotypes with bold seeded with short duration were preferred for vegetable type as useful in crop rotation purpose.

The assessment of variability helps in utilization of plant traits to develop suitable variety (Priti, *et al.*, 2020). Genetic variability is a prerequisite for any successful breeding program. Heritability and genetic advance of characters indicated scope for improvement of characters through selection. The present study was undertaken to estimate the genetic component of variance for yield and yield component traits to compute broad sense heritability, genetic advance in soybean for vegetable type.

MATERIALS AND METHODS

The present study was conducted at ICAR-Indian Institute of Soybean Research, Indore during *kharif,* 2019. A 105 soybean germplasm accessions were received from World Vegetable center (AVRDC), Taiwan through ICAR-NBPGR, New Delhi. The experiment was conducted in Augmented Block Design with 5 blocks and 4 checks (NRC 105, Karune, Harasoya, AGS Farm ACC.) in replication. Each block contains 21 genotypes with 4 checks sown in 3 m length. Observations were recorded on five randomly tagged plants for days to 50 percent flowering, days to maturity, plant height, number of nodes per plant, number of primary branches per plant, number of pod clusters per plant, number of pods per plant, number of seeds per pod, 100 seed weight and grain yield per plant. However, observations for the characters viz., days to 50 percent flowering and days to maturity were recorded on a plot basis. The mean values were used for statistical analysis. Analysis of variance was done for partitioning the total variation into variation due to treatments and blocks according to the procedure given by Federer (1956). Heritability in broad sense was calculated by Burton and Devane (1953). The estimates of genetic advance were obtained using the formula given by Johnson *et al*., (1955).

RESULTS AND DISCUSSION

The analysis of variance showed significant differences for all the characters studied except number of nodes per plant, number of primary branches per plant, number of pod clusters per plant and number of seeds per pod representing the presence of a high amount of variation The adjusted block effects were non significant for all the traits indicating homogeneity of blocks. The estimates of phenotypic (PCV) and genotypic (GCV) coefficients of variation indicated that the values of PCV were higher than GCV. High estimates of PCV and GCV were recorded for row yield (104.28, 101.6), grain yield per plant (52.28, 41.96), number of primary branches per plant (40.15, 24.79), 100 seed weight (30.65, 27.84), number of pods per plant (26.35, 22.71), number of pod clusters per plant (25.26, 12.8) and plant height (21.66, 18.16) .This provides considerable variability and offers scope for genetic improvement through selection. Similar results were reported by Vangala Rajesh *et al.,* (2021), Jandong *et al.,* (2020) and Bhakuni *et al.* (2017).

Heritability was found to be higher days to 50 percent flowering (97.99), row yield (94.93), days to maturity (94.52), 100 seed weight (82.53), number of pods per plant (74.24), plant height (70.33) and grain yield per plant (64.42). High values of heritability in broad sense indicate traits were less influenced by environmental effects. Similar results were observed by Priti *et al.,* (2020) and Bhakuni et al. (2017).

High heritability accompanied with high genetic advance provides a reliable conclusion (Johnson *et al.,* 1955). Traits like row yield, grain yield per plant, 100 seed weight, number of pods per plant, plant height exhibited high heritability along with high GCV and genetic advance as percent mean indicating additive gene action and provides scope for improvement of traits through selection. Whereas high heritability along with low GCV and genetic advance as percent mean indicating non-additive gene action which provides a limited scope of improvement of traits through selection. Similar results were found by Vangala Rajesh et al., (2021), Jandong *et al.,* (2020), Ravindra Kumar Jain *et al.,* (2017).

This reveals careful selection leads to improvement of traits and further provides better opportunities for selecting plant material for in soybean breeding program for vegetable type such as 100 seed weight, grain yield per plant, number of pods per plant along with short duration. This understanding of genetic parameters of soybean germplasm for vegetable type leads to development of vegetable soybean varieties.

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Fig 1: Variability of soybean germplasm for vegetable type from AVRDC, Taiwan

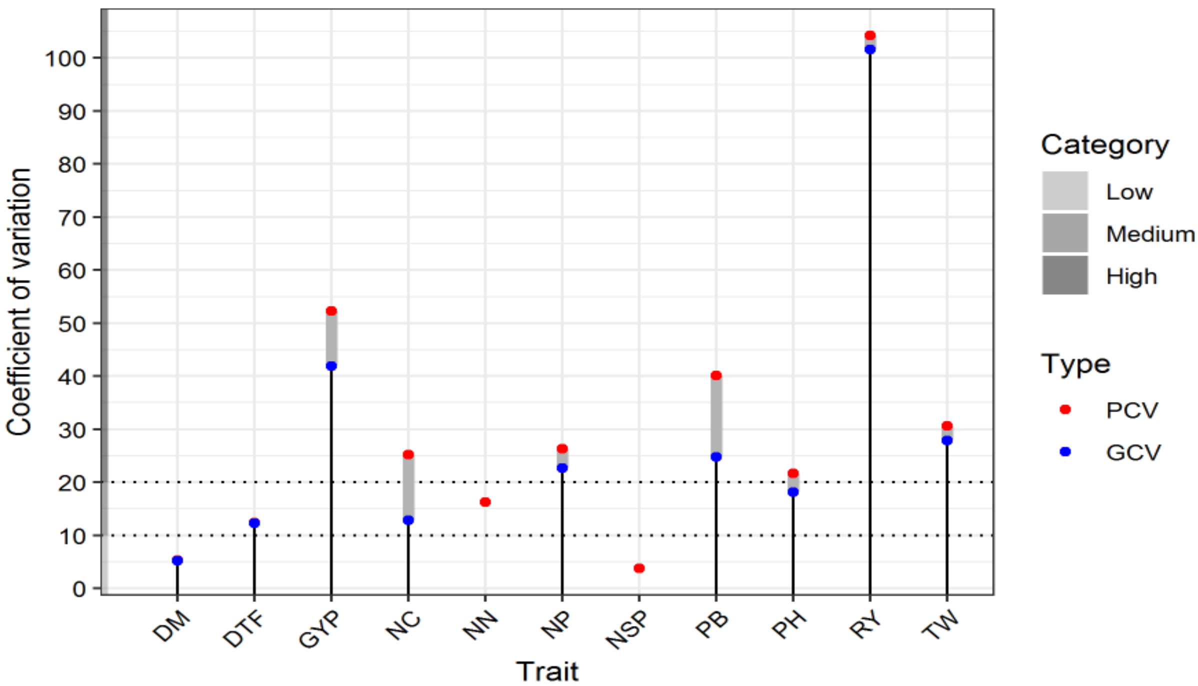

Fig 2: PCV and GCV for yield and yield component traits for vegetable type soybean germplasm

Effect of spacing and boron application and spacing on growth, yield parameters and yield of sunflower (*Helianthus annuus* L.) hybrids in spring season

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ABSTRACT

A field experiment was conducted during 2020 and 2021 spring season on loamy sand soils to study the effect of boron on sunflower hybrids sown under varied crop geometry. Treatment comprised four hybrids (PSH 1962, PSH 2080, KBSH 44 and KBSH 53) allocated to main plots, three spacings to sub plots (60 cm x 30 cm, 67.5 cm x 25 cm and 67.5 cm x 30 cm) and foliar application of boron (control and 220 ppm) at ray floret opening stage to sub sub plots which were replicated thrice. Hybrid KBSH attained the highest plant height and head diameter. Hybrids PSH 2080 and PSH 1962 produced similar but significantly higher seed yield, oil content and oil yield by virtue of higher number of seeds per plant (except over KBSH 53), seed weight per captulum, 100 seed weight and hectolitre weight than KBSH 44 and KBSH 53 in both years and mean analysis. Spacing of 60.0 cm x 30.0 cm and 67.5 cm x 25.0 cm resulted in similar but higher seed and oil yields than 67.5 cm x 30.0 cm. Foliar application of boron significantly increased the seed yield, oil content and oil yield through improvement in growth and yield parameters over without it application.

Keywords: Boron, Hybrid, Oil, Spacing, Yield

Sunflower (*Helianthus annuus* L.) is an important oilseed crop which can be grown on varied soils and diverse agro-climatic conditions under different seasons in the country. Sunflower oil is considered as premium cooking oil due to higher proportion of linoleic acid and anti-oxidants with cholesterol lowering properties and high smoke point. Use of sunflower seeds (raw or roasted) in confectionery and snack food is also on the rise in many developed countries. In north India, spring sunflower fits well in the intensive cropping systems and is an ideal crop for diversification due to its short duration, higher per day productivity and low input requirements. Demand of sunflower in the country is increasing and annually about 2.0-2.5 million tonnes of sunflower oil is imported to meet the demand. Thus there is urgent need to increase domestic production of sunflower which can be achieved through enhanced productivity by cultivation of high yielding hybrids and improved agronomic practices.

Boron is one of the micronutrients required for normal growth and development of many crops including sunflower where it is involved in cell division, cell wall structure, cell wall synthesis, sugar translocation, enzymatic reactions and plant growth regulation (Blevins and Lukaszewski, 1998; Souza *et al*., 2004). The objective of the present investigation was to study the production potential of sunflower hybrids under varied spacing and boron application during *spring* season.

MATERIALS AND METHODS

Field study was conducted in *spring* season (January – June) during 2020 and 2021 at Punjab Agricultural University, Ludhiana. The soil of the experimental field was loamy sand, neutral in pH and tested low in 0.27% organic carbon, medium in available phosphorus (28.0 kg/ha), rich in available potassium (232 kg/ha). Experiment was laid out in split-split plot design with four hybrids (PSH 1962, PSH 2080, KBSH 44 and KBSH 53) as the main plot, three spacings (60 cm x 30 cm, 67.5 cm x 25 cm, 67.5 cm x 30 cm) as sub plot and two doses of boron (0 and 220 ppm) as sub-sub plot treatments with three replications. Crop was sown on ridges on 31st and 30th January in 2020 and 2021 by using 5 kg seed per hectare. Gross plot size was 4.0 m x 4.5 m. Boron as per treatment was applied as foliar application at ray floret opening stage (one spray). Prior to sowing, seed was treated with metalxyl @ 6g per kg seed. Application of 30 kg nitrogen, 30 kg phosphorus and 30 kg potassium through urea, single super phosphate and muriate of potash was made at sowing and 30 kg nitrogen through urea was applied after irrigation at one month after sowing. Crop received 8 and 9 irrigations during 2020 and 2021 crop seasons, respectively.

RESULTS AND DISCUSSION

The study was conducted for two years. Results of mean analysis are presented.

Hybrids: Hybrids KBSH 44 and KBSH 53 attained significantly more height than PSH 1962 and PSH 2080 which in turn were at par with each other (Table 1). Head diameter of KBSH 53 was significantly higher than other hybrids. Differences in stem girth of hybrids were inconspicuous. Hybrid PSH 2080 produced highest number of seeds per plant which was at par with KBSH 53 and both these hybrids significantly outperformed PSH 1962 and KBSH 44 for number of seeds per plant (Table 1). Hybrid PSH 2080 produced significantly more 100 seed weight than KBSH 44 and KBSH 53 but was at par with PSH 1962. Hybrids PSH 1962 and KBSH 44 also produced significantly more 100 seed weight than KBSH 53. Hybrid PSH 2080 also registered significantly higher hectolitre weight than all other hybrids. Hybrids differed significantly for seed yield, oil content and oil yield (Table 1). Hybrid PSH 2080 produced statistically similar seed yield, oil content and oil yield with PSH 1962 but significantly higher seed yield than KBSH 44 and KBSH 53. Seed yield of PSH 2080 was 2.3, 6.3 and 7.2 per cent higher than PSH 1962, KBSH 44 and KBSH 53, respectively. Similarly PSH 2080 produced 6.3, 23.2 and 15.2 per cent higher oil yield than PSH 1962, KBSH 44 and KBSH 53, respectively.

Spacing: Wider spacing of 67.5 cm x 30.0 cm resulted in significantly more stem girth than 60.0 cm x 30.0 cm spacings. Number of seeds per plant, seed weight per capitulum, 100 seed weight and hectolitre weight were not influenced by varied spacings. Seed and oil yields with spacing of 60 cm x 30 cm and 67.5 cm x 25.0 cm were almost similar but significantly higher than that obtained with 67.5 cm x 30.0 cm spacing (Table 1). Seed yield (2141 kg/ha) and oil yield (800 kg/ha) produced with spacing of 60 x 30 cm were 6.6 and 6.7 per cent higher than that of 67.5 cm x 30.0 cm spacing.

Boron: Foliar application of boron @ 220 ppm significantly increased the stem girth over without boron application (Table 1). Foliar application of boron significantly increased the number of seeds per plant, seed weight per capitulum, 100 seed weight and hectolitre weight over without its application (Table 1). Foliar application of boron increased the seed yield by 5.1 per cent and oil yield 8.4 per cent and oil content (1.1 per cent) over without its application (Table 1).

Interactions: Interactions between hybrids and spacing for oil yield and between spacing and boron for seed yield and oil yield were significant.

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Table 1**.** Effect of hybrids, spacing and boron application on growth and yield parameters and seed yield, oil content and oil yield of sunflower

Treatments	Plant height (cm)	Stem girth (cm)	Head diameter (cm)	Number of seeds per plant	Seed weight per capitulum (g)	100 Seed weight (g)	Hectolitre weight (kg)	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)
Hybrids										
PSH 1962	151.6	5.1	16.5	732	54.4	6.5	41.5	2119	38.3	813
PSH 2080	150.2	5.1	16.6	788	57.7	6.9	44.1	2167	39.8	864
KBSH 44	198.4	4.7	16.9	729	52.9	6.1	40.4	2038	34.1	701
KBSH 53	205.1	5.1	18.3	775	52.5	5.1	40.9	2022	36.9	750
CD (p=0.05)	9	N.S.	0.6	38	N.S.	0.4	1.0	84	2.7	68
Spacing (cm)										
60 x 30	176.0	4.9	16.9	742	53.9	6.3	41.5	2141	37.2	800
67.5 x 25	178.1	5.0	16.9	772	54.3	6.2	41.9	2111	37.5	796
67.5 x 30	174.9	5.1	17.4	754	55.0	6.1	41.7	2009	37.1	750
CD (p=0.05)	N.S.	0.15	N.S.	N.S.	N.S.	N.S.	N.S.	42	N.S.	24
Boron application										
220 ppm	177.4	5.1	17.2	778	55.8	6.4	42.3	2138	37.8	814
Without spray	175.2	4.9	16.9	734	53.0	5.9	41.1	2035	36.7	751
CD (p=0.05)	N.S.	0.1	N.S.	11	1.7	0.2	0.5	24	0.6	16
CD (p=0.05)										
H x S	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	48
H x B	N.S.	N.S.	N.S.	N.S.	N.S.	0.5	0.9	N.S.	N.S.	N.S.
S x B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	42	N.S.	27
H x S x B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	83	N.S.	54

Comparative virulence of microbial bioagents against castor spiny caterpillar, *Ariadne merione* (Lepidoptera: Nymphalidae)

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ABSTRACT

The castor spiny caterpillar, *Ariadne* (*Ergolis*) *merione* is one of the major insect pests of castor. Microbial bioagents offer considerable promise for eco-friendly insect pest management. Hence, pathogenicity of the entomopathogenic bacteria and fungi were evaluated against larvae and pupae of *A. merione* under laboratory conditions. Among the microbial bioagents, entomopathogenic fungi, *Beauveria bassiana* recorded high pathogenicity against *A. merione* larvae followed by entomopathogenic bacteria, *B. thuringiensis.* The LC_{50} of *B. bassiana* and *B. thuringiensis* against *A. merione* larvae was 0.89 and 1.18 g/l, respectively. *B. bassiana* @ 2 g/l effected pupal mortality and pupal malformation, while *M. rileyi* did not cause any pupal mortality. Hence, *B. bassiana* and *B. thuringiensis* can be used in IPM programme as a potential microbial bioagents against castor spiny caterpillar in castor.

Keyowrds: Castor, Spiny caterpillar, Virulence of microbial agents

Castor (*Ricinus communis* L.) is one of the most important non-edible oilseed crops that support quite a large number of agro-based industries. One of the major constraints in exploiting higher productivity in castor is the damage due to lepidopteran insect pests (Lakshminarayanana and Duraimurugan, 2014). The castor spiny caterpillar, *Ariadne* (*Ergolis*) *merione* (Crammer) (Lepidoptera: Nymphalidae), is one of the major insect pests of castor. Microbial bioagents are potential alternatives to synthetic chemical insecticides for safe and eco-friendly insect pest management (Vimala Devi and Duraimurugan, 2013; Vimala Devi *et al*., 2020). The present findings provide insight into the virulence of the entomopathogenic bacteria (*Bacillus thuringiensis*) and fungi (*Beauveria bassiana* and *Metarhizium rileyi*) against *A. merione*.

MATERIALS AND METHODS

Laboratory bioassays were conducted to evaluate the pathogenicity of the entomopathogenic bacteria and fungi against larvae and pupae of castor spiny caterpillar, *A. merione.* Bioassays were carried out using five different concentrations of spores / conidial powder of entomopathogenic bacteria (*Bacillus thuringiensis*) and entomopathogenic fungi (*Beauveria bassiana* and *Nomuraea rileyi*) along with commercial formulation of Bt (Delfin®) @ (0.05, 0.1, 0.5, 1.0 and 2.0 g/l). An untreated control was used as a check. Leaf dip bioassay and topical bioassay methods were used to evaluate the effectiveness of the microbial bioagents against larvae and pupae of *A. merione*, respectively. The experiment was replicated thrice. Ten larvae were released in each replication. Mortality recorded at 24 hours interval up to 7 days after treatment and the Lethal Concentration for 50% (LC_{50}) was estimated using Probit Regression analysis using Statistical Packages for Social Sciences (SPSS software version 16.0).

RESULTS AND DISCUSSION

Among the microbial bioagents, entomopathogenic fungi, *B. bassiana* recorded high pathogenicity against *A. merione* larvae followed by entomopathogenic bacteria, *B. thuringiensis*, while moderate pathogenicity was observed with entomopathogenic fungi, *M. rileyi* (Fig. 1). The LC_{50} of *B. bassiana* and *B. thuringiensis* against *A. merione* larvae was 0.89 and 1.18 g/l, while the LC_{50} of *M. rileyi* was 1.73 g/l at 5 days after treatment. Among the microbial bioagents, *B. bassiana* @ 2 g/l effected pupal mortalityand pupal malformation, while *M. rileyi* did not cause any pupal mortality. Hence, the entomopathogenic fungi, *B. bassiana* and entomopathogenic bacteria, *B. thuringiensis* can be used in IPM programme as a potential microbial bioagents against castor spiny caterpillar in castor.

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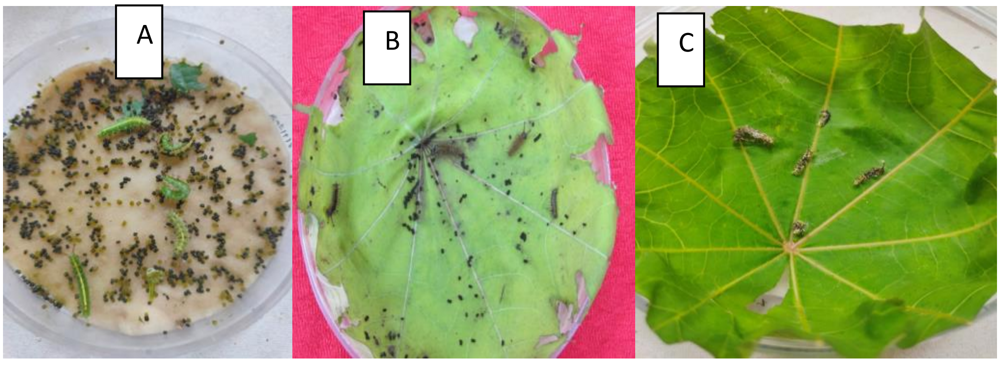

Fig.1. Bioassay and mortality of *Ariadne merione* larvae due to microbial bioagents,
A. Control (Healthy larvae); B. Larvae infected with Bt; C. Larvae infected with *B. bassiana*

High yielding, multiple resistant Spanish bunch groundnut variety, KADIRI LEPAKSHI (K1812), notified for All India Summer Zone III

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ABSTRACT

Spanish bunch groundnut variety, Kadiri Lepakshi (K1812) is a derivative of complex cross ((ICGV 92069 x ICGV 93184)SIL4 x ICGV 98300) notified for All India Summer Zone IIIa consisting of Karnataka and Maharashtra states is developed at Agricultural Research Station, ANGRAU, Kadiri by modified pedigree method. It gave an average dry pod yield of 3840 kg ha^{-1} and kernel yield of 2666 kg ha^{-1} which is 31.87% and 29.74% higher than the national check TAG 24 and 43.07% and 44.67% higher than zonal check-1, Kadiri Harithandhra and 13.81% and 20.84% higher than zonal check -II, R 2001-3 respectively during summer irrigated condition (2016, 2017 and 2020).

Keywords: High yield, High yield, Kadiri Lepakshi, K1812, Multiple disease resistance

Globally, Groundnut covers 295 lakh hectares with the production of 487 lakh tonnes with the productivity of 1647 kg per hectare (FAOSTAT, 2019). With annual all-season coverage of 47 lakh hectares globally, India ranks first in Groundnut acreage and is the second largest producer of Groundnut in the world with 67 lakh tonnes after China with a productivity of 1422 kg per hectare (FAOSTAT, 2019). Groundnut is a major oilseed crop contributing around 37 per cent of the total oilseeds production in the country during 2020-21. Groundnut contributes 19.1 per cent area and 21.3 per cent production to total oilseeds area and production in India respectively. In India, seventy percent of the area and seventy five percent of the production has been concentrated in the major states like Gujarat, Rajasthan, Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh and Maharashta states. In Andhra Pradesh, it is cultivated in an area of 8.69 lakh ha with a production of 7.74 lakh tones and productivity of 891 kg/ha during 2020. Groundnut is cultivated in *kharif*, *rabi* and summer seasons, but nearly 80% of acreage and production comes from kharif crop (June-October). Agricultural Research Station, ANGRAU, Kadiri working on development of new groundnut varieties for high pod yield, oil content coupled with resistance to biotic and abiotic stresses. Current research efforts are congregated to develop high yielding, drought tolerant and resistance to pest and diseases and release of Kadiri Lepakshi (K1812) is one of such efforts.

MATERIALS AND METHODS

K1812 is a derivative of a complex cross (ICGV 92069 x ICGV 93184) SIL4 x ICGV 98300) made at ICRISAT, Hyderabad and the segregating material was subsequently handled at ARS, Kadiri. The population was subjected to induced midseason drought and the selected drought tolerant lines were advanced further by single seed descent method. Finally, stable line K1812 was tested in a hierarchy of successive trials. Further, it was also tested in All India Co-ordinated Spanish bunch trials in IVT-I & IVT-II during Summer Irrigated in 2016-17 and 2017-18. Based on its superiority in pooled analysis in zone IIIa it was promoted to AVT in 2020-21 and recommended for identification and then notification in 2022.

RESULTS AND DISCUSSION

Kadiri Lepakshi (K1812) is a profuse branching plant type with a height of 23-25 cm and completes its duration in 122 days during summer has small obovate dark stay green foliage with high SPAD chlorophyll meter reading and high photosynthetic efficiency. It has medium sized pods with moderate beak and reticulation and has 1-2 rose coloured attractive seeds tapering at both the ends.

After achieving genetic uniformity by advancing generations, this genotype was tested in a hierarchy of successive trials at Agricultural Research Station, Kadiri and also tested in AICRPG trials during 2016-17 to 2020-21 (Table 1) under summer irrigated condition, wherein, it recorded an average dry pod yield of 3840 kg/ha and kernel yield of 2666 kg/ha which is 31.87% and 29.74% higher than the national check TAG 24 and 43.07% and 44.67% higher than the zonal check-1, Kadiri Harithandhra and 13.81% and 20.84% higher than the zonal check-II, R 2001-3 respectively during summer irrigated condition (2016-17 to 2020-21). Further, it has 100 kernel weight of 41 %, oil content of 51%, protein content of 27% with shelling of 69% and sound mature kernel of 88% (Table 2). In large scale demonstrations conducted during *Rabi* 2019-20 in farmer's fields of Rayalaseema districts of Andhra Pradesh, K1812 recorded a mean pod yield of 4275 kg/ha, which is 29.5 % higher over most popular cultivar, Kadiri 6 (3314 kg/ha). It responded to high dose of fertilizer application with high B:C ratio at 125% (4383 kg/ha; 2.77) and 150 % (4428 kg/ha; 3.31) than 100 % (4124 kg/ha; 2.62). Moreover, high SCMR (43.6) and low SLA (103.3 g/cm^2) coupled with high pod yield/plant (9.05 g) and small leaf size with stay greenness up to maturity are the physiological attributes that sustain K1812 in severe drought years (2014 and 2015).

The disease severity of major foliar diseases (leaf spots and rust) were recorded using 1-9 scale (Subrahmanyam *et al*., 1995). While, seed and soil borne diseases were recorded at regular intervals and cumulative per cent incidence (%) was noted (Table 3a). Intensity of foliar and fungal disease score of the variety, Kadiri Lepakshi for ELS (1.5), LLS (3.4), rust (2.4), *Alternaria* Leaf blight (2.0) are less. The incidence of collar tot (4.8%), stem rot (13.4%) and dry root rot (11.1%) were also very less. The PSND (4.0) and PBND (0.8) incidence was minimal against 8.0 and 2.3 in susceptible check). Leaf hopper (2.9), Thrips (2.8), *Spodoptera* leaf damage (2.7) and leaf minor damage (2.3) is also much lower (Table 3b).

DNA fingerprinting data for K1812 genotype was generated at Regional Agricultural Research Station, Tirupati using six SSR markers (TC3E05, TC7H11, Seq3BO5, Seq7H06, TC3H07 and TC11E07) on five popular cultivars (Tirupati 3, Kadiri6, Narayani, Dharani and TCGS 1694) and all could differentiate K1812 from other cultivars.

The genotype K1812 has been assigned with national identity, IC634900 by ICAR-NBPGR, New Delhi. The Central Sub Committee on Crop Standards, Notification and Release of Varieties has also notified this variety for Zone IIIa under area extension as this variety was already notified with the notification S.O 500(E) dt.21.01.2021 for All Inia Zone V for *kharif* cultivation and the gazette notification published on 30.11.2022.

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Metarhizium rileyi: A potent bio control agent against noctuids infesting groundnut is a boon to the farmers of northern transitional zone of Karnataka

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ABSTRACT

Field monitoring was done regularly during *kharif* (2019-2022) *& rabi/summer* (2019-2021) at MARS, UAS, Dharwad, Karnataka to know the natural occurrence of entomopathogenic fungi, *Metarhizium rileyi* in combating the later instars of *Spodoptera litura, Thysanoplusia sp.* and *Helicoverpa armigera* at vegetative (2.2%), pod formation (36%) and maturity stage (48%) resp. In the consecutive four years, natural pathogenecity rates were very high during *Kharif* (August and September) which coincided with high rainfall. Local field strain is extremely virulent in supressing the mixed population of different lepidopterans. So it's an excellent, worthy environmentally safe biocide.

Keywords: Groundnut noctuids, Metarhizium rileyi

The production of groundnut is threatened by more than 90 species of insects (Nandagopal, 1992). Among them, defoliators were menace during *kharif in* northern transitional zone of Karnataka. The continuous use of chemicals resulted in resistant strains, environmental pollution and negative impact on non-targets. Thus one such environmentally safe alternative is entomopathogenic fungi. However, this is not only an insect pathogen but it also readily colonizes in the plant rhizosphere (Clifton *et al*., 2018). Hence in the present study we were interested to document the natural larval pathogenesity by *Metarhizium* in groundnut ecosystem.

MATERIALS AND METHODS

Regular monitoring was done (var. JL-24 raised on 10x10 m plot) during *kharif* (2019-2022) *& rabi/summer* (2019-2021) at MARS, UAS, Dharwad, Karnataka to know the natural occurrence of *Metarhizium rileyi* on different defoliators infesting groundnut. Dead cadavers were brought to the laboratory from the field and kept under petri plates with wet blotting paper. Later larvae showed green fungal sporulations on their body wall and confirmed its presence under microscope. Observation on dead cadavers/10 m^2 area due to *Metarhizium* were recorded at weekly intervals starting from seedling stage to till harvest. Percent larval mortality was calculated.

RESULT AND DISCUSSION

The activity of *Spodoptera, Helicoverpa* male moths trap catch and larval population were maximum during *kharif* (August-September) as compared to *rabi*/summer irrespective of the year. Natural infestation of *Metarhizium rileyi* was noticed on later instars of *Spodoptera litura, Thysanoplusia* sp. and *Helicoverpa armigera at* vegetative (2.2%), pod formation (36%) and maturity stage (48%) resp. at research station. Infectivity rates were very high in the months of August and September, when high rainfall occurred. Farmers can collect green coloured dead larvae from their fields. Grind them in mixer by adding water. Drain the extract through muslin cloth. Take out the supernatant & spray during cool hours in field after diluting with water. In conclusion, *Metarhizium* is a very good ecofriendly IPM tactic and boon to the organic farmers.

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Evaluation of sunflower germplasm against charcoal rot

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ABSTRACT

A total of 85 sunflower genotypes were evaluated against charcoal rot by imposing drought conditions during flowering. Disease assessment was done by taking inner lesion length that varied from 0.70 cm 47.82 cm and the average inner lesion length of non-irrigated trials was more as compared to irrigated trials. The disease spread was more prominent in drought conditions that affect the plant height, root width as well as the head diameter.

Keywords: Charcoal rot, Drought, Macrcophomina phaseolina, Sunflower

Charcoal rot caused by *Macrophomina phaseolina* is a serious threat to sunflower crop particularly in arid region. *M. phaseolina* is reported to be seed, soil, and stubble-borne. Low precipitation and high temperatures coincided with the flowering stage of plants, result in increased disease severity and posing a potential threat to sunflower production. Management of charcoal rot is ineffective due to the soil-borne nature of fungus, reliable screening technique, and lack of resistance source. Till now, there is no resistance source in sunflower germplasm against *Macrophomina* and only a moderate kind of resistance can be found in sunflower germplasm (Ijaz *et al* 2013, Jalil *et al* 2013). Keeping all this in view, the present study was carried out to identification of resistant genotypes against charcoal rot in drought conditions in sunflower.

MATERIAL AND METHODS

The field experimentation for the screening of sunflower germplasm (85 genotypes) was carried out in the spring season 2020-21 in the fodder fields of PAU, Ludhiana. Single row trail was laid in RBD design in two replications and all the standard agronomic practises were followed during the crop trial with one trail being regularly irrigated and other trail with no irrigation at flowering stage. At flowering the sunflower plants were inoculated with the artificial inoculation technique using toothpick method. Plants were recorded for various agronomic traits including disease severity that measured as lesion length by splitting the stem of inoculated plants.

RESULTS AND DISCUSSION

All the sunflower tested entries were evaluated in 2020-21 for parameters namely plant height, head diameter, yield, root length, root width, and inner lesion length for every healthy and diseased plants in both the irrigated and non-irrigated trails, and graphic presentation of same is given in Figure1. Post inoculation plant height data was recorded at maturity for both the irrigated and non-irrigated trails and it was observed that the height in irrigated plot was significantly higher than the non-irrigated plot. The plant height of healthy plants of sunflower genotypes was ranging from 52.5cm to 150 cm while the diseased plant heights varied 30 cm to 165cm. The recorded head diameter of tested sunflower entries responded differently and found to be significantly lower in non-irrigated trial as compared to irrigated trial. Further, the head diameter of diseased plants (2.1cm to 26cm) was also less than the healthy plants (3cm to 20.33cm) in both the irrigated and non-irrigated trials. The average root length of each healthy and diseased plant was at par ranging from 12.87 cm to 13.79 cm in both irrigated and non-irrigated trials. However, the average root width of tested entries was significantly lower in non-irrigated plot as compared to irrigated plot especially in case of diseased plants with average root width between 10.54 cm to 13.99 cm than healthy plants where average root width varied from 14.67 cm to 16.54 cm. The inner lesion length of tested entries varied from 0.70 cm to 47.82 cm and the average inner lesion length of non-irrigated trials (13.16 cm) was more as compared to irrigated trials (11.54cm). Thus we conclude that the disease spread was more prominent in drought conditions that affect the plant height, root width as well as the head diameter. Further these already tested sunflower entries will be evaluated for same parameters in consecutive years for more reliable screening of sunflower germplasm against charcoal rot in drought conditions.

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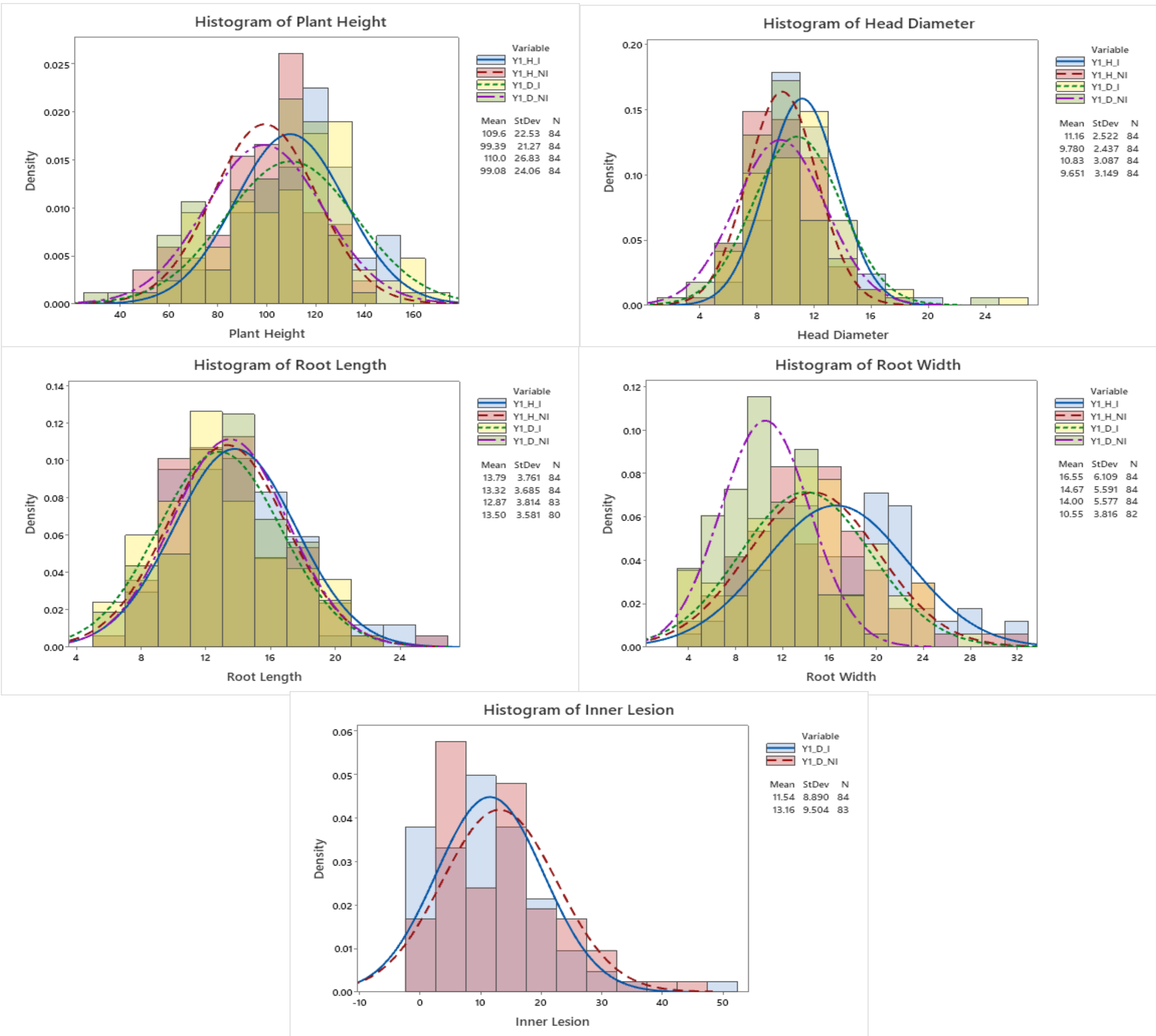

Fig.1 Histograms of recorded parameters for healthy and diseased plants in irrigated and non-irrigated trials

Table 1: Pod and Kernel yields of Kadiri Lepakshi (K1812) against Nationals and Zonal checks in AICRP-G trials in Zone IIIa

S. No.	Trial	No.of Locations	P/K	K1812	TAG 24 (NC)	Kadiri Harithandhra (ZC I)	R 2001-3 (ZC II)
1	IVT I	2	P	4156	2498	3353	2623
	(2016-17)		K	2888	1750	2305	1707
2	IVT II	2	P	3587	4119	2192	4714
	(2017-18)		K	2579	3032	1584	3090
3	AVT	4	P	3776	2120	2506	2785
	(2020-21)		K	2530	1382	1639	1821
	Mean		P	3840	2858	2806	3177
			K	2666	1988	1910	2073
	% increase of K1812 with		P	-------	31.87	43.07	13.81
	corresponding checks		K	-------	29.74	44.67	20.84

P: Pod yield (kg/ha) K: Kernel yield (kg/ha) NC: National Check ZC: Zonal Check

Table 2: Ancillary data of Kadiri Lepakshi (K1812) compared with checks over Locations and years in AICRPG trials (2016-17, 2017-18 and 2020-21)

Trait	K1812	TAG 24 (NC)	Kadiri Harithandhra (ZCI)	R 2001-3 (ZC II)
100 kernel weight (g)	41	45	54	37
Shelling (%)	69	69	69	65
Sound Mature Kernel (%)	86	88	88	-
Oil content (%)	51	50	50	49
Protein content (%)	27	27	27	24
Days to maturity	122	119	120	117

NC: National Check ZC: Zonal Check

Table 3a: Mean disease score of Kadiri Lepakshi (K1812) over locations and years in AICRPG trials

Name of the Disease	ELS	LLS	Rust	ALS	CR	SR	DRR	PBND	PSND
Score in Susceptible check	2.7	4.8	4.0	3.1	15.4	22.1	18.8	8.0	2.3
IVT I & II Mean	1.0	3.7	2.8	1.0	4.7	14.8	8.2	2.0	1.6
AVT Mean	2.0	3.0	2.0	3.0	5.0	12.0	16.0	6.0	0.0
Grand Mean	1.5	3.4	2.4	2.0	4.8	13.4	11.1	4.0	0.8

ELS: Early Leaf spot, LLS: Late Leaf Spot, ALS: *Alteranaria* Leaf Spot CR; Collar Rot, SR: Stem Rot, DRR: Dry Root Rot, PBND: Pea nut Bud necrosis disease, PSND: Peanut Stem Necrosis Disease

Table 3b: Mean pest score of Kadiri Lepakshi K1812 over locations and years in AICRPG trials

Name of the Pest	Leaf hopper	Thrips	*Spodoptera*	Leaf Minor
Score in Susceptible check	4.8	4.5	4.4	3.2
IVT I & II Mean	3.5	3.4	3.1	2.2
AVT Mean	2.3	2.3	2.3	2.5
Grand Mean	2.9	2.8	2.7	2.3

Note: All the pest score was taken on leaf damage in 1-9 scale

Exploration of Newer/Lesser-Known Oils of Indian Origin

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ABSTRACT

CSIR-IICT during 12 th FYP programme investigated on more than 200 treeborne oil seeds. Exploiting Indian Forest base for newer and lesser-known tree-borne oilseed sources for edible and non-edible applications was the objective of this study. Oil seeds namely, *Swietenia mahagoni* (52% oil content), *Calophyllum inophyllum* (65%), *Melia dubia* (43%), *Ailanthus excelsa* (38%), *Mesua ferrea* (75%) and *Entada Rheedii* (12.8%) were some of the oilseeds investigated during the study.

Keywords: Edible, Indian Forest, Newer/Lesser-Known Tree-born Oilseeds, Non-edible Applications

India imports more than 50% of vegetable oils for its domestic requirements. Spent about Rs 120, 000 cr. of foreign exchange for the import of vegetable oils during 2020-21 (imported 63% of total vegetable oil consumed) [*The Economic Times, Last Updated on Nov 16, 2021*]. Indian vegetable oil production is stagnant at 8-9 million tones for the several years. Domestic oilseed production in 21-22 is pegged to rise by 7% to 38.5 million tonnes against 35.9 million tonnes in 2020-21. This was achieved by encouraging farmers to plant more oilseeds in preference to competing crops, via good price realization for the output. Total Vegetable oil production in 21-22 is estimated to rise by 5% to 10.3 million tonnes against 9.8 million tonnes in the previous year. Palmoil imports fell by 4, 77, 541 tonnes (12%) i.e., 39, 28, 535 tonnes (3.9 million tonnes, imported during Jan-June 2021) and 34, 50, 994 tonnes (3.4 million tonnes, imported during Jan-June 2022) [*Global Oils & Fats Business Online*]. Import of Soft oils (those oils which are liquid at room temperature are soft oils) went up by 6, 28, 455 tonnes (28%) i.e., 22, 80, 758 (2.2 million tonnes, imported during Jan-June 2021) and 29, 09, 213 tonnes (2.9 million tonnes, imported during Jan-June 2022) driven by higher soybean oil imports. The share of soft oils in the import basket stood at 46%, compared to 37% in first half of 2021. To meet the demand, search for alternative oil-bearing materials is imperative. Apart from edible purpose, vegetable oils are also attractive feed stock for petrochemical substitutes. Keeping this in view, CSIR-IICT during 12 th FYP programme investigated on more than 200 treeborne oil seeds.

MATERIALS AND METHODS

The seeds were supplied by the Andhra Pradesh Forest Department and also procured from different parts of the country. The authentication of the specimen was done at Andhra Pradesh Forest Department, Hyderabad, India.

RESULTS AND DISCUSSION

During the study oil content, fatty acid composition, physico-chemical properties (if oil content is above 20%) were investigated. Several oils were converted into biodiesels (fatty acid methyl esters) and compared with ASTM and EN specifications. Almost all methyl esters prepared fell within the range of either ASTM or EN specifications. Aforementioned oils can be exploited, in future, for edible applications after conducting general toxicology studies.

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Table 1 Oil Contents of Various Treeborne Oilseeds

Name	Oil Content (%)
Swietenia mahagoni	58.1
Calophyllum inophyllum	65.0
Melia dubia (kernel)	41.5
Ailanthus excelsa	38.0
Mesua ferrea	75.0
Entada Rheedii	12.8
Butea Parviflora	33.0
Knema attenuata	33.8

Seed to seed mechanization in major oilseed crops - A review

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ABSTRACT

Mechanization in oilseed crops help in efficient utilization of time, labour, fertilizers, water and timely completion of agronomic operations, reduce drudgery and wastage thus augment production efficiency. However, mechanization index (MI) in oilseed crops is low i.e. 32.52% for rapeseed and mustard, 26.4% for soybean, 11.83%

for groundnut as compared to that of wheat (40.77%). As better crop yield are recorded in states with higher MI, efforts must be to design and develop cost effective machinery from seed to seed mechanization and also oil extraction in oilseeds crops in all the states.

Keywords: Mechanization, Oilseeds, Resource conservation, Yield

Seven edible (rapeseed-mustard, groundnut, soybean, sunflower, sesame, safflower and niger) and two non-edible (castor and linseed) oilseed crops are grown in India. Besides, non-conventional edible oils (cotton seed and rice bran) and tree borne oils (oilpalm and coconut) are also being used as secondary source. The demand for edible oils is increasing fast due to enhanced income levels, improvement in the standard of living of people and change in food habits. As there are meagre chances to enhance oilseed cropped area, there is a dire need to augment the production and productivity with technological backup. Among many reasons for low productivity, lack of mechanization is very important for non-completion of agronomic operations timely, wastage during harvesting and post-harvest processing. Though India is fast moving towards mechanization, still the level of mechanization is only 40% as compared to that of U.S.A. and W. Europe (95%), Russia (80%) and Brazil (75%). Further, extent of mechanization is low in oilseed crops. Hence, an effort is made to compile the existing information on mechanization in oilseed crops and propose future plan of action.

MATERIALS AND METHODS

The principal oilseed crops that are grown in India are selected for study. The available literature is collected from published research and review article and books and compiled. Based on the existing information, research and extension needs in promoting mechanization in oilseed crops are being discussed.

RESULTS AND DISCUSSION

Most of the oilseed crops are grown under rainfed conditions (>70%) where sowing window is narrow. Further, some of the oilseed crops (mustard, castor, sesame, safflower) have high scattering property at the time of maturity, hence, timely harvesting and threshing is important.

In rainfed castor, adoption of motorised power sprayers, tractor drawn mechanical intercultivation, harvesting with secature and mechanical threshing resulted in higher infiltration rate, rain water use efficiency and energy indices and 13.2% more seed yield, saved 23 man days and 54 hours time thus higher net returns by Rs. 9448/ha over CPs (Ramanjaneyulu et al., 2021). However, there is a need to develop complete mechanization package duly including mechanized sowing and harvesting. Groundnut cultivation is costly (Rs. 50000/ha) in general and labour intensive in particular. However, 87% farmers in Guajarat and 69% in A.P. and Telangana are using bullock carts for sowing operation, 83% rely on bullock drawn implements and manual labour for weeding. Partial mechanization in groundnut (planter, power tiller sprayer, Asha guntaka, mechanical threshing) reduced the cost of cultivation by Rs. 2500/ha besides timely completion of operations (Wesley, 2004).

Mechanical sowing of safflower on broad bed furrow (BBF) in paired rows at 30 cm x 20 cm on 60 cm bed width conserved 9.6% more soil moisture resulting in 6.5% higher yield and 38% less cost over traditional practice (Khambalkar et al., 2011). Further, manual picking is difficult due to presence of spines. In a prototype of safflower picking robot experiments in China, average picking cycle of safflower filaments of 16 s/flower ball and the average net picking rate of filaments of 87.91% were realised (Guo et al., 2022). In soybean, running combine harvester (Yanmar-CA760) at a speed of 2.6 km/h, cylinder speed of 10.89 m/s and grain moisture content of 18.50% for harvesting and threshing of soybean was found better over manual harvesting and gathering followed by mechanical threshing and winnowing, in view of less loss, damage, costs and satisfactory performance and high efficiency (Goma et al., 2009). In rapeseed and mustard, mechanized sowing is difficult due to small sized seeds. There is a dire need to breed varieties with suitable traits for mechanised sowing and harvesting cum threshing for timely execution of operations, reduce wastage and enhance yield. In India, new sesame cultivars amenable for mechanical harvesting-threshing, are to be bred to minimize the losses and improve seed yield. In case of Niger crop, improvement in grain yield was to the tune of 70.9 and 42.7% and net monetary returns to the tune of 117.7 and 72.8% for the T1 (mechanization+seed priming+seed treatment+NPK) and T2 treatment (mechanization+seed priming+rock phosphate seed coating), respectively over control. Mechanization needs to be combined with yield enhancing technologies for higher profits (Nourou et al., 2020)

In oilpalm plantations, mechanization should be aimed at increasing land: labour ratio and reduce drudgery. The planting, fertilizer application and harvesting are least mechanized. While, threshing of fruits, oil extraction processes (30%) and kernel cracking and palm kernel oil extraction (50%) are partially mechanized (Akande et al., 2013).

Finally, complete mechanization of oilseed crops with machinery to suit to location specific situations duly involving engineers and innovative farmers, is essential for reducing the cost and enhance net farm income. Successful running of custom hiring centres to improve availability and accessibility of machinery to the farmers can promote mechanization in oilseed crops. Similarly, oil extraction units or expellers which can extract total amount of oils from seeds need to be developed.

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Stability analysis of different sunflower hybrids (*Helianthus annuus* L.)

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ABSTRACT

In present study eleven hybrids along with two check hybrids for seed yield per plot (g), head diameter (cm), plant height (cm) and 100 seed weight (g) over three environments. The Genotype x environment interaction was found significant for all the characters suggesting the presence of genetic variability in the hybrid population. The genotype and environment were found significant for all the traits studied. The environment indices revealed that E_1 was the favorable environment for seed yield per plot (g), for 100 seed weight (g) E_2, for plant height (cm) and head diameter environment E_3 was favorable. For stability parameter, the hybrids SVSH-488, SVSH-514, SVSH-517 and check Phule Raviraj found stable for seed yield per plot (g); SVSH-520 for head diameter (cm); SVSH-488, SVSH-512, SVSH-517, SVSH-519 and check Phule Raviraj were found stable for 100 seed weight (g) with high mean, bi value nearer to unity (bi=1) and non-significant S^2di. For plant height (cm) SVSH-512, SVSH-513, SVSH-514 and SVSH-517 showed stable performance.

Keywords: Genotype and Parameters, Regression coefficient, Sunflower, Stability

Information leads to successful evaluation of stable genotype, which could be used for general cultivation. Yield is a complex quantitative character and highly influenced by environmental fluctuation; hence selection for superior genotype based on yield at single location may not be very effective. Thus evaluation of genotype in different environment condition for yield is important aspect of any breeding programme. Breeding efforts are directed towards increase the yield levels through the development of high yielding varieties and hybrids for different seasons. Hence, there is a need for the development of season specific hybrids in addition to the identification of stable hybrids over environments.

MATERIALS AND METHODS

In the present study 9 hybrids along with two checks *viz*; (Phule Raviraj and MDSFH-411) were evaluated in randomized block design with three replication and evaluated in three different centers of Mahatma Phule Krushi Vidyapeeth, Rahuri, Maharashtra *viz.*, Savalvihir (E1), Rahuri (E2) and Solapur (E3) in during *kharif* 2021. The performance of different hybrids studied for four characters studied and estimating the stability and significance of G X E interactions. Each hybrid was represented by five rows of 4.5 m length with 60 x 30 cm spacing between and within rows, respectively. Observations were recorded in each entry on per plot basis for seed yield, for 100 seed weight randomly selected 100 seeds and for head diameter and plant height on five plant basis. The analysis was carried as per standard method of

Eberhart and Russell (1966) by using INDOSTAT software in order to estimate the three parameters of stability *viz*., mean, regression coefficient (bi), and mean squared deviation (S^2di) for each genotype.

RESULTS AND DISCUSSION

In the present investigation the genotypes x environments interaction were found to be highly significant for all the characters studied when tested against pooled deviation indicating significant difference among them. The Environment + (G x E) and Environment (linear) were found non significant for all the characters under studied when tested against pooled deviation. Estimates of environmental indices (Ij) suggested that Savalvihir was the most favorable environment for seed yield per plot; Solapur for 100 seed weight as well as plant height and Rahuri for 100 seed weight. The significance of G x E interactions has also been reported by Bhoite *et al*. (2018).

The stability parameters for seed yield per plot (g) four out of eleven hybrids have non linear portion of G x E interaction as only S^2di values non significant for seed yield per plot (g). Among the hybrids, hybrid SVSH-514, SVSH-517 and check Phule Raviraj were with high mean than hybrid mean (1.08 g) along with mean squared deviation (S^2di) non significant and regression coefficient (bi) were more than unity (bi>1), hence this hybrids found highly responsive suitable for favorable environments showed below average stability. Hybrid SVSH-488 found high mean value with non significant S^2di and bi less than unity showed above average stability suitable for unfavourable environment. Similar results were also reported by Bhoite *et al*. (2018).

The result for head diameter three hybrids found high mean values than hybrid mean (14.5 cm) and mean squared deviation (S^2di) non significant. Hybrid SVSH-520 and check Phule Raviraj exhibited high mean values coupled with regression coefficient less than unity (bi<1) and non significant S^2di indicating its highly responsive suitable for unfavourable environment i.e. above average stability (bi<1). Hybrid SVSH-488 found high mean S^2di non significant and bi value more than unity means showed below average stability and suitable for favourable environment. These findings are in conformity with Tyagi *et al*. (2018).

The hybrid namely SVSH-512, 514 and 517 recorded significantly lower for plant height than hybrid mean (167 cm) with regression coefficient less than unity (bi□1) and non significant deviation from regression (S^2di), thus found stable above average stability and suitable for poor environment also reported by Chandra *et al*. (2018).

For 100 seed weight five hybrids found high mean values than hybrid mean (5.3 g). Hybrids SVSH-488,512 and check Phule Raviraj exhibited high mean values coupled with regression coefficient more than unity and non significant S^2di indicating its highly responsive suitable for favourable environments i.e. below average stability (bi>1). SVSH-519 found high mean S^2di non significant and bi less than unity showed above average stability suitable for unfavourable environments. Hybrid SVSH-517 found stable for all type of environment (bi=1). These findings are in conformity with Tyagi *et al*. (2018).

From the above findings, it could be summarized that none of the hybrids were stable for all the characters under study. Similar results were also reported by Bhoite *et al.* (2018). Based on mean performance for seed yield per plot, 100 seed weight and head diameter the hybrid SVSH-488 found superior. For plant height hybrid SVSH-513 found stable for poor environment.

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Table 1 Analysis of variance for stability (Eberhart and Russell, 1966) for Seed yield/plot, Head diameter Plant height (cm) and 100 Seed weight in Sunflower hybrids

Characters	Genotype	E + (G x E)	Environment	G x E	E (L)	G x E (L)	Pooled deviation	Pooled Error
	10	22	2	20	1	10	11	60
Seed yield per plot (g)	0.06**	0.08	0.05**	0.04**	0.93	0.06*	0.02**	0.01
Head diameter (cm)	0.88**	4.10	30**	1.48**	61	1.25	1.55**	0.31
Plant height (cm)	254**	232	2066**	49**	4132	31	60**	22
100 Seed weight (g)	0.38**	0.49	3.54**	0.18*	7.07	0.23	0.13	0.10

*, ** Significant at 5 and 1 per cent, respectively; SVSH=Savalvihir Sunflower Hybrid.

Identification of soybean (*Glycine max* (L.) Merrill) varieties suitable for different sowing windows

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ABSTRACT

Seven soybean genotypes were evaluated across three seasons to identify genotypes suitable for different sowing windows. Percent variance contributed by genotypes main effects was more to total genotypic variability than that contributed by seasons, dates of sowing, genotypes × seasons interactions and genotypes × dates of sowing interactions for 50% flowering, number of branches and 100 seed weight. Seasons and dates of sowing main effects contributed more to total genotypic variability than genotypes, GSI and GDOSI for plant height, number of pods and grain yield. DSb 21, DSb 23 and KBS 23 showed lowest estimates of AMMI Stability Value and Stability Index for grain yield hence they are considered as widely adopted genotypes across the seasons.

Keywords: AMMI Stability Value (ASV), GSI, Soybean, Stability Index (SI)

Soybean is the world's most important seed legume which contributes about 25 % of the global edible oil production and demand for Soybean increasing rapidly. The climate change is a challenging situation to Soybean production. We need to identify varieties which are suitable for different seasons and different dates of sowing.

The effects of sowing date and growing season on seed yield vary much depending on the genotypes of soybean crop. Understanding genotype ×environment interaction has become critical to identify genotypes that are stable when subjected to grow-under different environments. We hypothesized that available varieties/elite genotypes interact significantly with temporal environments representing different dates of sowing and seasons; hence, it is possible to exploit such interaction by identifying varieties suitable for each date of sowing and season.

MATERIALS AND METHODS

Seven soybean genotypes namely, KBS 23, Karune, DSb 21, DSb 23, KB 79, JS 335, and MAUS-2 were evaluated on fifteen different dates of sowing, from 19th June to 6th November 2020, with an interval of 10 days covered three seasons, namely *Kharif*, late *Kharif* and *Rabi*. Seeds were sown in a randomized complete block design (RCBD) with three replications, at University of Agricultural Sciences, GKVK, Bengaluru. Genotypes were sown in 2 rows of 3 m length with spacing of 40 x 10 cm. Data on 50% flowering, plant height (cm), number of branches, number of pods, grain yield (g) and 100 seed weight (g) were recorded. The means of quantitative traits were subjected to ANOVA following additive main effects and multiplicative interaction (AMMI) model (Gauch and Zobel, 1988), Genotype + Genotype ×Environment (GGE) bi-plot (Yan *et al.,* 2000), AMMI stability value (ASV) (Purchase *et al.*, 2000) and Stability Index (SI) (Farshadfar, 2011).

RESULTS AND DISCUSSION

The estimate of ASV is a useful parameter for the objective assessment of genotype stability. The genotypes are more stable when ASV is lower in magnitude. In the present study, soybean varieties were evaluated across seasons. The estimates of ASV were lower in DSb 23, DSb 21 and Karune for days to 50% flowering; DSb 21, KB 79 and DSb 23 for plant height; JS 335, KB 79 and KBS 23 for the number of branches/plant; KB 79, JS 335 and KBS 23 for the number of pods/plant; KB 79, DSb 21 and JS 335 for grain yield/plant; KBS 23, DSb 21 and JS 335 for 100 seed weight.

Apart from evaluation of soybean varieties across seasons, they wereevaluated across dates of sowing. For days to 50% flowering, the ASV estimates for the soybean varieties Karune, DSb21 and DSb23 were lower in magnitude than those for other genotypes. DSb21, KB79 and DSb23 for plant height; JS 335, KB 79 and KBS 23 for the number of branches/plant; KB 79, JS 335 and DSb 21 for the number of pods/plant; DSb 21, KB 79 and KBS 23 for grain yield/plant; JS 335, MAUS 2 and DSb 21 for 100 seed weight.

The estimates of SI were lower in magnitude for the DSb 21, DSb 23 and MAUS 2 for days to 50% flowering; MAUS 2, DSb 21 and DSb 23 for plant height; KBS 23, DSb 21 and KB 79 for the number of branches plant^{-1}; KBS 23, DSb 21 and DSb 23 for the number of pods plant^{-1}; KBS 23, DSb 21 and DSb 23 for grain yield plant^{-1}; MAUS 2, JS 335 and Karune for 100 seed weight. This shows the positive relationship between the number of pods plant^{-1} and the grain yield plant^{-1} (Painkra *et al.*, 2018).

Thus, the AMMI ANOVA indicated significant variability attributable to GEI for all six quantitative traits across seasons and dates of sowing. The genotypes DSb 23, DSb 21 and KB 79 with the lowest estimate of ASV and SI were widely stable across seasons for grain yield/plant. The genotypes KBS 23, DSb 21 and DSb 23 with the lowest estimate of ASV and SI were widely stable across dates of sowing for grain yield/plant

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Bio-rational management of groundnut defoliators (*Spodoptera litura* and *Helicoverpa armigera*) in *kharif* season

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ABSTRACT

Field trial was laid at ORS, Latur (MS, India) to evaluate insecticides for the management of *Helicoverpa armigera* (Hubner) and *Spodoptera litura* (Fabricius) infesting groundnut. Insecticides/bioinsecticides evaluated were Bt-127 SC @3ml/lit, Delfin (Bt commercial formulation) @1g/lit, Quinalphos 25 EC @ 2ml/lit and Chlorantraniliprole 18.5 SC @ 0.3ml/lit. The results revealed that insecticidal treatments were significantly superior over untreated control in reducing the infestation groundnut defoliators. However, chlorantraniliprole 18.5 SC was significantly most effective as well as safer to natural enemies. Significantly higher pod yield (1672 kg/ha) of groundnut was recorded in treatment Chlorantraniliprole 18.5 SC @ 0.3ml/lit, and it was at par with treatment Bt-127 SC @3ml/lit (1559 kg/ha).

Keywords: Bio-efficacy, Groundnut, Helicoverpa armigera, Spodoptera litura

Groundnut *(Arachis hypogaea* Linnaneus) is an important leguminous oilseed crop in India contributing about 30% of the total domestic supply of oil and mainly grown as rainfed crop by resource poor farmers. India has the largest groundnut growing area in the world and is the second largest producer after china. The reason for low productivity of groundnut in India is due to biotic and abiotic stresses during crop growth. In which pests and diseases are the major biotic stresses. In recent years tobacco caterpillar, *Spodoptera litura* (Fab.) and American bollworm, *Helicoverpa armigera* (Hubner) have emerged as the major pests of groundnut in India and cause about 26 to 100 % yield loss under field conditions.

MATERIALS AND METHODS

The studies on "Bio-rational management of groundnut defoliators (*Spodoptera litura* and *Helicoverpa armigera*)." were conducted at Oilseed Research Station, Latur,(MS). The experiment was conducted in a randomized block design (RBD) with five treatments with 4 replications. Groundnut variety (LGN-1) was sown in a gross plot of 4.2m x 5 m maintaining net plot of 3.6 m x 4.8m. Spacing of 30cm X 10cm was maintained. RDF was given. The treatments of insecticides *viz.,* Bt-127 SC @3ml/lit (From IIOR, Hyderabad), Delfin (Bt commercial formulation) @1g/lit, Quinalphos 25 EC @ 2ml/lit, Chlorantraniliprole 18.5 SC @ 0.3ml/lit. Were applied. The observations on total number of *Spodoptera litura and Helicoverpa armigera* larvae were recorded per five plants from each on top, middle and bottom leaves of five randomly selected plants from each treatment at one day before treatment and 10 days after application of insecticides. Pod yield (kg/ha) were recorded after harvesting and data was computed; statistically analyzed.

RESULTS AND DISCUSSION

Groundnut defoliators were uniformly distributed in all the plots before application of the treatments. However at 10 DAS, the treatment T4- Chlorantraniliprole 18.5 SC @ 0.3 ml/l recorded lowest population (0.43 and 0.37 larvae/5 plant) of *S.litura* and *H. Armigera* respectively, which was at par with T3- Quinalphos 25 EC @ 2 ml/l (0.67 and 0.55 larvae5plant) and T1- Bt-127 SC formulation @ 3 ml/l (0.80 and 0.62 larvae/5plant.). Similar results were reported by the Gadhiya *et al* (2014), Waykule *et al.* (2020) and Devaki *et a.l* (2020). In case of pod yield, the treatment T4- Chlorantraniliprole 18.5 SC @ 0.3 ml/l recorded highest pod yield (1672 kg/ha) and was at par with T1- Bt-127 SC formulation @ 3 ml/l (1559 kg/ha) followed by T3-Quinalphos 25 EC @2ml/l (1436 Kg/ha). Chandrayudu *et al.* (2015) also reported the same results.

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Effect of different insecticidal spray on Population of defoliators and natural enemies in groundnut

Tr. No.	Treatment Details	Population of defoliators/5plant				Pod yield (Kg/ha)
		S. litura		*H. armigera*		
		Before	10 DAS	Before	10 DAS	
1	Bt-127 SC formulation @ 3 ml/lit	1.65 (1.46)	0.80 (1.14)	1.10 (1.26)	0.62 (1.05)	1559
2	Bt Commercial formulation (Delfin) @ 1 g/lit	1.50 (1.41)	0.95 (1.20)	1.15 (1.28)	0.70 (1.09)	1315
3	Quinalphos 25 EC @ 2 ml/lit	1.63 (1.45)	0.67 (1.08)	1.30 (1.34)	0.55 (1.02)	1436
4	Chlorantraniliprole 18.5 SC @ 0.3 ml/lit	1.68 (1.47)	0.43 (0.96)	1.28 (1.33)	0.37 (0.93)	1672
5	Untreated check	1.59 (1.44)	1.91 (1.55)	1.20 (1.30)	1.58 (1.44)	1021
SE m (±)		0.05	0.05	0.05	0.05	75.47
CD (*P*=0.05)		0.15	0.16	0.14	0.13	223.38
CV (%)		7.04	9.06	7.19	8.18	10.78

Genetic diversity analysis of released Indian linseed (*Linum usitatissimum* L.) varieties using SSR markers

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ABSTRACT

A genetic diversity analysis was performed on 91 released linseed varieties of India using 20 polymorphic linseed specific SSR markers. The genotypes were categorized in to 15 clusters. The mean allele frequency was 0.7 and Shannon diversity index was 4.15, indicating that the germplasm was highly diverse.

Keywords: Genetic diversity, Linseed, SSR markers, Varieties

Linseed (*Linum usitatissimum* L.) or flax has been cultivated for centuries and is grown all over the world for seed, oil and fibre market. Domestication events have given rise to two types of flax: seed flax and fibre flax. Flax seed is grown primarily for its oil, which is high in omega-3 fatty acids. Flaxseed is rapidly becoming popular in the human diet due to its high dietary fibre, omega-3 fatty acid, and anti-carcinogenic lignans. Flaxseed oil is used in paints and varnishes due to its unique drying properties. Fibre flax, on the other hand, is grown to extract fibre for the production of linen cloth. In recent years, the fibre industry has focused on high-value product development from flax stem. Diversity is an essential characteristic of a sustainable breeding program. A greater variety of germplasm provides breeders with better options for selecting parents to develop cultivars based on their needs (Hoque et al., 2020). The concentrated efforts of AICRP-linseed researchers resulted in the release of 96 varieties over a span of 50 years. For broadening the genetic base, it is essential to assess the diversity in the released cultivars that have been developed using diverse germplasm and through different breeding procedures. Hence, in the present study, the genetic diversity of 91 linseed varieties from different parts of India was examined.

MATERIALS AND METHODS

Ninety-one linseed varieties released for different geographical regions of India were used in this study. DNA from 15-day-old seedlings were genotyped with 38 linseed specific SSR markers (Deng et al., 2011), out of which 20 markers were found to be polymorphic. The data was analyzed using Powermarker v.3.25 to obtain the genetic diversity indices. NTSYSpc v.2.2 was used to construct dendrogram depicting the evolutionary relationship between the varieties.

RESULTS AND DISCUSSION

The genotypes were subjected to molecular analysis using 20 polymorphic linseed specific SSR markers and the data was scored. The allele frequency ranged between 0.4 to 1.0 with a mean value of 0.7. Number of alleles ranged between 1 to 15. The polymorphism information content (PIC) values ranged from 0.08 (LU11) to 0.77 (LU25) with a mean value of 0.36. The mean Shannon diversity index was 4.15 which ranged between 3.3 and 4.522, indicating that the germplasm used in this study were highly diverse. The dendrogram categorized the genotypes in to 15 clusters (Table 1). Cluster IV had the highest number of genotypes (38). The cophenetic correlation coefficient value was 0.915, indicating that the clustering was in accordance with the genotypic data analyzed. Nine clusters such as I, VI, X, XI, XII, XIII, XIV and XV had single accession each, including TL-99 having low α-linolenic acid (<4%) which falls in Cluster VI. The unique genotypes of the same clusters can be used in crop improvement programme and to diversify the genetic base of the cultivated types.

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Table 1 Cluster wise classification of linseed accessions

Cluster	Linseed accessions
I	Pratap Alsi-2
II	Kota Barani Alsi-3, Pratap Alsi-1, Shikha, Jeewan
III	Priyam, Sabour Tisi-1, Rashmi, Shekhar, Uma
IV	Kota Barani Alsi-4, Kota Barani Alsi-5, Chambal Alsi, Divya, Birsa Tisi-1, Sabour Tisi-3, BUAT Alsi-4, Laxmi-27, Padmini, Parvati, Mau Azad Alsi-1, Mau Azad Alsi-2, Mukta, Shubhra, Sweta, Garima, Gaurav, Sheela, Ruchi, Indu, Surya, Rajan, Aparna, Janaki, Nagarkot, Binwa, Baner, Bhagsu, Him Palam Alsi-2, Him Palam Alsi-1, Tiara, Jawahar-1, Jawahar-17, Jawahar-552, Jawahar Linseed-9, NL-97
V	Kota Alsi-6, Kota Barani Alsi-6
VI	Meera, RL-914, Neelum, Heera, T-397
VII	TL-99
VIII	Sabour Tisi-2, Himalini, Surbhi, Jawahar-7, Jawahar Linseed-23, Kiran, Kartika, Indira Alsi-32, RLC-92, Chhattisgarh Alsi-1, Utera Alsi, Varsha Alsi, Suvee, RLC-164, RLC-167, Suyog, Shival, JLS-73, Jawahar Linseed-41, JLS-79, JLS-66, Jawahar Linseed Sagar-95, Jawahar Linseed-165, Arpita, K2, LC-185, LC-54, LC-2063
IX	Sharda
X	Himani
XI	PKVNL-260
XII	Deepika
XIII	Utera Alsi-2
XIV	Neela
XV	LSL-93

Diversity of niger (*Guizotia abyssinica* L.F. Cass.) landraces for major agronomic traits

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ABSTRACT

A diverse set of 870 Indian niger accessions were evaluated for various quantitative traits. Principle component analysis revealed the contribution of first three PCs to maximum variability and clustering analysis separated the accessions into eight different clusters. A significant diversity was revealed among these accessions and they can be further used as trait-specific donors in hybridization program for improvement of seed yield related traits in niger.

Keywords: Clustering, Diversity, Niger, Principal component analysis

Niger is an unexploited edible minor oilseed crop mainly grown in African countries like Ethiopia as it meets nearly 50-60% of their edible oil requirement. Although, it meets only 2% of the total edible oil requirement (Dutta *et al*., 1994), India is reported to be one of the major niger growing countries in the world and is a lifeline for tribal agriculture. It is highly cross pollinated crop and due to its self-incompatible nature (Getinet and Sharma, 1996), breeding has become quite arduous. For any successful breeding program, presence of amenable variation is a key factor which could be further utilized for the trait improvement and varietal development. Hence, the present study was undertaken to evaluate diversity in the Indian niger accessions using multivariate analysis.

MATERIALS AND METHODS

The experiment was conducted during the *kharif* 2020-21 at research farm of ICAR-IIOR, Hyderabad. A total of 870 accessions along with the three checks *viz*., JNS-9, JNS-28, JNS-30 were evaluated in augmented block design. The data on eight quantitative traits *viz*., days to 50% flowering, plant height (cm), number of branches/plant, number of heads/plant, head diameter (cm), oil content (%), seed yield/plant (g) and 1000 seed weight (g) were recorded. The crop was raised by following the recommended package of practices. Data was subjected to appropriate statistical analysis *viz*., cluster analysis and principal component analysis using R software v.4.2.1 to construct dendrogram illustrating the hierarchial relationship among the accessions.

RESULTS AND DISCUSSION

Genetic diversity plays a key role in the understanding the magnitude of variation, which is directly correlated with the crop improvement. Various statistical techniques have been used to study the diversity among the different accessions. Among these techniques, multivariate analysis is the most frequently used method for determining the genetic association of genotypes (Ali *et al*., 2021). Multivariate analysis divided the 870 accessions into eight different principal components. The first three components are having the eigen value more than 1 contributing the cumulative variation of 58.83% (Table 1). Out of them, PC1 was found to have major contributor with few agronomic traits. Cluster analysis revealed that all the accessions were distributed among eight different clusters. First cluster had the largest number of accessions (659), followed by cluster III, cluster IV, cluster II, cluster VI and cluster VII.

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Table 1 Principal components and cumulative percent variation

Principal components	Cumulative percent variation
PC 1	30.921
PC 2	46.363
PC 3	58.831
PC 4	70.454
PC 5	80.641
PC 6	88.949
PC 7	95.430
PC 8	100.00

Efficacy of Cyclaniliprole 100 DC for the management of major defoliators in Soybean

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ABSTRACT

The efficacy of newer insecticide molecule Cyclaniliprole 100 DC was evaluated against major insect pests of soybean during *kharif* 2020 and 2021. Among the different treatments, Cyclaniliprole 100 DC @ 40 g a.i/ha (400 ml/ha) was found to be effective and economical dose for the management of semilooper, spodoptera and girdle beetle pests in Soybean. It has recorded higher seed yield and found equally good with recommended insecticidal check. No phytotoxicity was observed on all the dosages of Cyclaniliprole 100 DC evaluated.

Keywords: Cyclaniliprole 100 DC, Efficacy, Insect pests, Soybean

Soybean is considered as major oilseed crop and is valued for its high protein (40%) and oil content (20%). It is the cheapest, richest and easiest source of best quality proteins, fats and it has multiple uses both as food and as industrial product. The area, production and productivity of soybean in Karnataka are 0.33 m.ha, 0.37 m.t and 1124 kg/ha respectively (Anonymous, 2021). In Karnataka, Bidar, Belagavi, Dharwad, Haveri and Bagalkot are the major soybean growing regions during *kharif* season. The major defoliators *viz*., *Spodoptera litura*, *Thysanoplusia orichalcea* and *Spilarctia oblique* feed on foliage, flower and pods causing significant yield loss. Defoliation often reaches population levels that significantly reduce the yield in soybean. Therefore, it is necessary to develop effective control measures to manage defoliators in soybean.

MATERIALS AND METHODS

The field experiments were conducted at Main Agricultural Research Station, Dharwad to evaluate the efficacy of Cyclaniliprole 100 DC against leaf eating caterpillars in soybean during *kharif* 2020 and 2021. The experiments were laid out at randomized block design with three replications and seven treatments including standard check with untreated control. Ten plants (one meter row) were selected randomly and tagged in each plot to take observations on number of semilooper and spodoptera larvae/mrl, day before spray (DBS), 5, 10 and 15 days after spray (DAS). The percent larval reduction over untreated control was calculated after second spray. The leaf damage due to defoliators was recorded at 10 days after each spray. The data were subjected for statistical analysis.

RESULTS AND DISCUSSION

The results indicated that, incidence of spodoptera and semilooper insect pests in all the treatments before taking the first spray ranged between 8.45 to 8.69 and 4.28 to 4.40 larvae/meter row length, respectively and there was no significant difference among them. At ten days after spray, significant difference on the incidence of defoliator population was observed among the treatments. The treatment Cyclaniliprole 100 DC @ 45 g a.i/ha recorded least number of spodoptera and semilooper larval population (0.69 and 0.45 l/mrl, respectively) and found on par with treatment Cyclaniliprole @ 40 g a.i/ha (0.78 and 0.67 l/mrl, respectively) which was significantly superior to its lowest dosage and recommended insecticidal check Chlorantraniliprole 18.5% SC. After 15 days of spray, Cyclaniliprole 100 DC @ 40 and 45 g a.i/ha significantly excelled over all other treatments by recording lowest population of defoliator larvae and were significantly superior to its lowest dosage and recommended insecticidal check (Table 1).

Table 1: Bioefficacy of Cyclaniliprole 100 DC against defoliators in soybean (Mean of *Kharif* 2020 & 2021)

Treatment	Dosage g a.i./ha	Product (ml/ha)	*Spodoptera litura* (No. of larvae/mrl) *				Semilooper (No. of larvae/mrl) *				Seed Yield (Kg/ha)
			1 DBS	10 DAS	15 DAS	% larval reduction over control	1 DBS	10 DAS	15 DAS	% larval reduction over control	
T_1: Cyclaniliprole 100 DC	30	300	8.48 (3.00)	2.10 (1.61)	1.92 (1.56)	85.85	4.35 (2.20)	1.25 (1.32)	1.12 (1.27)	87.11	2286
T_2: Cyclaniliprole 100 DC	35	350	8.57 (3.01)	1.58 (1.44)	1.43 (1.39)	89.46	4.28 (2.19)	1.04 (1.24)	0.89 (1.18)	89.76	2348
T_3: Cyclaniliprole 100 DC	40	400	8.69 (3.03)	0.78 (1.13)	0.35 (0.92)	97.42	4.40 (2.21)	0.67 (1.08)	0.08 (0.76)	99.08	2689
T_4: Cyclaniliprole 100 DC	45	450	8.45 (2.99)	0.69 (1.09)	0.27 (0.88)	98.01	4.29 (2.19)	0.55 (1.02)	0.05 (0.74)	99.42	2665
T_5: Flubendiamide 39.35% SC	72	150	8.61 (3.02)	2.15 (1.63)	2.03 (1.59)	85.04	4.38 (2.21)	1.39 (1.37)	1.19 (1.30)	86.31	2196
T_6: Chlorantraniliprole 18.5% SC (Standard Check)	30	150	8.55 (3.01)	0.85 (1.16)	0.42 (0.96)	96.90	4.32 (2.20)	0.61 (1.05)	0.14 (0.80)	98.39	2591
T_7: Untreated control	-	-	8.68 (3.03)	12.24 (3.57)	13.57 (3.75)	-	4.37 (2.21)	8.14 (2.94)	8.69 (3.03)	-	1089
S.Em+	-	-	0.42	0.19	0.12	-	0.33	0.13	0.07	-	14.59
CD @ 5%	-	-	NS	0.57	0.37	-	NS	0.39	0.21	-	44.12

* Figures in the parenthesis are transformed $\sqrt{x + 0.5}$ values; DBS: Days before spray; DAS: Days after spray

The per cent larval reduction over control in Spodoptera was highest in the treatments Cyclaniliprole @ 40 and 45 g a.i/ha by recording 98.01 and 97.42 %, respectively and found on par with each other. Similar trend was noticed in semilooper population wherein highest per cent larval reduction over control was found in the treatment Cyclaniliprole @ 40 and 45 g a.i/ha by recording 99.42 and 99.08 %, respectively. No phytotoxicity symptoms were observed. The newer molecule was found to be effective and economical dose for the management of defoliators in soybean. Patil *et al.* (2014) reported that chlorantraniliprole 18.5 per cent SC @ 30 g a.i./ha provide consistent protection from defoliation to soybean crop from *S. litura* with highest cost benefit ratio among the tested insecticides. Acharya *et al.* (2015) revealed that chlorantraniliprole 0.006 per cent were found to be the most effective against *S. litura* on groundnut. Thus, the present findings are more or less in confirmation with the reports of earlier workers.

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Management of leaf eating caterpillars through intercropping with Suva, *Anethum graveolens* in soybean

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ABSTRACT

Defoliators are common insect pests of soybean and often cause economic losses. Insecticides are the first option that farmers choose to minimize the damage caused by the defoliators, and the result is not only the emergence of resistance to insecticides in the pests but also environmental pollution. A field experiment carried out at the UAS, Dharwad, India, during *Kharif* 2021 tested different combinations of Soybean+suva intercrop for their ability to reduce the damage caused by defoliators to soybean leaves and the effect on grain yield of soybean. Among these, Soybean + Suva (3 soybean: 2 suva: 3 soybean rows combination) was effective in reducing larval population.

Keywords: Defoliators, Intercropping, Soybean, Suva

Soybean [*Glycine max* (L.) Merrill], a golden bean of 21st century belongs to family Leguminaceae, is the world's most important seed legume which revealed unprecedented growth in terms of both area and production. Soybean contributed 42 per cent of India's total oilseeds and 25 per cent of edible oil production (Sharma *et al.,* 2014). Soybean is attacked by more than 20 insect-pests in Karnataka, amongst major pests are green semilooper, *Thysanoplusia orichalcea* Fab. *Spilarctia obliqua* Walk, *Chrysodeixis acuta* Walker and tobacco caterpillar, *Spodoptera litura* Fabricius. Intercropping is an approach to improve diversity in an agricultural ecosystem. It is pursued with various objectives such as maintaining ecological balance, more efficient utilization of resources, increasing the quantity and quality of farm produce, and lowering the damage from insect-pests, plant diseases and weeds. Intercropping and staggered sowing offers a source of diversity and stabilizes the crop production environment by discouraging pest species while improving crop performance. In this context, the present study was planned to investigate the different row combination of soybean+Suva intercropping against defoliator pests in soybean.

MATERIALS AND METHODS

The field experiments were conducted at Main Agricultural Research Station, Dharwad to evaluate different row combination of soybean+suva intercropping against defoliator pests in soybean during *kharif* 2021 (June to September). The experiment was laid out at randomized block design design with four replications and five treatments under completely unprotected condition. Suva, *Anethum graveolens* was intercropped with Soybean with different row combination. Ten plants (one meter row) were selected randomly and tagged in each plot to take observations on number of spodoptera, semilooper and Bihar hairy caterpillar (larvae/mrl). The leaf damage due to defoliators was recorded and the data were subjected for statistical analysis.

RESULTS AND DISCUSSION

It was observed that, among different treatments T4: Soybean + Suva (3 Soybean: 2 suva: 3 Soybean rows combination) was significantly superior by recording lower *Spodoptera litura* (2.27 larvae/mrl), *Thysanoplusia orichalcea* (1.76 larvae/mrl), *Spilarctia obliqua* (2.58 larvae/mrl) larval population and recorded less leaf damage (24.15%) followed by T2: Soybean + Suva (3 Soybean: 1 suva: 3 Soybean rows combination) intercropping system. The next best treatment was T5: Soybean + Suva (6:2:6). The treatments T3 (6:1:6) and T1 (Sole soybean) was found on par with each other and larval population was higher in these treatments (Table 1). This indicates that, Soybean + Suva intercropping system has got added advantage in controlling defoliator population. Bapatla *et al.* (2018) reported that the incidence of the defoliators and the extent of damage to soybean leaves were the lowest and the yields were the highest in 3.56 t/ha in soybean–maize and 3.25 t/ha in soybean–pigeonpea intercropping system.

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Table 1 Manage of defoliators through intercropping with suva in soybean

Tr. No.	Treatment details	Defoliators population (No. of larvae/mrl)*			Leaf damage (% defoliation)**
		Spodoptera litura	*Thysanoplusia orichalcea*	*Spilarctia obliqua*	
T_1	Sole soybean (12 rows)	5.01 (2.35)	3.01 (1.87)	3.98 (2.12)	45.23 (42.25)
T_2	Soybean + Suva (3 soybean: 1 suva: 3 soybean rows combination)	3.02 (1.88)	2.10 (1.61)	2.86 (1.83)	28.32 (32.14)
T_3	Soybean + Suva (6 soybean: 1 suva: 6 soybean rows combination)	4.36 (2.20)	2.89 (1.84)	3.47 (1.99)	43.39 (41.49)
T_4	Soybean + Suva (3 soybean: 2 suva: 3 soybean rows combination)	2.27 (1.66)	1.76 (1.50)	2.58 (1.75)	24.15 (29.42)
T_5	Soybean + Suva (6 soybean: 2 suva: 6 soybean rows combination)	3.78 (2.07)	2.35 (1.69)	3.04 (1.88)	35.26 (36.41)
	S.Em±	0.39	0.30	0.27	0.92
	CD @ 5%	1.18	0.91	0.84	2.76

* Figures in the parenthesis are transformed $\sqrt{x+0.5}$ values; ** Figures in the parenthesis are angular transformed values

Linseed as new host for emerging pathogens dichotomized through molecular phylogeny from Karnataka, India

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ABSTARCT

A characteristic disease was noticed in linseed with symptoms that resembled phytoplasma disease with 6·5 to 16·5 per cent incidence at UAS, Raichur. Previously linseed is known to be associated with 16SrII-D phytoplasma but the association of the 16SrXIV-A group of phytoplasma is the new host record for *Ca. P. cynodontis* (16SrXIV-A) phytoplasma associated with linseed stem fasciation, phyllody from India. A characteristic powdery mildew symptom with white fungal mycelial growth was noticed on the abaxial as well as on adaxial leaf surfaces. For molecular confirmation through ITS-rDNA barcoding, genomic DNA was amplified using powdery mildew-specific ITS universal primer pair PN23/PN34 and sequenced directly. The ITS regions were amplified at ~700bp and nBLAST analysis revealed that the ITS sequence shared 100 per cent similarity with reference sequence AB045148.1 respectively. Further amplification of L1/L2 primer pair from ITS region were PCR amplified and an expected amplicon of 374bp was analyzed. Though, the ITS-rDNA and L1/L2 specific region analyzed, they are not specific exclusively to the *L. taurica*. However, combination of morphology and molecular sequence was used to confirm the identity.

Keywords: Amplification, Linseed, Morphology, Molecular, Phytoplasma, Powdery mildew.

Linseed plants are affected by numerous diseases incited by bacteria, fungi and viral diseases. Among the biotic constraints linseed phytoplasma and powdery mildew are known to affect the linseed production. The important reports revealed that *Oidium lini* causes powdery mildew and phytoplasma is reported as aster yellows from India and Canada. It is unclear whether the phyllody and fasciation is caused by *Candidatus*

Phytoplasma asteris or *Candidatus Phytoplasma aurantifolia* or it could be different from these two. As a mixed infection, the white powdery mass is present on both the surfaces of the leaves. Later, molecular detection based on the 16S rRNA and ITS region amplification, sequencing and nBLAST analysis has confirmed the phytoplasma associated with the phyllody and *Leveillula taurica* also associated with the powdery mildew in linseed.

MATERIAL AND METHODS

Field survey was conducted in Northern Karnataka (India) and collected the linseed plants with phyllody and powdery mildew symptoms. The genomic DNA from the infected and asymptomatic samples of both diseases was extracted and the 16Sr region explicit for Phytoplasma was PCR amplified with P1/P7 primer pair by nested PCR assay. SecA gene was amplified from the genomic DNA by semi-nested PCR assay using SecAfor1/SecArev3 in first round and SecA for 2/Secrev3 primer pair (Hodgetts *et al.* 2008). The Nested PCR products of 16SrRNA region (1.25kb) and semi-nested PCR products of SecA gene (>400bp) were purified and were directly sequenced bidirectionally using automated Sanger DNA sequencer. The sequences obtained were analyzed by nBLAST to recognize the closely allied reference sequences from GenBank. The sequences obtained in the current study are submitted in NCBI GenBank database and accession numbers were obtained. Identification based on 16SrRNA sequence, Ca. phytoplasma species assignment and virtual RFLP analysis was performed in iPhyClassifier web resources (Zhao *et al.* 2009).

For molecular confirmation of powdery mildew pathogen, the genomic DNA was isolated from conidial suspension and ITS-rDNA barcoding region was amplified using powdery mildew-specific ITS universal primer pair 40 PN23/PN34 and sequenced directly.

RESULTS AND DISCUSSION

All phyllody symptomatic samples produced amplification of expected size at 1.8 Kb size from P1/P7 primers and no such amplifications were observed from healthy samples. The results exposed that phytoplasma specific amplicon were consistently obtained in P1/P7 primer (~1.8kb). Further nested PCR assay produced amplicons of 1.2kb size from symptomatic samples using R16F2n/R16R2 primer pair and control samples. However, no such amplifications were detected from asymptomatic samples thereby confirming the non-phytoplasma association with asymptomatic samples. Amplification of P1/P7 and F2n/R2 phytoplasma specific region was also detected from positive sample used in the current investigation. Amplified nested PCR products were sequenced from both the directions and consensus sequences were obtained for analysis. A representative phyllody and stem fasciation samples were subjected for sequencing purpose. The nested PCR products were purified and sequenced from both the directions using F2n/R2 primers. The consensus sequences were deposited in GenBank database with the accession number MT681916.1 (phyllody) and MT681917.1 (fasciation), respectively. Further, partial sequence of SecA gene were deposited in GenBank with the accession No. MZ590568.1 & MZ590569.1 for MYS1 and MYS 2 isolates respectively. The 16Sr gene sequence analysis using nBLAST search revealed that the sequences shared 100% similarity with KY439870.1 from *Vigna unguiculata* ssp. sesquipedalis, LT558777.1, and LT558776.1 from *Cynodon dactylon*. Similarly, nBLAST search revealed that, SecA gene showed that they shared 100 per cent sequence similarity with MT432653.1, MT432627.1, and MT432623.1 from *Digitaria ciliaris* from Thailand.

Further, the phylogenetic relationship of phyllody and fasciation infected linseed samples with other phytoplasma groups were studied with representative 16S rDNA gene sequences retrieved from GenBank database. A phylogenetic tree was constructed using 16S rRNA sequence from *Ca*. phytoplasma cynodontis. The phylogenetic analysis based on 16SrRNA regions confirmed that the phytoplasma identified in linseed phyllody and fasciation is closely related to the member of 16Sr XIV-A group (Fig. 1). Correspondingly, Phylogentic analysis based on SecA gene region also confirm the identity of phyllody and fasciation obtained in the present study belonging to 16Sr XIV-A (Fig. 2). Further, sequence analysis in iPhyClassifier database (Zhao *et al.*, 2009) and virtual RFLP analysis using sequences from the present study revealed that the linseed phytoplasma collected in the present study belonged to 16Sr group XIV, subgroup A as the virtual RFLP pattern derived from the query sequence of 16S rDNA F2nR2 fragment identical to the reference pattern of 16Sr group XIV-A (GenBank accession: AJ550984). Virtual RFLP obtained through iPhyClassifier for both the sequences (MT681916.1 & MT681917) along with reference accession (AJ550984.1) are presented in fig 3. Furthermore, this is the new host record for *Ca*. phytoplasma cynodontis (16SrXIV-A) phytoplasma associated with linseed stem fasciation and phyllody from India.

ITS region was amplified using powdery mildew-specific ITS universal primer pair PN23/PN34 and sequenced directly (Chen et al., 2008). The ITS regions were amplified at ~700bp and nBLAST analysis revealed that the ITS sequence shared 100% similarity with reference sequence AB045148.1 respectively. Further amplification of L1/L2 primer pair from ITS region were PCR amplified and an expected amplicon of 374bp was analyzed. The identity was confirmed upon microscopic observation of spores from artificially inoculated plants, thus confirming the association. *Leveillula taurica* is known to cause powdery mildew on tomato, chilli and other crops. Amano (1986) reported the occurrence of *L. taurica* on linseed, however, no further details are available on the association, as well as molecular confirmation of *L. taurica* associated with linseed from India (Farr and Rossman, 2021). To the best of our knowledge, this is the first report of *L. taurica* associated with powdery mildew of linseed in India.

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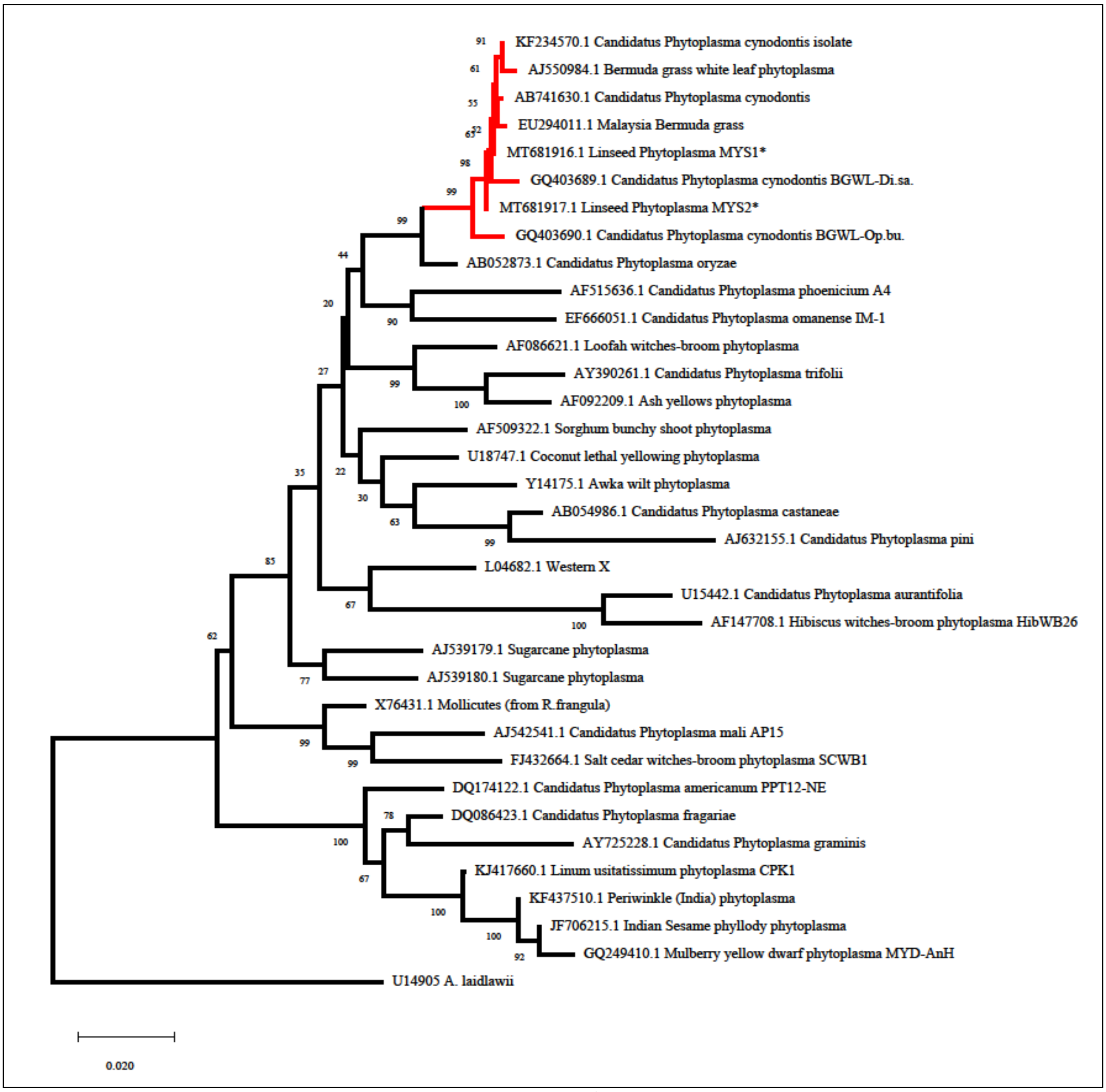

Fig 1. Phylogenetic tree based on 16SrRNA regions showing the placement of *Ca. Phytoplasma cynodontis* associated with linseed phytoplasma sequences with reference sequence (red highlighted branches in the tree) retrieved from GenBank database using Tamura-Nei Substitution model and nearest neighbour-interchange search options with 1000 bootstrap replicates. *A. laidlawii* was used as an out group in the phylogenetic analysis. Sequences with *mark are from the present study.

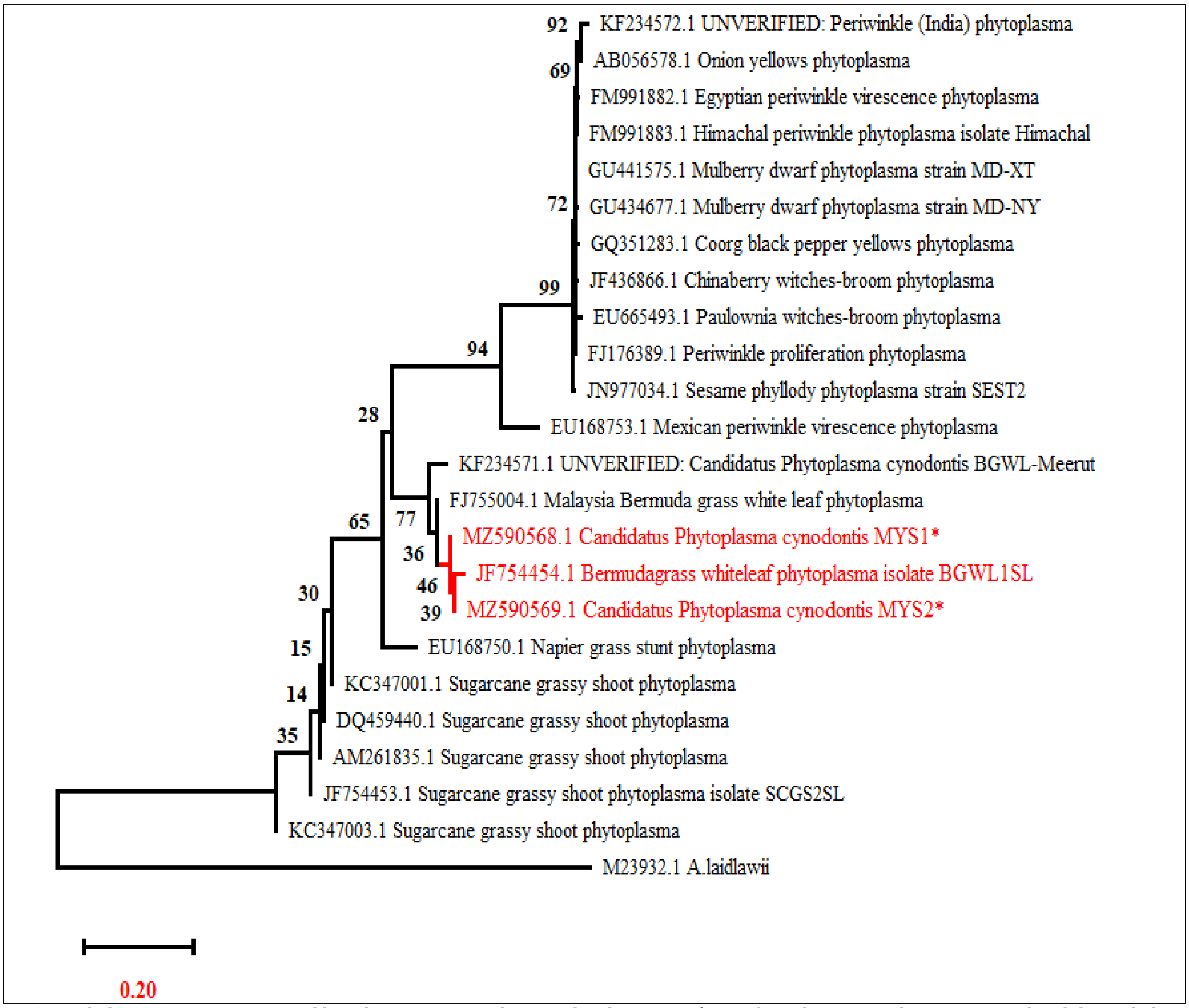

Fig 2. Phylogenetic tree constructed based on SecA gene showing the placement of *Ca. Phytoplasma cynodontis* associated with linseed phytoplasma sequences with reference sequence (red highlighted branches in the tree) retrieved from GenBank database using Tamura-Nei Substitution model and nearest neighbour-interchange search options with 1000 bootstrap replicates. *A. laidlawii* was used as an outgroup in the phylogenetic analysis. Sequences with *mark are from the present study.

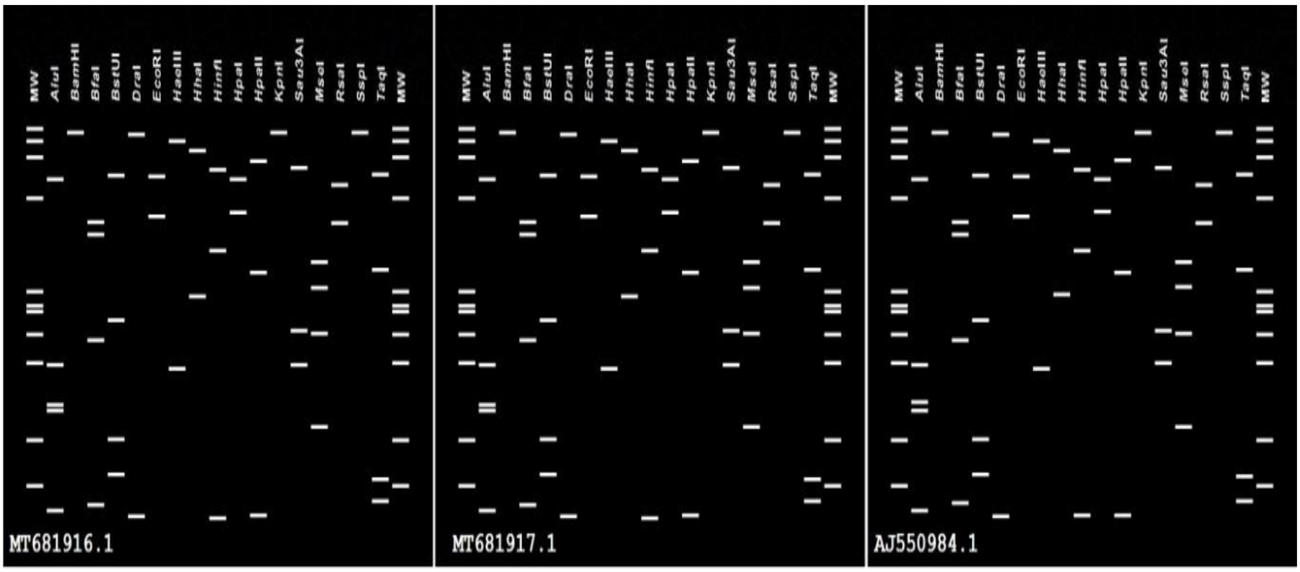

Fig 3. Virtual RFLP analysis of Phytoplasma associated with linseed phyllody (MT681916.1) and fasciation (MT681917.1) compared with the reference sequence of *Ca*. phytoplasma cynodontis (16SrXIV, subgroup A) phytoplasma (AJ550984.1) using *iPhyClassifier* tool.

Enhancing productivity and profitability of linseed (*Linum usitassimum* L.) through foliar application of growth regulators

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ABSTRACT

Considering the profitability, two foliar applications of auxin @ 2.0 ppm (one each at vegetative & flowering stage) was found to be the best treatment having additional net gain of Rs. 6226/ha over control with acceptable linseed seed yield of 1087 kg/ha under rainfed mid hill conditions of Himachal Pradesh. However, the treatments involving GA, applied either alone or in combination with auxin although have higher seed yield over the other treatments but could not achieve better returns due to higher cost of GA product adding to higher cost of cultivation.

Keywords: Foliar application, Growth regulators, Linseed, Productivity

In linseed, plant growth regulators (PGR's) have significant responses on crop growth and yield (Rastogi et al., 2013). Among PGRs, auxin and gibberellin play vital role in regulating growth & developmental processes within plant bodies. Auxin induces apical dominance, rooting, regulate abortion of flowers, promote development of flowers as well as seed during the reproductive stages and affect senescence (Figueiredo et al., 2016)., while gibberellic acid helps to promote growth through increasing absorption of nutrients (Singh *et al*., 2005), enhanced nitrogen use efficiency (Khan *et al*., 2002) and cell expansion/elongation by stimulating the destruction of growth-repressing proteins. Likewise, salicylic acid also plays an important role in induction of plant defense against a variety of biotic and abiotic stresses through morphological, physiological and biochemical mechanisms and thereby increases growth and productivity. Considering the above mentioned roles of these PGRs, the present study was conducted to evaluate their performance on growth, production and profitability of linseed under rainfed conditions.

MATERIALS & METHODS

The present experiment was conducted with eight treatments comprising of two doses of Auxin (1.0 & 2.0 ppm), two doses of Gibberalic acid (200 & 400 ppm), Salicylic acid 75 ppm, Tebuconazole 0.1%, Auxin 1.0 ppm + GA 200 ppm were tested against control (water spray) in RBD with three replications at Linseed Unit, Department of Crop Improvement during *Rabi* 2018-19. Two applications of each PGR were done, one at vegetative & another at flowering stage. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.8), low in organic carbon and medium in available nitrogen, phosphorus and potassium. The linseed variety 'Him Palam Alsi -2' was sown at 22 cm apart rows. Yield attributes were recorded from the randomly selected five plants of linseed and averaged to get number of particular yield attribute per plant. Net plot yield was expressed in kg/ha by multiplying it with the conversion factor. Economic gain (net returns and BC ratio) of each treatment was calculated based upon the yield and prevalent market price of produce and inputs.

RESULTS AND DISCUSSION

The data presented in Table-1 reveals that plant height and all yield attributes *viz.* primary & secondary branches and capsules/plant except seeds/capsule were influenced significantly by different treatments. Plants receiving two application of GA and auxin at either of the doses (T_3, T_4, T_2 &T_1) and GA in combination with auxin (T_7) produced significantly taller plants as compared to other treatments. Applications of GA @ 400 ppm being at par with combined application of auxin @ 1.0 ppm along with GA @ 200 ppm at two stages, resulted in significantly higher seed yield of 1297 and 1214 kg/ha, respectively. Treatments having two sprays of GA @ 200 ppm and auxin @ 2.0 ppm behaving statistically similar to two sprays of auxin @ 1.0 ppm + GA @ 200 ppm were the other better treatments in this regard. Highest net returns of Rs. 26023/ha with significantly higher net returns per rupee invested (1.57) were achieved with two applications of auxin @ 2.0 ppm as higher yielding treatments involving GA had more product cost which substantially raised the cost of cultivation in these particular treatments. As compared to control, there was an additional net gain of Rs. 6226/ha through twice application of auxin @ 2.0 ppm. Rastogi et al. (2013) also found that the use of 0.5–1 ppm of auxin is effective in stimulating vegetative growth, increasing seed yield and yield components in linseed. Results are also in conformity with the finding of Lee, 1990, who also reported increase in plant height, number of leaves per plant, pod size with consequent enhancement of karnel yield in groundnut with the application of IAA.

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Table 1 Effect of different plant growth regulators on plant height, yield attributes, yield and economics of linseed

Treatment	Plant height (cm)	Primary branches/plant	Capsules/ Plant	Seed yield (kg/ha)	NMR (Rs/ha)	B:C
Auxin 1.0 ppm	73.37	4.87	29.00	1022	22127	1.18
Auxin 2.0 ppm	74.23	5.00	30.27	1087	26023	1.57
GA 200 ppm	75.73	4.87	33.53	1123	18580	0.75
GA 400 ppm	76.80	4.93	36.60	1297	20553	0.66
Salicylic acid 75 ppm	69.93	4.33	27.60	987	20753	1.11
Tebuconazole 0.1%	71.70	4.60	26.20	1040	21652	1.09
Auxin 1.0 ppm + GA 200 ppm	75.03	4.93	34.80	1214	23447	0.79
Control	71.17	4.33	25.13	953	19797	1.08
CD (P=0.05)	3.88	0.49	2.88	154	-	-

Effect of neem cake in the management of root knot nematode

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ABSTRACT

Neem enrichment extract (NEE) was used at different concentrations *viz*., 0, 2.5, 5 and 10% to check its effect on second stage juveniles of *Meloidogyne* spp. Root knot nematode bio-assay in Petri Plates as well as in pot culture experiments were carried out with NEE.The results indicated that neem cake extracts was effective to control the root knot nematodes due to the presence of biological substance (azadirachtin, salannin, nimbin) and its derivative compounds (triterpenoid, limonoid).

Keywords: Management of nematode, Neem enrichment extract, Root knot nematode

INTRODUCTION

Neem cake is used to enrich the soil, ward off nematodes and control insect pests. Nortriterpenoids and isoprenoids are the nematicidal compounds present in the neem cake, which protect the crops against nematodes and other infections. The best effects are obtained when it is applied during the early crop cycle. Nematode control has traditionally been accomplished with the aid of synthetic or chemical insecticides. However, as we are aware, employing the chemicals repeatedly had a negative impact on our food chain. Chemical pesticides are expensive as well. Neem cakes seem to be one of the most promising organic alternatives to combat nematodes in this regard.

MATERIALS AND METHODS

About 100 g of neem cake was grinded and soaked into 200 ml of 96% alcohol for 4 h and then extracted by filtering the solution 4 times through the sterilized millipore 0.45µm filter, the rest was discarded. All filtrations were mixed up together and vacuum extracted by rotation of the obtaining solution. About 100 ml of neem enrichment extract (NEE) was taken and prepared at different concentrations *viz*., 0, 2.5, 5 and 10% (Vu Van Do, 2007). Second stage juveniles of *Meloidogyne* spp. were collected from the pure culture maintaining in tomato roots and the juveniles were extracted through modified Baermann funnel method. For the root knot nematode bio-assay, two ml of the different concentrations (2.5, 5 and 10%) of the neem cake extract were separately poured into Petri dishes and to the Petri dish about 2 µl of nematode suspension containing about 100 J_2 / 2 µl were added. All treatments were replicated three times in CRD. The Petri dishes were incubated at room temperature. Per cent mortality was calculated after 12, 24 and 48h of incubation. Mortality data collected were the data were subjected to ANOVA SPSS 16 software. For the pot culture experiment, ground neem cake was thoroughly mixed with sandy clay loam soil (51% sand, 15% silt and 34% clay; pH 7.8 and organic matter of 0.73%) at 2.5, 5 and 10% in 15-cm clay pots. Pots without amendments were kept as control. All pots were arranged in a completely randomized block design on a bench in a greenhouse that averaged 27°C minimum and 32°C maximum temperature. Each treatment was replicated five times. The pots were watered daily to ensure proper decomposition of organic matter. After 2 weeks, 15 day old tomato seedling was transplanted into each pot. The plants were then inoculated with 2,000 J_2 of *M. incognita* after 48 h. The control treatments received sterile distilled water of a volume equal to that of the inoculum suspension. Plants were uprooted 30 days after inoculation of nematodes and the growth parameters of plants were recorded. The number of galls/root system, egg mass/ root system, eggs/egg mass and soil population was also counted.

RESULTS AND DISCUSSION

The effect of neem cake on the J_2 of *Meloidogyne incognita* (Fig. 1) reported the mortality of 90 and 100% after 12 and 24 h of exposure exposed in 5% concentration, respectively. At 2.5% concentration, the mortality of *M. incognita* juveniles was nearly 80% after 48h of incubation. This study proved that the neem cake has a stronger potential to suppress the juveniles of *Meloidogyne incognita* due to the presence of bioactive substances present in them. These substances are regarded as the key elements in nematode management, which can be further explored for the preparation of effective compounds to control nematodes.

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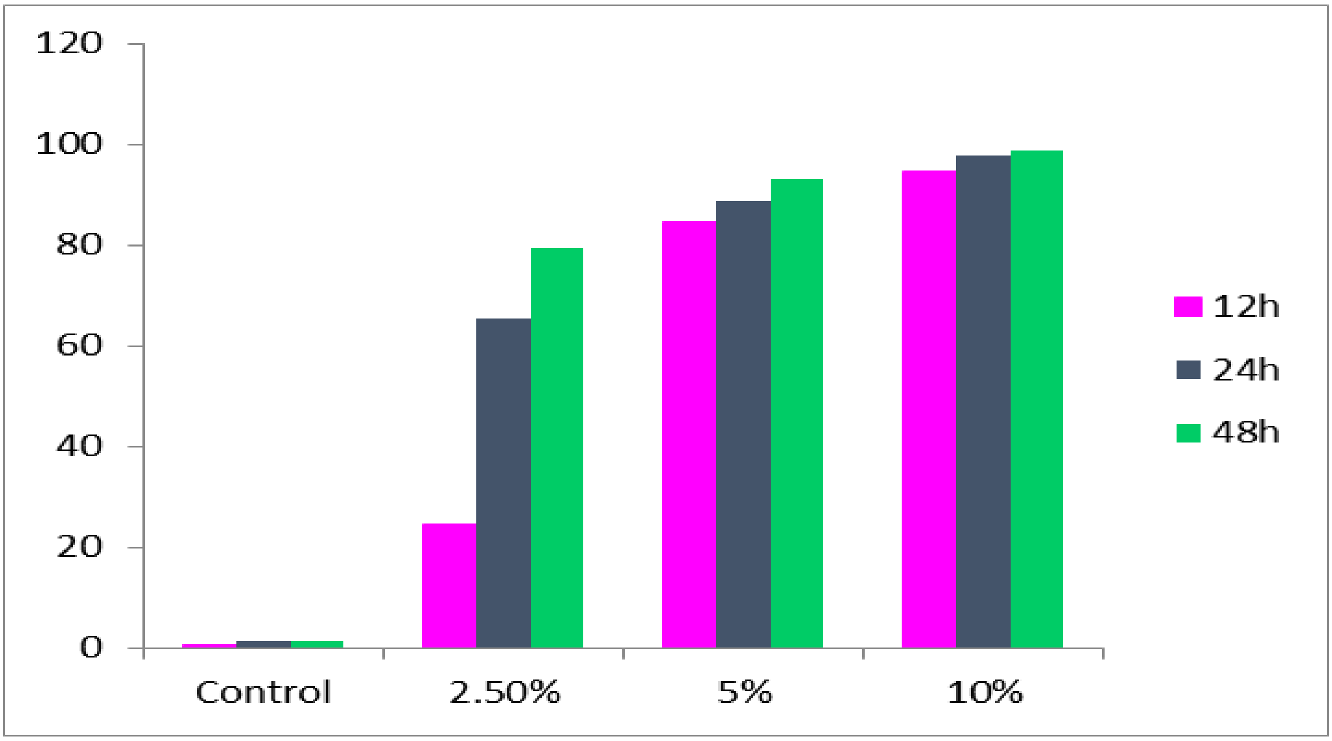

Fig. 1. Per cent juvenile mortality of root knot nematode treated with neem cake

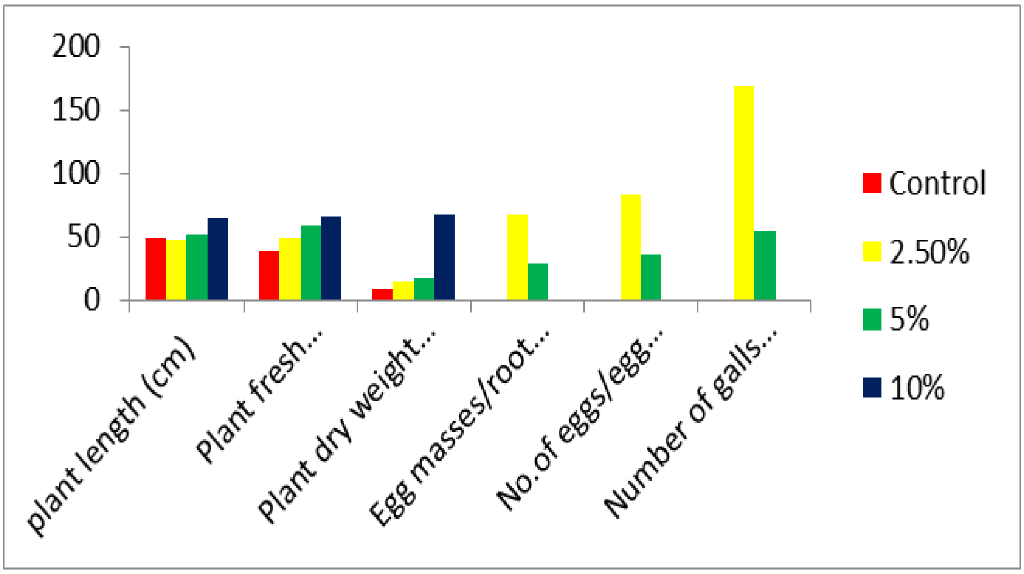

Fig. 2. Effect of neem cake on plant growth parameters and root population of nematode

Field evaluation of *Bt* 127SC formulation for efficacy against Lepidopteran larvae infesting soybean under Manipur conditions

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ABSTRACT

Bt 127 SC formulation supplied by the Indian Institute of Oilseeds Research, Hyderabad was field tested at Imphal (Manipur) during *kharif* 2018 - 2020 against lepidopteran larvae infesting soybean.Two spray applications of *Bt* 127 SC formulation @ 3 ml/litre of water was observed to be less superior to commercial synthetic insecticides but at par with *Bt* commercial delfin in reducing bihar hairy caterpillar (BHC) and bean leaf webber and comparatively similar in efficacy with the synthetic insecticides in reducing tobacco caterpillar.

Keywords: *Bt* 127SC formulation, Bihar hairy caterpillar, Bean leaf webber, Lepidopteran defoliators

Soybean [*Glycine max* (L.) Mirrill] is a unique crop with high nutritional value containing about 40-42 per cent protein and 20-22 per cent oil. About 70% soybean production in Manipur is used for the production of a fermented food item known as *Hawaijar.* The region is a great biodiversity hotspot and the agro climatic conditions are very conducive for the growth and multiplication of many species of insect pests (Azadthakur *et al.*, 1987). Indiscriminate use of pesticides has led to problems of pest outbreak, development of resistance, elimination of natural enemies, risk to human and animal health and environmental pollution. This scenario facilitated the search foralternative tactics to manage the pests.

MATERIALS AND METHODS

Field studies on the efficacy of *Bt* 127SC formulation for efficacy against lepidopteran larvae viz, bihar hairy caterpillar (BHC), bean leaf webber and tobacco caterpillar which are voracious defoliatorof soybean in Manipur was undertaken at Central Agricultural University, Imphal during three consecutive *kharif* season of 2016 – 2018 by raising recommended soybean variety, JS-335. All the recommended agronomic practices were followed to grow the crop. The formulation was compared with *Bt* commercial Delfin along with recommended chemical insecticides viz., Indoxacarb 15.8SC, Quinalphos 25EC and Chlorantraniliprole 18.5SC. Two spray applications of each treatment were given at 30 days and 50 days after sowing and observations on insect population were recorded at pre-treatment, 3 and 7 days after each treatment. Yield data (kg/ha) was recorded at harvest.

RESULT AND CONCLUSION

Based on the results of three years, it can be inferred that 2 spray application of *Bt* 127 SC @ 3 ml/litre was less superior to commercial synthetic insecticides but at par with *Bt* commercial delfin in reducing bihar hairy caterpillar and bean leaf webber. However, it is comparatively similar in efficacy with the synthetic insecticides in reducing tobacco caterpillar. Biopesticides based on pathogenic microorganisms may therefore be recommended as it offers an ecologically sound and effective solution to pest problems.

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Performance evaluation of sulphur oxidizing bacteria (*Thiobacillus thiooxidans*) on productivity and quality of sunflower (*Helianthus annuus* L.)

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ABSTRACT

Field experiments were conducted with an objective of assessing the performance of Sulphur Oxidizing Bacteria (SOB) on productivity and quality of sunflower during *Kharif* and *rabi* seasons 2021. The results revealed that, application of RDF (60:90:60 kg NPK/ha) + sulphur @ 20 kg/ha with SOB as seed treatment @ 1 kg/ha + soil application @ 1 kg/ha recorded significantly higher value of head diameter (18.6cm), grain/capitulum (1015 Nos.), seed yield (2440 kg/ha), oils content (42.5%), gross return (□109800/ha), net return (□54400/ha) and benefit cost ratio (1.98) compared to application of RDF alone and control. However, it was on par with application of RDF + sulphur @ 20 kg/ha combined with SOB as soil application @ 2 kg/ha. From the experimental results, it was concluded that application of RDF (60:90:60 kg NPK/ha) + sulphur @ 20 kg/ha with SOB as seed treatment @ 1 kg/ha and soil application @ 1 kg/ha is an economically viable options to enhance productivity and oil content of the sunflower.

Keywords: Seed treatement, Soil application, Sulphur oxidizing bacteria, Sunflower, *Thiobacillus thiooxidans*

In India, nearly 72% of the total oilseeds area is restricted to poor and marginal soils and predominantly cultivated under drought prone dryland ecosystem has resulted in poor realization of its genetic potential and thus low productivity. Sunflower is cultivated in an area of 0.23 M ha area and that too mostly under rainfed conditions with limited resources. It also faces frequent threat of biotic and abiotic stresses resulting in low productivity of 1011 kg/ha. Among nutrients, sulphur element considered as the fourth important nutrient after N, P_2O and K_2O and is dynamically involved in plant growth, seed yield, oils and protein synthesis as well as improvement in enzymatic and metabolic process (Hussain *et al*., 2011). To overcome sulphur deficiency, application of sulphur with sulphur-oxidizing bacteria and SOB enriched farmyard manure could be a constructive and sustainable strategy for improving the availability of major and micronutrients, which ultimately enhanced plant growth, yield attributes and yield of sunflower (Pujar *et al*., 2014).

MATERIALS AND METHODS

Field experiments during *kharif* and *rabi* seasons 2021 were conducted in randomized block design with three replications by adopting following treatments *viz*., T_1 - Control, T_2 - Recommended Dose of Fertilizer (RDF - 60:90:60 kg NPK/ha), T_3 - RDF + Sulphur @ 20 kg/ha, T_4 - T_3 + SOB as seed treatment @ 1 kg/ha, T_5 - T_3 + SOB as soil application @ 2 kg/ha, T_6 - T_3 + SOB as seed treatment @ 1 kg/ha + soil application @ 1 kg/ha, T_7 - T_2 + SOB as seed treatment @ 1 kg/ha + soil application @ 1 kg/ha. Seeds of sunflower hybrid COH 3 were sown with spacing of 60cmx30cm. Treatments specific nutrients requirement were applied through urea, di-ammonium phosphate, muriate of potash and sulphur fertilizers. Data on yield parameters, yield and oil content were observed and economic analysis were studied.

RESULTS AND DISCUSSION

Among the treatments studied, application of RDF @ 60:90:60 kg $NP_2O_5K_20$/ha + sulphur @ 20 kg/ha in combination with SOB as seed treatment @ 1 kg/ha + soil application @ 1 kg/ha (T_6) recorded significantly higher yield attributes *viz*., head diameter (18.6cm), grain/ capitulum (1015 Nos.), seed yield (2440 kg/ha) and oil content (42.5%), when compared to application of RDF alone (T_2) and absolute control (T_1). Nevertheless, it was on par with the treatment combination of RDF @ 60:90:60 kg $NP_2O_5K_20$/ha + sulphur @ 20 kg/ ha combined with SOB as soil application @ 2 kg/ha (T_5). However, no significant variation was observed in seed volume and 100 seed weight by application of RDF and sulphur nutrition in combination with SOB as seed treatment as well as soil application. Application of sufficient quantity of sulphur combined with sulphur-oxidizing bacteria can alter the rhizosphere environment of the crop by oxidizing the applied and fixed sulphur in the soil profile and lowering pH to increase nutrient availability and nutrient uptake of the macro and micro nutrients thus facilitated better crop growth and development which enhanced yield attributes, yield and oil content of the sunflower. This result was in accordance with the findings reported by Pujar et al. (2014).

The maximum gross return (□109800/ha), net return (□54400/ha) and higher benefit cost ratio (1.98) were also recorded under the treatment combination of RDF @ 60:90:60 kg $NP_2O_5K_2O$/ha + sulphur @ 20 kg/ha in combination with SOB as seed treatment @ 1 kg/ha + soil application @ 1 kg/ha (T_6), followed by application RDF and sulphur @ 20 kg/ ha combined with SOB as soil application @ 2 kg/ha (T_5). Whereas, the least gross return (□62586/ha), net return (□12058/ha) and benefit cost ratio (1.24) was recorded under absolute control (T_1). Results of the experiments advocate that application of RDF + sulphur with sulphur-oxidizing bacteria could be a beneficial strategy for improving the yield of sunflower and thereby augmenting maximum gross income, net income and benefit-coat ratio of the irrigated sunflower (Hussain *et al*., 2011).

From the field experimental results, it was concluded that, application of recommended dose of fertilizer @ 60:90:60 kg $NP_2O_5K_20$/ha + sulphur @ 20 kg/ha in combination with SOB as seed treatment @ 1 kg/ha + soil application @ 1 kg/ha is the economically viable options for maximising the yield attributes, yield, oil content and economics of the irrigated sunflower.

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Table 1. Effect of sulphur oxidizing bacteria on yield attributes, yield, oil content and economics of sunflower *(Mean of two seasons)*

Treatments	Head diameter (cm)	No. of grains/ capitulum	Seed volume (g/100ml)	100 grain weight (g)	Seed yield (kg/ha)	Oil content (%)	Cost of cultivation (□/ha)	Gross return (□/ha)	Net return (□/ha)	B:C ratio
T_1	12.2	705	4.07	43.1	1215	41.0	40800	54675	13795	1.34
T_2	16.0	818	4.21	45.2	1863	41.4	50500	83835	33335	1.66
T_3	17.0	905	4.30	46.3	2051	42.0	52150	92295	40145	1.77
T_4	17.4	949	4.37	46.6	2183	42.2	53400	98235	44835	1.84
T_5	17.8	982	4.58	47.1	2272	42.4	53250	102240	48990	1.92
T_6	18.6	1015	4.75	47.5	2440	42.5	55400	109800	54400	1.98
T_7	16.4	863	4.23	45.6	1948	41.3	51250	87660	36410	1.71
SEd	1.0	60	0.2	1.9	118	0.5	-	-	-	-
CD (p=0.05)	2.2	131	NS	NS	256	1.1	-	-	-	-

Heterosis studies for seed yield and yield contributing traits in sesame (*Sesamum indicum* L.)

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ABSTRACT

The highest magnitude of significantly positive heterosis over mid parent to the extent of 77.91 per cent and over standard check JLT-408 to the extent of 34.63 per cent was recorded by the cross RT-351 X TMV-4 and the cross RT-346 X PKDS-11 showed heterosis (57.01 %) over better parent for seed yield/plant. The best crosses based on heterosis were RT-351 X TMV-4 and RT-346 X THILARANI identified as the best cross combinations for further exploitation.

Keywords: Analysis, Heterosis, Line x tester

Sesame (*Sesamum indicum* L.) known as *gingelly, til, benniseed, simsim*, of family Pedaliaceae. Sesame is a self-pollinated crop, having (2n = 26) chromosome number. It requires average temperature of 25-27^{o} C for rapid germination, initial growth and flowering. Sesame is called as the 'Queen' of oil seeds in view of its oil (38-54%) and protein (18-25%) are of very high quality. Brown or black seeded are valued more for oil (for medicinal purpose) extraction whereas white seeded are rich in iron.

MATERIALS AND METHODS

The experimental material was consisting of 4 lines (AKT-101, RT-351, JLT-07, RT-346) and 7 testers (GT-10, KRISHNA, TMV-4, PKDS-11, THILARANI, VRI-2, CO-1) and 28 F_1 hybrids developed in line x tester mating design including 2 check varieties (Phule Til-1 and JLT-408). The experiment was laid out in a Line x tester mating design in randomized block design with two replications. A total of 41 treatments, comprising 4 females, 7 males, 28 F_1`s and 2 check hybrids were randomized separately in each replication. Each treatment comprised of two rows of 3 m length, row spaced at 45 cm apart and with plant to plant distance of 20 cm. Sowing was done by dibbling one to two seeds at per hill. The recommended dose of fertilizers was applied was applied and other cultural operations were followed. Observations were recorded on Seed yield per plant (gm), Oil content (%), 1000 seed weight (gm), Days to maturity, Length of capsule (cm), Number of seeds/capsule, Number of capsules/plant, Plant height (cm), Number of branches/plant, Days to 50 per cent flowering. Statistical analysis was done as per Rai (1979).

RESULT AND DISCUSSION

Based on mean performance, female parent AKT-101 and RT-346 and male parent GT-10 and KRISHNA and hybrids RT-351 X TMV-4, RT-346 X THILARANI, RT-346 X PKDS-11, JLT-07 X CO-01 were found best for seed yield and yield components. The magnitude of heterosis and heterobeltiosis for all the characters in the present study was highly appreciable. Among all the characters the magnitude of mid parents and better parent heterosis was for seed yield/plant to the extent of (77.91 % and 53.99 %) respectively for the cross RT-351 X TMV-4 which was followed by the characters *viz.*, number of seed/capsule (52.95 % and 50.65 %) in the cross AKT-101 X KRISHNA, number of capsule/plant (52.91 % and 47.75 %) in the cross RT-351 X CO-01, number of branches/plant (49.40 % and 29.17 %) in the cross RT-351 X VRI-2, number of seed/capsule (22.33 % and 16.67 %) in the cross RT-351 X GT-10. After comparison of heterotic crosses and their *per se* performance for various characters, two crosses *viz.*, RT-351 x TMV-4 and RT-346 x THIALARANI were identified as most potential for exploitation of their hybrid vigour commercially.

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Combining ability analysis for yield and yield contributing traits in sesame (*Sesamum indicum* L.)

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ABSTRACT

Among the parents JLT-07 proved to be good general combiner for the characters *viz.,* number of branches per plant and 1000 seed weight, RT-346 for character plant height, PKDS-11 for days to flowering and CO-1 for maturity and number of capsules per plant, RT-351, GT-10, VRI-2 and TMV-4 for oil content. These seven parents could be utilized in the breeding programme for further improvement.

Keywords: Combining ability, Gene action, Heterosis, Sesame

Sesame (*Sesamum indicum* L.) known as *gingelly, til, benniseed, simsim*, of family Pedaliaceae. Sesame is a self-pollinated crop, having (2n = 26) chromosome number. It requires average temperature of 25-27^o C for rapid germination, initial growth and flowering. Sesame is called as the ‘Queen’ of oil seeds in view of its oil (38-54%) and protein (18-25%) are of very high quality. Brown or black seeded are valued more for oil (for medicinal purpose) extraction whereas white seeded are rich in iron.

MATERIALS AND METHODS

The experimental material was consisting of 4 lines (AKT-101, RT-351, JLT-07, RT-346) and 7 testers (GT-10, KRISHNA, TMV-4, PKDS-11, THILARANI, VRI-2, CO-1) and 28 F_1 hybrids developed in line x tester mating design including 2 check varieties (Phule Til-1 and JLT-408). The experiment was laid out in a randomized block design with two replications. A total of 41 treatments, comprising 4 females, 7 males, 28 F_1`s and 2 check hybrids were randomized separately in each replication. Each treatment comprised of two rows of 3 m length, row spaced at 45 cm apart and with plant to plant distance of 20 cm. Sowing was done by dibbling one to two seeds at per hill. The recommended dose of fertilizers was applied and other cultural operations were followed. Observations were recorded for characters *viz.,* Seed yield per plant (gm), Oil content (%), 1000 seed weight (gm), Days to maturity, Length of capsule (cm), Number of seeds/capsule, Number of capsules/plant, Plant height (cm), Number of branches/plant, Days to 50 per cent flowering. Statistical analysis was carried out as per modified line x tester following Arunachalam (1974).

RESULT AND DISCUSSION

Based on mean performance female parent AKT-101 and RT-346 and male parent GT-10 and KRISHNA and hybrids RT-351 X TMV-4, RT-346 X THILARANI, RT-346 X PKDS-11, JLT-07 X CO-01 were found best for seed yield and yield components. The analysis of variance for combining ability revealed that, the mean sum of squares due to parents were significant for the majority of the traits except days to maturity and length of capsule under study and crosses were significant for all the characters. The parents *v/s* crosses interaction mean sum of squares were significant for the characters days to maturity, number of capsule/plant, length of capsule, number of seed/capsule, 1000 seed weight and seed yield/plant. The variance due to lines x tester interaction was significant for the characters plant height, number of branches/plant, length of capsule, number of seed/capsule, seed yield/plant and oil content indicating appreciable amount of variability in parents and crosses. Among the female parents AKT-101 was the best general combiner for oil content and 1000 seed weight. The female parent RT-351 for oil content, JLT-07 for number of branches/plant and RT-346 for plant height found to be better combiners. Among the male parents GT-10 and TMV-4 showed positive significant gca effects for oil content. The parent PKDS-11 was the best general combiner for length of capsule and days to 50 per cent flowering, VRI-2 for plant height and oil content and CO-1 was the best general combiner for days to maturity and number of capsules/plant. It was concluded that the crosses showing high heterosis and high *per se* performance involved the parents possessing high x high, high x low and low x low combiners indicating importance of additive and non-additive gene action. There was good correspondence between highly heterotic crosses and their respective sca effects for all the characters.

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Effect of Genotype × Environment interaction for agro-physiological traits in thermo-tolerant early maturing Indian mustard (*Brassica juncea* L. Czern & Coss) genotypes under heat stress condition

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ABSTRACT

Brassica juncea is the predominant oilseed brassica in the Indian subcontinent. It accounts for about 80 per cent of the total area under rapeseed-mustard cultivation in India. A study was carried out at the research farm of ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur during *rabi* 2018-19, 2019-20 and 2020-21 to study effect of Genotype × Environment interaction and genetic variability of early maturing thermo-tolerant genotypes of Indian mustard (*Brassica juncea* L. Czern & Coss)**.** G x E interaction was significant for all the characters *viz*., days to flowering, days to maturity, seed yield (kg/ha), membrane stability index (%), excised leaf- water loss (%), relative water content (RWC %), and water retention capacity of leaves (%) except 1000-seed weight. G x E interaction (linear) was also significant for all these eight characters, indicating substantial amount of predictable G x E interaction. Genotype DRMRHT-13-13-5-4 attained minimum days to maturity (122.88) alongwith regression coefficient near to unity and S^2di near to zero considered as stable. While the genotype DRMRHT-13-13-5-5 attained minimum days to maturity (124.44) alongwith regression coefficient near to unity exhibit average stability. Genotype DRMRHT-13-13-5-4, DRMRHT-13-13-5-5 and DRMRHT-13-22-10 could be included in breeding programme where objective is to develop high yielding and heat tolerant stable genotypes over the environment.

Keyword: Effect, Genotype × Environment Interaction, Indian mustard, Stability, Thermo-tolerant, Variability

In Rajasthan, Rapeseed-Mustard is mostly grown under limited soil moisture conditions where sowing commences after cessation of southwest monsoon rains. Early rains may lead the farmers to sow the crop early in the season to take advantage of conserved moisture in the soil (Venkateswarlu and Prasad, 2012). However, at the time of early sowing (second fortnight of September to the first fortnight of October), the mean surface soil temperature may reach as high as 45^o C. Therefore, efforts to strengthen resilience by genetic upscaling of heat stress at seedling and terminal stage in Indian mustard would be vital to stabilize the productivity of the crop in India. Consequently, the present investigation was come up to study effect of genotype-by-environment (G×E) interaction with respect to eight agro-physiological traits and identify some of the promising early maturing heat stress tolerant from amongst a pool of advanced breeding lines, to be used as potential donors for transferring heat stress tolerance in high yielding varieties.

MATERIALS AND METHODS

To study effect of Genotype × Environment interaction for Agro-physiological traits and genetic variability of early maturing thermo-tolerant genotypes of Indian mustard, ten advanced breeding lines including two checks, were grown in the field under heat stress conditions (maximum temperature 40.5^{0}C at 0 to 10 cm depths on seeding date on September 28, 2018; maximum temperature 41.02^{0}C at 0 to 10 cm depths on seeding date on September 28, 2019; maximum temperature 43.2^{0}C at 0 to 10 cm depths on seeding date on September 25, 2020) in RBD with 3 replications at the research farm of ICAR-DRMR, Bharatpur Rajasthan, India. Morpho-physiological characters, including, (DTF), (DTM), (1000 SW in gm), (PMSI), (PELWL), (PRWC), (PWRCL) and (SY in kg/ha) were recorded from five randomly selected plants of each genotype.

Analysis of variance (ANOVA) was calculated according to the formula described by Panse and Sukhatme (1978) and critical differences (CD) were determined at 5 and 1% probability level. Estimation of phenotypic and genotypic coefficient of variation, heritability in broad sense, genetic gain, and stability based on Eberhert and Russel Model were determined using Windostat version 8.5 software.

RESULTS AND DISCUSSION

The analysis of variance for all the traits showed highly significant different among the genotypes indicating sufficient amount of variability in the material. High heritability (in broad sense) estimates were focused for water retention capacity of leaves (99.98% E1), membrane stability index (99.96% E3), seed yield (99.78% E3), relative water content (99.07% E1), water retention capacity of leaves (99.05% E3), relative water content (99.41% E3), excised leaf water loss (97.40% E1) and 1000-seed weight (99.03% E3) indicating that these characters were less influenced by the environmental factors and direct selection for these characters would be effective for further improvement.

G X E interaction variance was significant for all observed characters. These results indicated presence of substantial amount of genotype x environment interaction. Genotype with bi=1 and lowest deviation around regression line could be termed most stable and vice-versa. According, it was possible to judge the stability of genotypes with due consideration to their mean performance and linear response. Genotype DRMRHT-13-13-5-5, DRMRHT-13-13-5-4, DRMRHT-13-22-10 and DRMRHT-13-13-5-6 possess relative stable and high performance for relative water content (%), membrane stability index (%), days to maturity, water retention capacity of leaves (%) and seed yield (kg/ha) over its respective population mean. The genotype DRMRHT-13-13-5-5 attained more membrane stability index (%) alongwith regression coefficient and equivalent to unity and S^2di near to zero considered as stable. While, the genotype DRMRHT-13-13-5-4 had attained maximum membrane stability index alongwith regression coefficient equilant near to unity, exhibit average stability. Based on these results, DRMRHT-13-13-5-4, DRMRHT-13-13-5-5 and DRMRHT-13-22-10 genotypes could be included in breeding programme where objective is to develop high yielding and heat tolerant stable genotypes over the environment.

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On-farm studies on rice-groundnut *vis-a-vis* rice-rice sequence system under irrigated dry situations of Telangana

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ABSTRACT

On farm studies on rice-groundnut *vis-a-vis* farmers' practice of rice-rice sequence was conducted in ten peasants' fields of Medak district of Telangana state. Rice-groundnut sequence realized 9.8% higher mean rice grain equivalent yield (13377 kg/ha) than rice-rice (12186 kg/ha). The mean gross and net returns of diversified sequence were Rs 227407 and 100651/ha, while that of traditional practice were Rs 207157 and 76710/ha respectively. On an average a B C ratio of 1.9 was gained in improved cropping sequence as against the 1.5 under farmers' practice indicating the profitability of diversified cropping systems.

Keywords: Irrigated condition, On-farm studies, Rice based cropping systems, Telangana

Rice-rice is the dominant mono cropping system under irrigated ecosystem of Telangana state of India. Further, in Telangana, oil seed crops are grown mainly as rainfed. Changing climate, decreasing water level and ever increasing electricity demand pose grave concerns for rice cultivation during *rabi* (dry season) and demand for inclusion of alternate crops. The ever increasing gap between the demand and supply of oilseeds at the state as well as country level opens up the scope to utilize the rice fallows for oilseeds paved an opportunity for expansion of the area of oilseed crop by inclusion of oil seeds as intercrop and sequence crop in cereals crop.

MATERIALS AND METHODS

To demonstrate the production potential and economic advantage of improved cropping sequence of rice-groundnut in comparison with traditional practice of rice-rice, front line demonstrations were conducted during the year 2018-19 in seven locations (irrigated and light soils) of Medak district. An area of 0.4 ha per each location was chosen for study. The variety MTU 1010 of rice and K-6 for groundnut were used in the study. Cultivation of rice-rice (farmer's practice) was considered as control. All management practices for sowing to harvesting were adopted as per the recommendations of PJTSAU. The data on grain yield was collected by random crop cutting method and the yield of both the crops was presented as rice equivalent yield. Benefit Cost ratio, gross and net returns were calculated based on grain and pod yield and prevailing market price.

RESULTS AND DISCUSSION

On an average the Rice Equivalent Yield (REY) of improved cropping system of rice - ground nut was 9.8 % higher (13377kg ha^{-1}) than grain yield in farmers' practice of rice-rice sequence (12186 kg ha^{-1}). Virdia and Mehata (2010) also reported paddy - groundnut as the biologically efficient as well as cash ensuring and profitable crop sequence and fetched more return per unit. The mean returns earned on per rupee investment were Rs 1.9 in improved cropping system, where as in farmers practice the benefit was 1.5. Higher economics in improved cropping systems over farmers' practice can be attributed to higher rice equivalent yield, high gross and net returns and lower cost of cultivation. Results obtained from yield and returns showed a significant advantage of diversifying the system with rice – groundnut sequence crop rather than mono-cropping of rice-rice system in limited irrigated situations of Telangana state.

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Study of genetic divergence in linseed genotypes

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ABSTRACT

In the present study, 75 diverse genotypes of linseed were grouped in 16 clusters by Tocher's method where cluster II was largest with 38 genotypes followed by cluster IV with 17 genotypes, cluster XI with 5 genotypes. The maximum intra-cluster distance was obtained for cluster IV (14.34) followed by cluster II (13.20). The highest inter-cluster D value was observed between cluster I and XI (40.62) followed by cluster V and XI (38.13). Cluster X showed highest value for number of primary branches and number of secondary branches per plant. Among the ten traits, number of capsules/plant contributed maximum towards genetic divergence. The grouping of genotypes in different clusters was not related to their geographic origin and genotypes from different geographic locations were grouped into one cluster while genotypes of the same geographic origin showed genetic diversity.

Keywords: Cluster, D^2, Genetic divergence, Linseed

The information about the nature and magnitude of genetic divergence is essential for selection of diverse parents which upon hybridization would lead to wide spectrum of gene re-combinations for quantitatively inherited characters. Mahalanobis D^2 statistics is a powerful tool for quantification of genetic divergence among the parents. Therefore, an attempt was made to assess the genetic diversity in 75 diverse linseed genotypes to understand the nature and magnitude of genetic divergence and the characters contributing to genetic diversity.

MATERIALS AND METHODS

The study was conducted at oilseed Research Farm, C. S. Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh. 75 diverse genotypes were selected for the present investigation from the various part of the country of linseed growing areas having different geographic origin. The experiment was laid out in a complete randomized block design with three replications. Each plot consists of 8 rows of 6 m long. The spacing between plants was 8 cm and rows 30 cm apart. Data were taken on 5 randomly selected plants for 10 characters. Mean values of different characters were used to assess the divergence (Mahalanobis D^2, 1936). Genotypes were grouped into different clusters using the Tocher's method (Rao, 1952)

RESULTS AND DISCUSSION

On the basis of D^2 values, 75 diverse genotypes were grouped into 16 distinct clusters. Cluster II was largest with 38 genotypes followed by cluster IV with 17 genotypes, cluster XI with 5 genotypes, cluster I with 3 genotypes and remaining cluster with single genotypes only. The result indicated that genetic diversity is not related to geographical diversity may possibly be due to the fact that varietal diversity among the lines evolved in same habitat might be due to diversity of their pedigree along with natural and directional selection pressure for certain agronomic traits. The inter cluster distances were greater than intra cluster distances revealing considerable amount of genetic diversity among the genotypes studied. The maximum intra-cluster distance was obtained for cluster IV (14.34) followed by cluster II (13.20), cluster XI (12.78) and cluster I (6.31). The highest inter-cluster D value was observed between cluster I and XI (40.62) followed by cluster V and XI (38.13). Since these clusters have more inter-cluster distance among them, crossing between these clusters is expected to realize higher heterosis. The comparison of cluster means for 10 characters under study marked considerable genetic differences between the groups. Cluster XIV had highest mean value for days to 50% flowering and days to maturity, Cluster X for number of primary branches and number of secondary branches/plant. Cluster VI had highest value for number of capsules/plant, seeds/ capsules and 1000-seed weight. The contribution towards genetic divergence indicated that the number of capsules/plant (35.75%), plant height (19.96%) and seed yield/plant (9.48%) contributed more towards the genetic diversity in linseed.

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Validation of DOR *Bt* 127 SC against capitulum borer, *Helicoverpa armigera* and coccinellid predators in Sunflower

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ABSTRACT

DOR Bt 127 SC was evaluated against capitulum borer *Helicoverpa* armigera and coccinellid beetles in sunflower crop during *Kharif* 2020 at farmers field, Myakalurahalli, Hiriyur Tq, Chitradurga dt., Karnataka. DOR Bt 127 SC was compared with Chlorantraniliprole 18.5 SC and farmer's practice. Chlorantraniliprole 18.5 Sc treated plot registered significantly lowest population (0.23) of *H. armigera* and was on par with Bt 127 Sc (0.40) during 10 days after spray. Farmers' practice registered significantly highest population (1.33) of *H. armigera*.

Keywords: Capitulum borer, Coccinellid predators, DOR Bt 127 SC, Sunflower

Sunflower is attacked up to twenty insect pests and among them, capitulum borer, *Helicoverpa armigera* causes economic loss. It is highly polyphagous with about 181 host plants including important crop plants such as pulses, cotton, vegetables, etc. (Manjunath *et al*., 1985). Capitulum borer causes direct damage to receptacle, ovaries, developing seeds of sunflower (Bhat and Virupakshappa, 1993) and even a single larvae per capitulum could cause economic damage (Margal, 1990). Therefore, to have effective control measure for capitulum borer is the need of the hour. Although chemical control method provides immediate control it causes various environmental and health hazards. So as an alternative DOR Bt 127 was validated as an alternative for management of Capitulum borer *H. armigera.*

DOR Bt 127 SC was evaluated against capitulum borer *Helicoverpa* armigera and coccinellid beetles during *Kharif* 2020 at farmers field, Myakalurahalli, Hiriyur Tq, Chitradurga dt., Karnataka. DOR Bt 127 SC was compared with Chlorantraniliprole 18.5 SC and farmer's practice. Pre-treatment counts were taken 1 day before the implementation of the treatments. Post treatment observations were recorded on 5 and 10 days after spray. The results are presented in Tables 1 and 2. Pre-treatment observations on population of capitulum borer and coccinellid beetles revealed that there were no significant differences among the treatments.

Chlorantraniliprole 18.5 Sc treated plot was found to be significantly superior (0.40) in controlling *H. armigera* over Bt 127 (0.67) during 5 days after spray. The population was significantly highest in farmers' practice (1.27) during 5 days after treatment (Table 1). Chlorantraniliprole 18.5 Sc treated plot registered significantly lowest population (0.23) of *H. armigera* and was on par with Bt 127 Sc (0.40) during 10 days after spray. Farmers practice registered significantly highest population (1.33) of *H. armigera*. The results are in line with Jayewar and Sonkamble, 2015 where they reported the biopesticides viz., HaNPV @ 2 x 108 POBs/ml, NSKE 5 %, DOR *Beaveria bassiana* 250 mg, DOR *Bt* 5 @ 2.5 gm/litre, PSE 5 % and Neem formulation 0.5% were effective in controlling *H. armigera*.The plots treated with Chlorantraniprole registered highest yield (1125 kg/ha.) followed by *Bt* 127 Sc (1050 kg/ha.) whereas untreated control recorded least yield (825 kg/ha.) (Table 1). Pre-treatment and post treatment observations of coccinellid beetles revealed that there were no significant differences among the treatments (Table 2).

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Table 1 Evaluation of Bt-127 against sunflower capitulum borer, *Helicoverpa armigera* during kharif 2020

Tr. No.	Treatment	No. of larvae/plant			Yield (Kg/ha.)
		Pre Treat. count	5 DAFS	10 DAFS	
T_1	Bt-127 SC formulation @ 3.0 ml/l	1.17	0.40	0.23	1125
T_2	Chlorantraniliprole 18.5 Sc @ 0.3 ml/l	1.27	0.67	0.40	1050
T_3	Farmers Practice	1.20	1.27	1.33	825
S.Em ±		0.04	0.05	0.06	-
C.D @ 5%		NS	0.15	0.17	-

Table 2 Evaluation of DOR Bt-127 SC against coccinellid beetles of sunflower during kharif 2020

Tr. No.	Treatments	No. of Coccinellids/plant		
		Pre Treat. count	5 DAS	10 DAS
T_1	Bt-127 SC formulation @ 3.0 ml/l	0.23	0.20	0.20
T_2	Chlorantraniliprole 18.5 Sc @ 0.3ml/l	0.20	0.20	0.27
T_3	Farmers practice	0.20	0.27	0.27
S.Em ±		0.02	0.04	0.04
C.D @ 5%		NS	NS	NS

Eco-friendly management of mustard aphid, *Lipaphis erysimi* Kalt.

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ABSTRACT

A field trial was conducted at Oilseed Farm, C S Azad University of Agriculture & Technology, Kanpur. The trial was laid out in RBD with three replications using mustard cultivars Varuna. Seven insecticides viz. NSKE@5%, Neem leaf extract@ 5%, Neem oil 2%, Eucalyptus leaf extract 5%, Fennel leaf extract 5%, Dimethoate 30EC @ 1ml/liter and Thiamethoxam 25WG @ 0.2gm/liter with second spray of each treatment after 15 days of first spray were evaluated. Thiamethoxam 25WG @ 0.2gm/liter followed by its second spray after 15 days of first spray was most effective treatments against mustard aphid followed by Dimethoate 30EC @ 1ml/liter followed by its second spray after 15days of first spray. The highest seed yield (18.73 q/ha.) was obtained with Thiamethoxam 25WG @ 0.2gm/liter followed by its second spray after 15 days of first spray which was at par with NSKE@5% followed by its second spray after 15days of first spray (16.83 q/ha.). The incremental Benefit Cost Ratio (1:40:63) was also highest with Thiamethoxam 25WG @ 0.2gm/liter followed by its second spray after 15 days of first spray.

Keywords: Botanicals and management, Chemical insecticides, Mustard aphid

Rapeseed-mustard is next to groundnut in terms of production among oil seed crops grown in India. The mustard aphid, *Lipaphis erysimi* Kalt. Is the pest of rapeseed-mustard and widely distributed in all parts of country wherever *Brassica* oilseed crops are grown. Mustard aphid alone is causing loss to the tune of 95 per cent under various agro climatic conditions. Hence, a trial was conducted to manage it through eco-friendly methods.

MATERIALS AND METHODS

Application of chemical insecticides and plant extract namely, NSKE@ 5% ,*Neem* leaf extract@ 5 % ,*Neem* oil 2%, Eucalyptus leaf extract 5 %, Fennel leaf extract 5 % ,Dimethoate 30 EC@ 1ml/L Thiamethoxam 25 WG @ 0.2 gm /lit were done using manually operated knapsack sprayer having duromist nozzle. Aphid population was counted from aphid top 10 cm central twig per plant at 1 day prior to spraying and 3, 7 ,10 & 15 days after spraying. The yield of seed from each plot was weighed separately. Data were complied and analyzed statistically. Incremental cost benefit ratio (ICBR) for each treatment was calculated by dividing net gain over control by total cost of plant protection. Finally, net ICBR for each treatment was evaluated by dividing net profit by total cost of plant protection measure.

RESULTS AND DISCUSSION

The significantly lower population (3.73 aphids in top 10 cm central twig/ plant) was recorded in Thiamethoxam 25 WG @ 0.2 g/lit, which differed significantly from the remaining 7 treatments at 15 days after spray (Table 1&2). Based on these observations, Thiamethoxam 25 WG @ 0.2 g/lit was found as a most effective insecticide followed by Dimethoate 30 EC @ 1.0 ml/ lit (5.40 aphids top 10 cm central twig/plant). Among 5 plant extracts tested, NSKE @ 5% and *Neem* oil @ 2% found at par (4.11 and 4.78 aphids top 10cm central twig/ plant). *Neem* leaf extract @ 5% 26.56 was at par with Eucalyptus leaf extract @ 5% and Fennel Seed extract @ 5%, (33.13 was at par with 35.40 aphids top 10cm central twig/ plant) were found in controlling mustard at 15 days after first spray.

The data representation depicts observation at 15 days after second spray (DAS). The spray of Thiamethoxam 25 WG @ 0.2 g/lit and Dimethoate 30 EC @ 1.0 ml/ lit was found highly significantly found at par as most effective against mustard aphid providing (1.23 and 2.33 aphid in the top 10 cm central twig / plant) with reduction per cent *viz*, 99.41 and 98.89 over control followed by NSKE @ 5%, *Neem* oil @ 2% and *Neem* leaf extract @ 5% were also found at par against mustard aphid giving (9.60, 12.30, and 13.90 aphid top 10 cm central twig per plant) with reduction per cent *viz*, 95.44, 94.16, and 93.40 over control followed by Eucalyptus leaf extract @ 5% and Fennel Seed extract @ 5%, were also found at par against mustard aphid giving(23.66 and 25.56 aphid top 10 cm central twig per plant) at 15 days after spray with reduction per cent *viz*, 88.77 and 87.87, respectively over control. (Table- 2)

Table: 1 Effect of treatment against mustard aphid, *Lipaphis erysimi* Kalt. After first spray

T.No.	Treatment	Mean population of mustard aphid top10 cm central twig / plant									
		Dose	1DBS	3DAS	PROC	7DAS	PROC	10DAS	PROC	15DAS	PROC
1	NSKE	5%	55.30 (7.46)	25.43 (5.09)	78.54	20.60 (4.59)	85.63	18.33 (4.33)	87.65	16.43(4.11)	88.97
2	*Neem* leaf extract	5%	63.07 (7.97)	36.96 (6.12)	68.52	32.03 (5.70)	77.66	30.76 (5.59)	79.28	26.56 (5.20)	82.69
3	*Neem* oil	2%	61.66 (7.88)	33.36 (5.81)	71.59	29.60 (7.48)	79.35	26.66 (5.21)	82.04	22.43 (4.78)	85.38
4	Eucalyptus leaf extract	5%	60.76 (7.82)	48.72 (7.01)	58.51	41.56 (6.48)	71.01	42.56 (6.56)	71.33	33.13 (5.79)	78.41
5	Fennel seed extract	5%	58.86 (7.68)	49.05 (7.03)	58.23	45.36 (6.77)	68.36	30.20 (5.54)	79.66	35.43 (5.99)	76.91
6	Dimethoate 30 EC	1ml/lit	50.60 (7.14)	12.76 (3.64)	89.10	8.43 (2.98)	94.12	6.73 (2.68)	95.73	5.40 (2.42)	96.48
7	Thiamethoxam 25 WG	0.2 g/lit	52.43 (7.27)	9.66 (3.18)	91.77	5.50 (2.44)	96.16	4.36 (2.20)	97.06	3.73 (2.05)	97.56
8	Control		48.50 (7.00)	117.66 (10.87)		143.40 (11.99)		148.48 (12.20)		153.49 (12.40)	
SE(m) ±				0.270		0.196		0.201		0.211	
C.D at 5%			N.S.	0.827		0.601		0.615		0.646	

Table: 2: Effect of treatment against mustard aphid, *Lipaphis erysimi* Kalt. After second spray

T.N.	Treatment	Mean population of mustard aphid per 10 cm central twig per plant										
		Dose	1DBS	3DAS	PROC	7DAS	PROC	10DAS	PROC	15DAS	PROC	Total yield (kg/ha)	ICBR
1	NSKE	5%	18.76 (4.38)	16.36 (4.10)	90.22	14.70 (3.89)	91.47	11.63 (3.48)	93.89	9.60 (3.17)	95.44	1683	1:6.56
2	*Neem* leaf extract	5%	38.60 (6.25)	24.63 (5.01)	85.28	21.66 (4.70)	87.43	16.46 (4.11)	91.36	13.90 (3.79)	93.40	1508	1:5.61
3	*Neem* oil	2%	28.50 (5.38)	23.20 (4.86)	86.14	20.53 (4.58)	88.09	13.60 (3.75)	92.86	12.30 (3.57)	94.16	1595	1:5.74
4	Eucalyptus leaf extract	5%	43.40 (6.62)	32.50 (5.74)	80.58	30.63 (5.57)	82.23	26.60 (5.20)	86.04	23.66 (4.91)	88.77	1191	1:4.96
5	Fennel seed extract	5%	36.46 (6.08)	34.50 (5.91)	79.39	32.53 (5.74)	81.13	29.56 (5.48)	84.49	25.56 (5.10)	87.87	1120	1:2.71
6	Dimethoate 30 EC	1ml/lit	12.46 (3.60)	10.70 (3.37)	93.60	6.33 (2.60)	96.32	4.36 (2.20)	97.71	2.33 (1.68)	98.89	1762	1:25.81
7	Thiamethoxam 25WG	0.2 g/lit	11.80 (3.50)	9.60 (3.17)	94.26	4.86 (2.31)	97.18	3.16 (1.91)	98.34	1.23 (1.31)	99.41	1873	1:40.63
8	Control		158.53 (12.61)	167.43 (12.95)		172.40 (13.14)		190.63 (13.82)		210.73 (14.53)		674	
	SE(m) ±		0.316	0.154		0.187		0.228		0.251			
	C.D at 5%		0.966	0.470		0.572		0.698		0.770			

Pre-treatment :1 Day before spray (DBS); Post-treatment: days after spray (DAS); Figure within parentheses is square root (√X+.5) PROC: Per cent over control

The highest net income was realized when Thiamethoxam 25 WG @ 0.2 g/lit followed by its second spray after 15 days (Rs 54414/ha) followed by Dimethoate 30 EC @ 1 ml/lit and NSKE @ 5 % (Rs 48705/ha and 40714/ha) followed by its second spray after 15 days, The lowest net income was obtained Fennel seed extract @ 5 %followed by its second spray after 15 days (Rs 15160/ha).

Based on Incremental Cost Benefit Ratio as shown Table 2 to Thiamethoxam 25 WG @ 0.2 g/lit followed by its second spray after 15 days was found most economical as it gave the maximum benefit (40.63) which was very much comperable to the remaining treatments. The next effective treatment was Dimethoate 30 EC @ 1 ml/lit and NSKE @ 5 % (25.81 and 6.56) followed by its second spray after 15 days:

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Effect of micronutrients and bio-fertilizers on growth, yield and quality of *kharif* Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was carried out during rainy season-2021 at Experimental farm, Oilseeds Research Station, Latur, to evaluate the effect of zinc and bio-fertilizers on growth, yield and quality parameters of *kharif* groundnut (*Arachis hypogaea* L.) variety LGN-1. Application of RDF (25:50:00 NPK kg/ha) + $ZnSO_4$ @ 20 kg/ha + *Rhizobium* @ 250ml/10 kg of seed + PSB @ 250ml/10 kg of seed (T_7) produced higher growth, yield and quality traits along with good net returns and B:C ratio.

Keywords: Phosphate solubilizing bacteria, Rhizobium, Zinc sulphate and Groundnut

Groundnut is an important oilseed crop in India which occupies first position in terms of area and second position in terms of production. Most of the soils of Maharashtra are black soils which are deficient in nitrogen, phosphorus, organic carbon and other micronutrients. Among micronutrients zinc is considered as a fourth most limiting nutrient and zinc deficiency is the most seen micronutrient deficiency in groundnut. Yield losses due to zinc deficiency to the extent of 15.5% (Singh, 2001). Zinc catalyses the oxidation process in plant cells and is essential for the transformation of carbohydrates, regulating sugar consumption, increasing the supply of energy for chlorophyll production and assisting in the formation of auxin. It has been claimed that natural soil rhizobial populations are insufficient and ineffectual in biological nitrogen fixation. Seed inoculation of legumes with an effective rhizobial strain is required to ensure an optimal rhizobial population in the rhizosphere. This aids in improving nodulation, N_2 fixation, and leguminous crop development and yield (Henzell. 1988). Though phosphorus supplied by fertilizers it is unavailable to crop plants due to phosphorus fixation in soils. To reduce this phosphorus solubilizing organisms like PSB is utilized which increases phosphorus absorption. The use of PSB as inoculants simultaneously increases the P availability to plants and hence, increase symbiotic nitrogen fixation (Wani *et al*. 2007). Under rainfed conditions, the ability of symbiotic N-fixation and PSB inoculation along with zinc fertilization may provide a chance to improve soil nitrogen status, phosphorus avalibility and crop yield. Thus realizing the importance of bio-fertilizers and their interaction with micronutrients a research entitled effect of micronutrients and and bio-fertilizers on growth, yield and quality of *kharif* groundnut (*Arachis hypogaea* L.) was conducted.

MATERIALS AND METHODS

The present study was conducted on experimental farm Agronomy section, Oilseeds Research Station, Latur during rainy season of 2021. The experiment was conducted on black clayey soil which was low in nitrogen (231 kg/ha), very low in phosphorus (8.55 kg/ha) and very high in potassium (580.89 kg/ha) which was located between $18^0$05' North to $18^0$75' North latitude and $76^0$25' East to 77^0 25' East longitude with subtropical climate. The experiment was laid out in randomized block design (RBD) with three replications and seven treatments. Rhizobium and PSB are applied through seed treatment and zinc sulphate as soil application. The treatments were **T_1** : Control (Absolute), **T_2 :** RDF (25:50:00 NPK kg/ha), **T_3 :** RDF (25:50:00 NPK kg/ha) + *Rhizobium* @ 250 ml/10 kg of seed + PSB @ 250 ml/10 kg of seed, **T_4 :** RDF (25:50:00 NPK kg/ha) + $ZnSO_4$ @ 20 kg/ha, **T_5 :** RDF (25:50:00 NPK kg/ha) + $ZnSO_4$ @ 20 kg/ha + *Rhizobium* @ 250ml/10 kg of seed, **T_6 :** RDF (25:50:00 NPK kg/ha) + $ZnSO_4$ @ 20 kg/ha + PSB @ 250ml/10 kg of seed, **T_7 :** RDF (25:50:00 NPK kg/ha) + $ZnSO_4$ @ 20 kg/ha + *Rhizobium* @ 250ml/10 kg of seed + PSB @ 250ml/10 kg of seed**.** Growth observations were taken from 5 randomly selected plants from each net plot. Yield observations like pod yield and kernel yield are taken from each net plot are taken in yield/plot and convert them to yield /hectare. The observations are statistically tested by "Analysis of variance method" (Panse and Sukhatme, 1967) at 5% level of significance.

RESULTS AND DISCUSSION

There was a continuous increase in plant height and number of branches of groundnut observed up to 90 DAS and remained constant up to harvest. The number of nodules, number of leaves/plant and leaf area/plant increased up to 90 DAS and decreased thereafter. The dry matter increased gradually up to harvest. The beneficial effect of bio-fertlizers and micronutrients on plant height (51.87 cm), number of branches (6.13), number of leaves (57.37), number of root nodules/plant (57.37), dry matter (43.3g) and leaf area (21.53 dm^2) of groundnut were noticeable during active growth period and maturity. Application of $ZnSO_4$ + *Rhizobium* + PSB (T_7) recorded maximum values for all the above mentioned attributes which was statistically at par with *Rhizobium* + PSB (T_3), $ZnSO_4$ + *Rhizobium* (T_5) and $ZnSO_4$ + PSB (T_6). The lowest values were recorded by T_1 i.e control. The maximum growth rates *viz.,* Absolute Growth Rate (AGR) for height and dry matter and Relative Growth Rate (RGR) was found with application of $ZnSO_4$ + *Rhizobium* + PSB (T_7) and lowest with control (T_1). Mean Absolute Growth Rate (AGR) for height and Relative Growth Rate (RGR) for dry matter was found highest at 31-60 DAS compared to other growth stages. Absolute Growth Rate (AGR) for Dry matter was found maximum at 61-90 DAS compared to other growth stages. Mean LAI was found maximum at 90 DAS compared to other growth stages. Application of $ZnSO_4$ + *Rhizobium* + PSB (T_7) recorded maximum values for all the yield attributes like pod yield (2916 kg/ha) and quality attributes like oil content (50.86%) and oil yield (1060.9 kg/ha). The lowest values were recorded by T_1 i.e control. Significantly higher GMR (Rs. 165365.3/ha), NMR (Rs. 108125.3/ha) and B:C ratio (2.89) was obtained with $ZnSO_4$ + *Rhizobium* + PSB (T_7) and it was at par with *Rhizobium* + PSB (T_3) and $ZnSO_4$ + *Rhizobium* (T_5).

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Table 1. Effect of Micronutrients and Bio-fertilizers on Growth, Yield and Quality of *Kharif* Groundnut

Tr	No. of Branches/plant at harvest	No. of nodules/plant at 90DAS	Leaf area (dm^2) 90DAS	Dry matter (g/plant) at harvest	Pod yield (kg/ha)	HI%	Seed Index (g)	Oil content (%)	Oil yield (kg/ha)	B:C ratio
T_1	4.33	62.33	16.62	19.23	1523.5	30.1	34.17	49.77	505.84	1.7
T_2	4.80	70.47	18.46	24.50	2256.8	33.23	35.17	50.05	770.06	2.39
T_3	5.80	104.50	21.47	40.20	2801.8	36.48	36.67	50.56	1004.2	2.86
T_4	4.93	78.37	18.79	28.20	2375.3	33.64	35.33	50.26	824.9	2.43
T_5	5.60	101.47	20.9	35.80	2655.6	35.13	36.33	50.37	931.76	2.67
T_6	5.49	86.80	19.66	31.90	2529.3	34.49	36.00	50.55	884.9	2.55
T_7	6.13	111.17	21.53	43.30	2916.5	37.05	37.67	50.86	1060.9	2.89
SE ±	0.22	3.70	1.1	2.64	124.56	2.13	0.82	0.1	46.63	-
CD@5%	0.65	10.91	2.95	7.78	367.46	NS	NS	NS	137.55	-
CV@5%	7.19	7.41	8.83	14.33	8.87	NS	NS	NS	9.44	-

Boosting linseed (*Linum usitatissimum* L.) production through application of micronutrients in North Western Himalaya

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ABSTRACT

In acidic soils, for getting significantly higher yield of linseed with highest monitory returns, soil application of Zn SO_4 @ 25 kg / ha+ foliar application of Zn SO_4 @ 0.5 % at 45 DAS should be done. However, the other best options in this regard were soil application of zinc @ 25 kg Zn SO_4 / ha + Borax @ 1.5 kg/ha and soil application of Zn SO_4 @ 25 kg / ha followed by foliar application of Zn SO_4 @ 0.5 % + Borax @ 0.3 % at 45 DAS.

Keywords: Linseed, Micronutrients, North Western Himalaya

Linseed (*Linum usitatissimum* L.) is a potential source of food, feed and fibre and is widely adapted to temperate climates of the world. Introduction of high yielding varieties, improved cropping intensity, applications of zinc and boron free fertilizers and limited use of organic manures have led to zinc and boron deficiency in most parts of India. Micro-nutrients are defined substances which are crucial for crop growth and development. In the absence of micronutrients especially zinc and boron, plants show physiological disorders which eventually lead to low crop yield and poor quality. Therefore, keeping these points in view, an experiment was conducted to study the effect of zinc and boron application on yield and economics of linseed production.

MATERIALS AND METHODS

A field experiment consisting of nine treatments (mentioned in Table-1) was conducted in RBD with three replications during *rabi* season of 2019-20 at CSKHPKV, Palampur. All the plots received recommended dose of fertilizer (50:40:20 kg NPK/ha). The soil of the experimental site was silty clay loam in texture with pH of 5.8 and organic carbon of 0.50 per cent. The available N, P_2O_5, and K_2O were 278, 38.5 and 188 kg/ ha, respectively whereas available zinc and boron were 1 ppm and 0.9 ppm, respectively in soil. The economics of the respective treatments were calculated based on the prevailing price of inputs and outputs. The data were recorded on yield and has been presented here.

RESULTS AND DISCUSSION

Significantly higher seed yield (1520 kg/ha) and maximum net returns (Rs. 40400/ha) were obtained with the soil application of $ZnSO_4$ @ 25 kg/ha + foliar application of $ZnSO_4$ @ 0.5 % at 45 DAS. However, soil application of $ZnSO_4$ @ 25 kg/ha + borax @1.5 kg/ha, soil application of $ZnSO_4$ @ 25 kg/ha and foliar application of $ZnSO_4$ @ 0.5 % + borax @ 0.3% at 45 DAS also behaved statistically similar to it for recording higher seed yield and for higher net returns. The per cent increase in seed yield was recorded with the soil application of $ZnSO_4$ @ 25 kg/ha + foliar application of $ZnSO_4$ @ 0.5 % at 45 DAS in the seed yield was 17.73% with additional net returns of Rs. 6680 per hectare over control. Application of zinc might have helped in enzyme activation and biosynthesis of auxin hormone, carbohydrate synthesis and cell elongation, while boron application could have enhanced the pollen tube germination, fertilization, increased root growth and protein synthesis. The results are in close conformity with the findings of Guggari et al. (1995.), Chaudry *et* al. (2007), Raghavendra *et* al. 2020.

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Table 1 Effect of zinc and boron micronutrients applications on seed yield and economics of linseed under limited irrigation

Treatment	Seed yield (kg/ha)	Gross return (Rs/ha)	Net returns (Rs/ha)
T_1-Control	1291	51640	33720
T_2-Soil application of Zn SO_4 @ 25 kg/ha	1485	59413	39713
T_3-Foliar application of Zn SO_4 @ 0.5 % at 45 DAS	1417	56693	37981
T_4-Soil application of Zn SO_4 @ 25 kg/ha+ Foliar application of Zn SO_4 @ 0.5 % at 45 DAS	1520	60800	40400
T_5 -Soil application of Borax @ 1.5 kg/ha	1370	54813	36473
T_6- Foliar application of Borax @ 0.3 % at 45 DAS	1352	54067	35447
T_7-Soil application of Borax @ 1.5kg/ha + Foliar application of Borax @ 0.3 % at 45 DAS	1396	55840	37000
T_8- Foliar application of Zn SO_4 @ 0.5 % at 45 DAS + Borax @ 0.3 % at 45 DAS	1452	58067	38947
T_9-Soil application of $ZnSO_4$ @ 25 kg/ha + Borax @ 1.5 kg/ha	1507	60293	40243
CD at 5%	98.06	-	-

Induced systemic resistance against *Alternaria sesami*, causing blight of sesame and its toxin characterization

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ABSTRACT

Different resistance inducing chemicals were tested for inhibition of growth and induction of resistance against blight in sesame. Among them, salicylic acid (10 mM) was effective in inhibiting the mycelial growth of A. sesami (68.8%) that causes the blight disease of sesame. The resistance inducing chemicals, plant extracts and bioagents tested *in vivo*, with challenge inoculation of *A. sesami*, salicylic acid at one per cent concentration was found to be effective in suppressing the pathogen and resulted in higher vigor index (1138.28) followed *by P. fluorescens* with good germination per cent of 97.35 and vigor index of 1029.85. The higher vigor index obtained in these treatments might be due to their support for increased germination, good root and shoot growth. Further, the pathogen produces toxic metabolite in culture, the crude toxin was extracted and analysed through infra-red analysis, the peak indicated that the compound may contain more than two OH groups and its assay on seeds and seedling of sesame and tomato showed least germination, shoot and root length and necrotic symptoms respectively.

Keywords: *Alternaria sesami*, Bioagents, Salicylic acid, Sesame and vigour index

Leaf blight of sesame, caused by *Alternaria* spp. (*Alternaria sesami Kawamura* and *Alternaria alternata* Fr Keissler), is an important foliar disease causes yield reduction up to 28.9 % (Naik *et al*., 2004)). The non toxic chemicals and bioagents are known to act as elicitor for plant defense reaction leading to induced systemic broad spectrum resistance. Further, *Alternaria* spp. are known to produce a variety of toxins even though they are not required for their normal growth and reproduction. Many non specific toxins have been studied in detail. Hence, an attempt was made to study the induced systemic resistance and toxin characterization.

MATERIALS AND METHODS

Resistance inducing chemicals such as salicylic acid, sodium nitrate, mannitol, potassium nitrate, sucrose, potassium dihydrogen phosphate, and magnesium sulphate were evaluated on the mycelial growth of A. sesame under *in vitro* by dual culture method. Three replications were maintained for each treatment. The diameter of the colony was measured in two directions and average was recorded and the per cent inhibition of growth was calculated by using the formula given by Vincent (1947). The seeds of E8 sesame variety were soaked in the bioagents such as *Pseudomonas flourescens* (5%), *Bacillus subtilis* (5%), leaf extract of *Occimum* spp., and *Prosopis julifera* (10%) and resistance inducing chemicals, salicylic acid and magnesium sulphate (1%) for 4 hours followed by 30 min shade drying. Further, inoculated with spore suspension ((1 X 10^6 spores/ml) of *A. sesami*. Seeds treated with fungus alone and distilled water served as control. The seed germination and seedling vigor were recounted after nine days of sowing and calculated by using the formula given by Abdulbaki and Anderson (1976). The pure culture of *A. sesami* obtained from sesame cultivar E8 was cultured on Czapeck's agar medium. Nine days old culture is transferred to Czapecks broth in conical flasks incubated at 27 ± 10 C for 11 days. Later culture medium was filtered using Whatman No. 42 filter paper. The toxin was extracted from culture filtrates using water saturated butanol (Bhaskaran and Kandaswamy, 1978). The purified toxin was subjected to infra-red analysis to confirm the chemical nature of compound. The toxin thus obtained was assayed on sesame and tomato seeds and seedlings at different concentration of 2000, 1000, 500, 250, 100 and 50 ppm. Thirty seeds of sesame was soaked for an hour in toxin and spread on moist blotter paper. Observation on seed germination, shoot and root length was recorded. Further, different concentration of toxin was tested on 25 days sesame and tomato seedling and its effect was recorded after 24 hrs exhibiting necrosis, chlorosis, epinasty and drooping symptoms.

RESULTS AND DISCUSSION

Salicylic acid (10 mM) was found to be significant in inhibiting the mycelial growth of *A. sesami* (68.18%) over rest of the resistance inducing chemicals. Sodium nitrate inhibited the growth of *A. sesami* to an extent of 67.10 per cent, which was on par with mannitol, showed the mycelial inhibition of 66.67 per cent. The least inhibition of mycelial growth was observed in potassium nitrate with an inhibition per cent of 55.81 per cent. The resistance inducing chemicals, plant extracts and bioagents when tested *in vivo,* with challenge inoculation of *A. sesami*, salicylic acid at one per cent concentration was found to be effective in suppressing the pathogen and resulted in higher vigor index (1138.28), which was followed by *P. fluorescens* (E) with good germination per cent of 97.35 and vigor index of 1029.85. The higher vigor index was obtained in these treatments is mainly due to their support for increased germination, good root and shoot growth by eliciting the resistance in host system by ISR molecules. The toxins play a vital role in the pathogenicity of *Alternaria sesami*, the incitant of leaf blight of sesame, where the culture filtrate produces toxic metabolite. The *in vivo* evaluation of toxin on host produced necrotic symptoms on sesame and tomato seedlings at various concentrations. The maximum inhibition of seed germination and shoot and root length was noticed at 2000 ppm concentration. Least inhibition of root and shoot length was observed at 50 ppm concentration. The infra red analysis of the toxin indicated lot of hydrogen bounded OH group. The nature of the peak indicates that the compound may contain more than two OH groups. The different concentrations of purified toxin were used for bioassay on sesame and tomato seed germination, root and shoot length elongation and induction of necrotic symptoms on sesame and tomato seedlings. The results revealed that, the maximum inhibition of seed germination (64.25 %) of sesame, shoot length (64.78 %) and root length (62.97 %) was noticed at 2000 ppm concentration. In bioassay of tomato seeds the inhibition of tomato seed germination (82.21 %), shoot length (83.2 %) and root length (67.62 %) was observed and which was much higher, indicating much more sensitivity of tomato to toxin than sesame

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Regenerative agriculture through indigenous practice of using remains of livestock feed residues as a manure to boost groundnut productivity

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ABSTRACT

Cow represents Mother Earth, as it is a source of goodness, its milk nourishes all creatures and dung is store house of millions of microorganisms' acts as source of organic manure and her urine aids in decomposition of crop residues. It's in practice for millennium but recently due to introduction of chemical fertilizer found to be disappearing in the farming community coupled with reduction in the livestock population. Application of manure prepared from livestock feed for four years resulted in mean groundnut pod yield of 1665 kg/ha as against application of FYM i.e., 1108 and control 818 kg/ha.

Keywords: Groundnut, Livestock feed residue, Regenerative agriculture

Review depicts that application of manure prepared from livestock feed resulted in improvement of crop yield in many crops. Low rainfall regions are exhibiting reduced yields as well as declined soil productivity. Furthermore, the cost of production using external inputs is constantly raising making farming uneconomical in most of the situations. The basic challenge is to make better use of available biophysical and human resources, which can be done by minimizing the use of external inputs and by utilizing and regenerating internal resources more effectively.

MATERIALS AND METHODS

The study conducted on farmer's field (c.f. table 1). Preparation of valuable manure from remains of livestock feed spread on the floor of the domestic live stock is one such indigenous practice followed by farmers of northern Karnataka. The Practice involves spreading remains of livestock feed under the livestock as bedding in the livestock shed generating farm residue manure. After the farm residue becomes soaked with livestock urine and mixed with dung (1-2 days), it is removed and heaped. With the onset of the rains, manure from the heap is spread in the fields just before preparatory cultivation. The farmers have been following this practice for several decades. In sheds where bullocks are housed, the material is left on the floor for only one day as bullocks trample more, while in the sheds housing cows and buffaloes, the material is changed every alternate day. Crop residues keep the floor of the shed dry leading to better hygienic conditions. After 1 or 2 days, the material is removed and heaped and allowed to decompose for 2-2.5 months. Decomposition is quicker due to the presence of moisture in the form of livestock urine. The quantity of crop residue prepared depends on the quantity of residue used and the number of animals.

RESULTS AND DISCUSSION

The analysis indicated that the crop residues of this region is combination of groundnut, soybean, wheat and chickpea crop residues and have the composition of 1.28% nitrogen, 0.12% P_20_5 and 0.66% K_20 with carbon of 34%. Livestock urine contains about 1.00% Nitrogen traces of P_20_5, and 1.0% of K_20 and approximately 2200 litres of urine are produced per year per animal. If this urine were not conserved, nitrogen in the urine, which is mainly in the form of urea, would be quickly lost as ammonia. If the whole quantity of urine is conserved through this method, about 20 kg nitrogen and 20 kg K_20 can be saved per year per animal. In addition to this, each animal produces 5-7 tonnes of dung containing 0.2-0.35% N, 0.1-0.15% P_20_5 and 0.2-0.3% K_20 nutrients. Therefore, the farmers through this indigenous practice can effectively utilize the renewable resources of dung and urine along with the large quantities of crop residues. Soils from the practicing farmers' fields over four year when analysed showed improvement in the available nitrogen, phosphorus and potassium when applied continuously for four years, increasing the pod yields by 547 and 847 kg/ha when compared to use of FYM and control, respectively. Through this method of bedding the cattle shed with agricultural residues, an effort was made to recycle at least a part of the dry matter harvested from the field. Since the farmer can carry out this practice routinely, he/she never feels an additional burden. Further, the farmers realize the importance of organic manures to the soil. Indigenous Knowledge, while it springs from local resources, local people and is used for solving local problems, can with refinement and adaptation, become global knowledge. The principle in this documented practice can be adopted in any growing regions.

Table 1. Nutritional status of different soils collected from village and groundnut yield at end of 4 years (No. of farmers: 5)

Source of soil samples	Organic carbon (%)	Available N (Kg/ha)	Available P_2O_5 (Kg/ha)	Available Potassium (Kg/ha)	Groundnut pod yield (Kg ha^{-1})
Untreated					
1st year(2018)	0.30	220	14.2	245	960
2nd year(2019)	0.28	215	14.0	240	840
3rd year(2020)	0.28	218	13.8	241	750
4th year(2021)	0.25	210	14.0	249	720
Mean	**0.28**	**216**	**14.0**	**244**	**818**
Use of Manure of Remains of livestock feed @ 7.5 ta/ha					
1st year(2018)	0.43	385	16.9	285	1500
2nd year(2019)	0.47	393	17.8	291	1620
3rd year(2020)	0.48	410	19.3	310	1740
4th year(2021)	0.51	429	21.2	315	1800
Mean	**0.47**	**404**	**18.8**	**300**	**1665**
Use of FYM @ 7.5 ta/ha					
1st year(2018)	0.35	282	14.5	251	990
2nd year(2019)	0.38	291	14.9	259	1050
3rd year(2020)	0.41	296	15.4	263	1180
4th year(2021)	0.42	299	16.2	266	1210
Mean	**0.39**	**292**	**15.3**	**260**	**1108**
Nutrient composition of different materials used in the experimentation (No. of farmers: 5)					
Material			**N%**	**P%**	**K%**
Remains of livestock feed			1.28	0.12	0.66
Manure of Remains of livestock feed			1.84	0.25	0.72
FYM			0.72	0.21	0.38

Evaluation of Castor parental lines for root growth (Poly Bags)

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ABSTRACT

Twelve castor parental lines were grown in poly bags to see the root and shoot growth till 90 DAS during *kharif*, 2020 in CRBD with 4 replications and 3 plants per replication. Total dry matter (TDM) showed strong positive correlation (>0.70) with all shoot and root traits. Among the studied parental lines, IPC-41, IPC-43, DPC-22 recorded good crop growth (stem girth, root length, root volume), root, stem dry weight and total dry matter (TDM).

Keywords: Castor, Parental lines, Root growth

Castor, a non-edible oilseed crop is grown in less fertile alfisols without supplemental irrigation as rainfed crop in southern India. Roots are the essential plant organ for nutrient and water uptake associated with drought avoidance. Improving root traits help in improving crop productivity. Hence, an experiment was conducted with important parental lines to identify best root parents for use in breeding programs.

MATERIAL AND METHODS

Twelve parental lines were grown in poly bags to see the root and shoot growth during *kharif*, 2020 in CRBD with 4 replications and 3 plants per replication till 90 DAS. Data on plant growth, root traits and TDM were recorded.

RESULTS AND DISCUSSION

TDM showed strong positive correlation (>0.70) with all shoot and root traits. Plant height is more in IPC-43 (130.7 cm) which is on par with IPC-46, ICS-164. Node number of DPC-25 is high (21) followed by ICS-164, IPC-43, IPC-40 and were on par. Stem girth is more and on par in IPC-43, IPC-41, DPC-22, DPC-25, ICS-164. Secondary branch production is seen in all genotypes at 90 DAS. IPC-41 recorded long tap root (121 cm) which is on par with IPC-43, IPC-46 and DPC-22. Higher root volume of 302 cm^3 is recorded in IPC-41 and is on par with IPC-43, DPC-22 and DPC-25. IPC-43 recorded more root dry weight (53.5 g/pl.) which is on par with IPC-41 and DPC-22. Highest TDM is recorded with IPC-43 (197.3 g/pl.) and on par with IPC-41 (185g/pl.) and DPC-22

(196.5g/pl.). IPC-41, IPC-43, DPC-22 recorded good crop growth (stem girth, root length, root volume), root dry weight and TDM. As the root traits have been claimed to be critical for increasing yield under soil-related stresses (Lynch, 2007) and genotypes with good root growth and WUE traits performed better and had positive effect on seed yield through improved transpiration even under moisture stress in crops like groundnut (Wright *et al*., 1991), these selected parental lines can be used for breeding rainfed/drought tolerant hybrids.

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Table 1: Growth of studied genotypes in poly bags at 90 DAS

Genotype	plant height (cm)	Node no.	Stem girth (mm)	Root length (cm)	Root Volume (ml)	Root dry weight (g/pl.)	TDM (g/pl.)
IPC-31	56.8	15	7.50	95.0	201.5	34.0	122.3
IPC-40	59.4	17	7.50	95.0	186.8	30.8	115.5
IPC-41	100.6	14	8.50	121.0	301.8	49.0	185.0
IPC-42	58.0	13	7.50	94.0	181.0	33.5	121.0
IPC-43	130.7	17	9.00	114.3	283.5	53.5	197.3
IPC-44	44.4	8	8.00	109.3	184.3	29.8	142.3
IPC-46	126.4	16	8.25	115.8	293.0	46.0	164.3
DPC-15	29.3	8	7.50	89.0	100.0	17.0	105.5
DPC-22	100.5	14	8.50	117.0	257.5	52.0	196.5
DPC-25	81.4	21	8.75	108.5	250.3	36.3	123.0
ICS-164	120.4	18	8.50	97.8	182.0	35.0	155.3
ICS-299	93.4	14	7.25	109.8	217.5	39.5	144.8
mean	83.4	14.4	8.06	105.5	219.9	38.0	147.7
SEm±	3.83	4.5	0.28	5.86	23.44	2.28	8.11
CD (0.05)	11.3	13.2	0.83	17.3	69.4	6.73	24.01
CV (%)	9.18	6.5	6.93	11.10	21.32	11.97	10.98

Host range study of powdery mildew disease of sunflower under glass house conditions

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ABSTRACT

The Host range study of powdery mildew disease of sunflower experiment was undertaken in glass house conditions during *Rabi* 2017-18 and 2018-19 at MARS, Raichur. The powdery mildew conidia were inoculated on 10 different hosts viz, Green gram, Black gram, Pea, Horse gram, French bean, Cluster bean, Mothbean, Cowpea, Tomato and Chilli. Among 10 cultivated crops the pathogen found to infecting on 4 different hosts such as Greengram, Blackgram, Cluster bean and French bean. Hence these 4 hosts can be considered as collateral hosts. In absence of sunflower, pathogen can survive in these four hosts and can act as primary source of inoculum whenever the crop is grown.

Keywords: Host range study, Powdery mildew, Sunflower

Sunflower crop is suffering from many diseases like leaf spot, blight, downy mildew, charcoal rot, sclerotium rot or wilt, rhizopus head rot, sunflower necrosis virus, cucumber mosaic virus and root knot nematode (Saharan *et al*., 2005). Recently, the powdery mildew caused by *Golovinomyces cichoracearum* (DC.) (Formerly known as *Erysiphe cichoracearum*) is becoming major problem in sunflower growing regions in India especially during rabi season. The pathogen may be host specific or may cause diseases on other crops. The host range studies of any pathogen will help in taking suitable management strategies during the off season and to avoid them during the cropping season. In view of it studies were under taken at MARS, UAS, Raichur during *Rabi* 2017-18 and 2018-19 to assess the host range of powdery mildew disease.

MATERIAL AND METHODS

Under glass house condition: To find out the host range of powdery mildew other than sunflower, some of the cultivated crops such as, Green gram, Black gram, Pea, Horse gram, French bean, Cluster bean, Mothbean, Cowpea, Tomato and Chilli were raised in earthen pots in poly house. The surface sterilized seeds of selected crops were sown in the pot mixture containing sand: soil: FYM (3:1:1) with three replications. In each pot five seedlings were retained and suitable un-inoculated control pots were also maintained and 30 days old seedlings were inoculated with powdery mildew pathogen. The powdery mildew infected leaves are collected from field and using camel hair brush powdery mass is discharged into 1% sucrose solution. This conidial suspension in 1% sucrose was sprayed on all cultivated crops. Observations for disease symptoms were recorded at five days interval for up to 27 days of post inoculation and powdery mildew severity was measured by using 0-9 scale given by Mayee and Datar (1986).

Percent Disease Index: The per cent disease index (PDI) was calculated by using the formula given by Wheeler (1969).

$$\text{PDI (\%)} = \frac{\text{Summation of all numerical ratings}}{\text{Total number of plants x maximum rating scale observed}} \text{x } 100$$

RESULTS AND DISCUSSION

The results revealed that the powdery mildew pathogen found to be able to infect on 4 different hosts such as Greengram, Blackgram, Cluster bean and French bean. Hence these 4 hosts can be considered as collateral hosts. Similarly, Whipps et al. (1998) screened species and cultivars of plants from 26 families and observed that 13 families contained species that were susceptible to *E. orontii* and that the disease reaction differed among cultivars of the same species. They also demonstrated the cross-infectivity of *E. orontii* onto other plant species. Smith et al. (1997) reported that tomato (15 cultivars), nightshade, eggplant and tobacco were susceptible to an Erysiphe sp. found on tomato in Connecticut.

Therefore, based on the host range studies, it was concluded that powdery mildew pathogen of sunflower infect Greengram, Blackgram, Cluster bean and French bean only under controlled and favourable conditions and these hosts can be considered as alternate hosts.

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Impact of Frontline Demonstrations on yield of soybean under rainfed condition in Marathwada region of Maharashtra

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ABSTRACT

The frontline demonstrations of soybean were conducted by AICRP on soybean, VNMKV, Parbhani during the *kharif* season 2019-20 under the guidance of IISR, Indore by adopting new cultivars of Soybean *viz.*, MAUS 162, MAUS 158 and MAUS 612 along with applying improved package of practice verses farmers practice in soybean cultivation. The productivity and economic returns of soybean in improved technologies (IT) were calculated and compared with the farmer's practices (FP). Findings of this experiment indicated that different cultivars of soybean recorded higher gross returns, net return and benefit cost ratio in improved technologies as compared to the plots where farmers using traditional practices in their cultivation. The average soybean yield in FLD plot was 24.30 per cent (Range: 23.52 to 25.22 %) higher than the framers practice field. It is suggested that location-specific improved production technology with improved variety would be needed to bridge the productivity gap of soybean in Marathwada region of Maharashtra.

Keywords: Frontline Demonstration (FLD), Improved Technologies, Oilseed crop, Soybean

Soybean (*Glycine max* L.) is a temperate origin crop introduced in India in the late sixties. It has a prominent place among modern agricultural commodities as the world's most important seed legume, and contributes about 25% and 65% to the global edible oil and protein concentrate for livestock feeding, respectively. It is also an important commodity for food manufacturers, Pharma industry and has many other industrial uses. Soybean production in India during 2019-20 was 11.22 million tons from an area of 11.39 million ha. Madhya Pradesh, Maharashtra and Rajasthan were the major states for soybean. Minimum support prices of soybean increased to Rs. 3710 per quintal for the marketing season 2019-20 from Rs 3399 per quintal for season 2018-19 (Director's Report and Summery Tables of Experiments 2020-21).

MATERIAL AND METHODS

Fifty Frontline Demonstrations (FLDs) were conducted during *kharif* 2019-20. The programme was implemented in randomly selected villages *viz.*, Sayala, Wai, Manwat, Pimpalgaon, Shelgaon, Jamb, Wangi, Parbhani, Bori, Zadgaon, Eatoli, Kudala, Thola, Taroda, Balasa, Etalapur and Khujad of Parbhani, Hingoli and Nanded districts in Marathwada region of Maharashtra and the farmers from each village with varied size land holding were selected. The intervention *viz.* use of high yielding varieties, proper seed rate, seed treatment with fungicides and biofetilizers, proper sowing time, suitable sowing method, timely irrigation, weed management, plant protection measures, care during harvesting, threshing and cleaning of seeds were demonstrated at the farmer's field. The yield data were collected from both the demonstration and farmers practice plots by random crop cutting method and analyzed by using simple statistical tools.

RESULTS AND DISCUSSION

The average Soybean yield increased in FLD plot by 24.30 per cent (Range 23.52 to 25.52%) higher in improved technology (IT) than the farmers practice (FP). The higher yield of Soybean in FLD was mainly attributed to the adoption of improved technologies. Improved soybean varieties *viz.*, MAUS 162, MAUS 158 and MAUS 612 are potential yielder.

Economic performance of soybean under frontline demonstration (FLD) is depicted in Table 1. The economic analysis results revealed that the soybean recorded higher gross return from improved cultivars *viz.*, MAUS 162, MAUS 158 and MAUS 612 with improved technology (IT) as compared to farmers practice (FP) for the year 2019-20.

The input and output prices of commodities prevailed during the period of demonstration study were taken for calculating gross return, cost of cultivation, net return and benefit cost ratio (Table 1). The cultivation of soybean with improved technologies gave higher net return that ranged from Rs. 68375/- to Rs. 76426/- as compared to farmer's practices. The benefit cost ratio of soybean in FLD ranged from 2.07 to 2.32 for the improved technology (IT). This may be attributed to the higher seed yields obtained under improved technologies compared to local practice. The finding is in corroboration with the findings of Raj *et al.*, (2014) and Singh (2018).

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Table.1 Economic analysis of frontline demonstrations (FLD) on soybean (2019-20)

S. N.	Variety	Yield (Kg/ha)		Per cent increase over (FP)	Gross Returns (Rs/ha)		Cost of Cultivation (Rs/ha)		Net Returns (Rs/ha)		BC Ratio	
		IT	FP		IT	FP	IT	FP	IT	FP	IT	FP
1	MAUS 162	2019	1626	24.16	74905	60325			42002	28546	2.27	1.89
2	MAUS 158	2060	1645	25.22	76426	61030	32903	31779	43523	29251	2.32	1.92
3	MAUS 612	1843	1492	23.52	68375	55353			35472	23574	2.07	1.74
	Average	1974	1588	24.30	73235	58903	Average		40332	27124	2.22	1.85

IT-Improved Technology, FP-Farmer Practice

Biopriming with *Trichoderma harzianum*: an effective tool for management of soil borne diseases of safflower

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ABSTRACT

An effect of biopriming with *Trichoderma harzianum* on different soil borne diseases of safflower was studied at three consecutive year 2018-19, 2019-20 and 2020-21 using safflower variety safflower variety PBNS-12. Safflower seed biopriming with *Trichoderma harzianum* @ 10g/litre water for 12 hrs (10 gm Thz + 1 ltr water + 1 kg seed + 12 hrs soaking) before sowing was found very effective and economical management of *Phytophthora* seedling blight, *Fusarium* wilt and *Rhizoctonia* root rot diseases of Safflower.

Keywords: Biopriming, Safflower, *Trichoderma harzianum*

Safflower is a major *rabi* oilseeds crop of Maharashtra having area of 0.22 lakh ha which accounts 42 % of the total area in the country with production of 0.15 lakh tones, which accounts 36% of the India's safflower production. The average productivity of the Maharashtra is very low due to constraints like soil borne diseases viz. *Phytophthora* seedling blight, *Fusarium* wilt and *Rhizoctonia* root rot. As biological management of plant diseases is gaining importance, an effort has been made at AlCRP on Safflower, VNMKV, Parbhani for management of these soilborne diseases through biopriming with biocontrol agents.

MATERIAL AND METHODS

A trial consisting of safflower variety PBNS-12 was conducted at research farm, AICRP (Safflower), V.N.M.K.V., Parbhani during *Rabi* season of 2018-19, 2019-20 and 2020-21. In this experiment two biocontrol agents, one combi fungicide were evaluated at different rates as priming of safflower seed against seed/soil borne diseases, consistently for three years. Observations on major seed/soil borne diseases caused by *Fusarium* spp., *Rhizoctonia* spp. *and Phytophthora* spp. were recorded. Gross returns, net returns and benefit: cost ratio was calculated. Data generated was subjected to statistical analysis and results are interpreted.

Table 1. Effect of priming of safflower seeds with biological agents and recommended fungicide on *soil borne* disease incidence of safflower and yield parameters. (Pooled data: 2018-19, 2019-20 and 2020-21)

S. No	Treatments	Fusarium wilt (%)	Rhizoctonia root rot (%)	Phytophthora seedling blight (%)	Seed yield (kg/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B: C ratio
T_1	Seed biopriming with *Trichoderma harzianum* @ 10 g/litre water for 12 hrs	11.03 (19.3)	8.8 (17.2)	2.0 (7.5)	1514	68948	42629	2.54
T_2	Seed biopriming with *Pseudomonas fluorescens* @ 10 g/litre water for 12 hrs	15.66 (23.2)	12.2 (20.1)	2.3 (8.6)	1290	58399	32071	2.14
T_3	Seed treatment with *Trichoderma harzianum* (10 g/kg seed) 1 hr before sowing	12.66 (20.7)	9.0 (17.3)	2.0 (7.5)	1476	67202	40769	2.46
T_4	Seed treatment with *Pseudomonas fluorescens* (10 g/kg seed) 1 hr before sowing	13.66 (21.6)	11.3 (19.5)	3.1 (10.0)	1370	63127	36741	2.31
T_5	Seed priming with only water (hydropriming) for 12 hrs	14.56 (22.3)	11.3 (19.5)	2.2 (8.4)	1169	53475	27089	1.95
T_6	Seed priming with cymoxanil 8% + mancozeb 64% @ 2 g/litre water for 12 hrs	12.23 (20.2)	11.0 (19.0)	1.8 (7.1)	1225	55441	29055	2.02
T7	Seed treatment with cymoxanil 8% + mancozeb 64% (2 g/kg seed) 1 hr before sowing	13.77 (21.7)	15.6 (21.3)	4.5 (12.2)	1113	50754	21556	1.86
T_8	Control (untreated)	23.33 (28.8)	23.5 (28.6)	4.7 (12.4)	934	40791	15122	1.52
	S.Em.±	1.3	1.15	0.4	88.8			
	C.D (p=0.05)	4.12	3.6	1.4	266.4			
	C.V (%)	15.8	16.5	19.7	13.4			

RESULTS AND DISCUSSION

The results on incidence of *Fusarium* wilt, *Phytophthora* seedling blight and *Rhizoctonia* root rot, seed yield and economics of safflower as influenced by priming of safflower seeds with biological agents and recommended fungicide indicated that all the treatments showed significant differences for seed germination, per cent disease incidence and seed yield than untreated control. The seed bio-priming with *Trichoderma harzianum*@ 10 g/litre water for 12 hrs recorded least incidence of *Fusarium* wilt, *Phytophthora* seedling blight and *Rhizoctonia* root rot on three consecutive year followed by the seed treatment with *Trichoderma harzianum* @ 10 g/kg seed 1 hr before sowing. The seed bio-priming with *Trichoderma harzianum* @ 10 g/litre water for 12 hrs before sowing recorded highest seed yield on three consecutive year followed by seed treatment with *Trichoderma harzianum* 1 hr before sowing. Accordingly, two demonstrations (One on farmer's FLD and one on research farm) were conducted for on-farm validation of technology of management of seed/soil borne disease of safflower bybio-priming with *T. harzianum*. The average of two demonstrations indicated that seed bio-priming with *T. harzianum* @ 10g/liter water for 12 hrs and seed treatment with *Trichoderma harzianum* (10g/kg seed) 1 hr. before sowing found most effective with significantly least incidence of seed/soil borne disease as compare to farmers practice. The treatment seed bio-priming with *T. harzianum* @ 10g/litre water for 12 hrs. and seed treatment with *T. harzianum* (10g/kg seed) 1 hr. before sowing recorded highest seed yield, whereas farmer practice recorded low yield. The cost-benefit analysis showed that seed biopriming with *T. harzianum*, Th4d WP @ 10g/litre water for 12 hrs recorded highest net returns of Rs.50550/- and B:C ratio of 3.41 followed by seed treatment with *T. harzianum*, Th4d WP @ 10g/kg seed 1hr before sowing (Rs.44430/-, 3.12) whereas in the farmer's practice least net monetary returns of Rs. 27290/- with a B:C ratio of 2.33 were recorded.

Management of major defoliators of soybean using microbial agents

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ABSTRACT

Field experiment was conducted in *kharif* 2019-20 at AICRP on Soybean, V.N.M.K.V., Parbhani to evaluate the bioefficacy of different biopesticides along with control against major defoliators of soybean. Among the different treatments, after 2nd spray, at 7 DAT, microbial agent *N. rileyi* recorded significantly lowest of 0.58 larvae/mrl and found superior over rest of the microbial agents in reducing the population of semiloopers. However, it was found at par with the microbial agent *B. bassiana* (0.75 larvae/mrl). Next best microbial agents were treatment Bt (0.83 larvae/mrl) and *M. anisopliae* (1.00 larvae/mrl). The microbial agent treatment *N. rileyi* recorded highest of 1281 kg/ha yield. However, it was found at par with microbial agents treatment *B. bassiana* (1141 kg/ha) and Bt (1110 kg/ha).

Keywords: Defoliator, Entomopathogenic fungi, Microbial control, Soybean

Soybean (*Glycine max* L.) is one of the important oilseed crop of the Leguminosae (Fabaceae) family. It contains 20% oil and contributes more than 50% to the global production of edible oil. Soybean contains 40% protein rich in all essential amino acids and vitamins A, B and D. Among the major constraints in economic losses of soybean the different insect pests and diseases are important. Among different insect pests, major losses are due to defoliators which include tobacco leaf eating caterpillar, *Spodoptera litura* (Fab.), green semilooper *Chrysodeixis acuta* (Walker) which feeds on foliage, flower and pods causing significant yield loss. To control these insect pests, number of chemical insecticides are used injudiciously which results in resistance in the insects, pest resurgence, adverse effect on natural enemies and creation of other residual effect on environment. Entomopathogens as biocontrol agents offer good and effective alternative to conventional insecticides.

MATERIAL AND METHODS

Field experiment was conducted in *kharif* 2019-20 in randomized block design (RBD) with four replications. Total four microbial biopesticides *viz., Beauveria bassiana, Metarhizium anisopliae, Nomuraea rileyi* and *Bacillus thuringiensis* (Bt) commercial along with control were tested against major defoliators of soybean crop. Insect pest susceptible soybean variety MAUS 2 was sawn at 45 cm X 5 cm spacing with plot size was 2.70 m x 3m (6 rows of 3m length each). When the incidence of defoliators was more two sprayings were given using knapsack spray. Total numbers of larvae per meter row length from three randomly selected places per replication were recorded at before spray, 3 and 7 days after 1st and 2nd spray.

RESULTS AND DISCUSSION

During *kharif* 2019-20, the overall incidence of semilooper was more. After 1st spray, at 7 DAT, microbial agent treatment T3 i.e. *N. rileyi* recorded lowest of 3.17 larvae/mrl and was found at par with microbial agents treatment T1 i.e. *B. bassiana* (3.58 larvae/mrl) and T4 i.e. Bt (3.75 larvae/mrl). It was followed by bio-pesticide treatment T2 i.e. *M. anisopliae* (4.00 larvae/mrl). Highest semiloopers larvae were observed in untreated control (10.67 larvae/mrl). After 2nd spray, at 7 DAT, microbial agent treatment T3 i.e. *N. rileyi* recorded significantly lowest of 0.58 larvae/mrl and found superior over rest of the microbial agents in reducing the population of semiloopers. However, it was found at par with the microbial agent treatment T1 i.e. *B. bassiana* (0.75 larvae/mrl). Next best microbial agents were treatment T4 i.e. Bt (0.83 larvae/mrl) and T2 i.e. *M. anisopliae* (1.00 larvae/mrl). Highest semilooper larvae i.e. 2.92 larvae/mrl were observed in untreated control. Chaware *et al.* (2019) also reported the superiority of entomopathogenic fungi viz., *M. anisopliae*, *B. bassiana* & *N. rileyi* at different concentrations against green semilooper over control which is in conformation with the result obtained during present investigation.

During *Kharif* 2019-20, the overall incidence of *S. litura* was very less. After 1st spray, at 7 DAT, lowest of 0.17 larvae/mrl were recorded in biopesticide treatment T3 i.e. *N. rileyi*. However, it was found at par with microbial agents *viz.* treatment T1 i.e. *B. bassiana* (0.25 larvae/mrl), T4 i.e. Bt (0.33 larvae/mrl) and T2 i.e. *M. anisopliae* (0.42 larvae/mrl). Highest *Spodoptera* larvae were recorded in untreated control (1.50 larvae/mrl)

After 2nd spray, at 7 DAT, there was higher reduction larval population and no *Spodoptera* larvae were observed in microbial agents treatment T1 i.e. *B. bassiana*, T3 i.e. *N. rileyi* and T4 i.e. Bt, which were found at par with microbial agents treatment T2 i.e. *M. anisopliae* (0.08 larvae/mrl). Highest of 0.42 larvae/mrl were recorded in untreated control. Similar findings of highly effectiveness of entomopathogenic fungi *N. rileyi* against *S. litura* reported by Bade *et al*. (2014) and Swathi *et al*. (2018) which is in agreement with present findings.

According to the yield data obtained it was found that all the microbial agents recorded significantly higher yield than untreated control. The microbial agent treatment T3 i.e. *N. rileyi* recorded highest of 1281 kg/ha yield. However, it was found at par with microbial agents treatment T2 i.e. *B. bassiana* (1141 kg/ha) and T4 i.e. Bt (1110 kg/ha). It was followed by microbial agent treatment T2 i.e. *M. anisopliae* which recorded 1032 kg/ha yield. Untreated control recorded significantly lowest yield of 869 kg/ha.

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Table 1. Effect of microbial agents on population of semiloopers and tobacco leaf eating caterpillar in soybean

T.N.	Treatment details	Semiloopers/mrl			*S. litura*/mrl			Yield kg/ha
		DBT	1st Spray	2nd Spray	DBT	1st Spray	2nd Spray	
			7 DAT	7 DAT		7 DAT	7 DAT	
1	*B. bassiana* @4ml/l	6.92 (2.72)	3.58 (2.02)	0.75 (1.11)	0.67 (1.07)	0.25 (0.86)	0.00 (0.70)	1141
2	*M. anisopliae* @4ml/l	8.08 (2.92)	4.00 (2.11)	1.00 (1.22)	0.83 (1.15)	0.42 (0.95)	0.08 (0.75)	1032
3	*N.rileyi* @4ml/l	7.42 (2.80)	3.17 (1.91)	0.58 (1.03)	0.75 (1.11)	0.17 (0.80)	0.00 (0.70)	1281
4	Bt. @1ml/l	6.83 (2.70)	3.75 (2.05)	0.83 (1.15)	0.58 (1.03)	0.33 (0.90)	0.00 (0.70)	1110
5	Untreated Control	7.33 (2.79)	10.67 (3.34)	2.92 (1.84)	0.83 (1.15)	1.50 (1.41)	0.42 (0.95)	869
	S.E. ±	0.05	0.05	0.04	0.05	0.05	0.03	76.97
	C.D. at 5%	NS	0.15	0.11	NS	0.16	0.09	236.84

Figures in parentheses are $\sqrt{x+0.5}$ transformed values, DBT = Day before treatment,
DAT = Days after treatment, NS = Non significant, mrl = Metre row length

Combining ability analysis for yield and it's contributing characters in Indian mustard

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ABSTRACT

Fifteen F_1 crosses of Indian mustard [*Brassica juncea* (L.) Czern & Coss] obtained by half diallel fashion using six parents (excluding reciprocal) and evaluated along with parents and checks to study the combining ability. The parent NRCHB-101 and Pusa Mustard-31 were recorded as good general combiners for seed yield and it attributing characters. The crosses NRCHB-101 × Pusa Mustard-31 and Pusa Mustard-31 × Kranti both showed significant negative SCA effects for seed yield and most of its contributing characters and also exhibited significant mean for most of yield contributing characters. These crosses can be forwarded to next generation for producing genotypes of inherent superiority by blending and mixing maximum favorable following by simple selection methods.

Keywords: General combining ability, Indian mustard half diallel, Specific Combining ability

Mustard offers good scope for diversification of cropping pattern in *rabi* season in Maharashtra as it requires minimum irrigation and other inputs. Similarly, environmental conditions in are favourable for growing mustard. But considering the low production in Maharashtra as compared to India, there is need of producing high yielding varieties with early maturity and high oil content. Combining ability studies provide useful information for selection of good combiners, which are expected to give high performance in their crosses and progenies. The present study was made with a view to study the combining ability of Indian mustard genotypes and their crosses to identify good combiner for best cross combinations, which can be utilized for selection in succeeding segregating generations for yield and yield attributing traits.

MATERIAL AND METHODS

The present study was undertaken to assess the general and specific combining ability of parents and crosses, respectively and isolate superior parents and crosses for studying them in further generation. The experimental material comprised of six parents of mustard, which were crossed in half diallel mating design excluding reciprocals to secure fifteen F_1's. These 15 crosses along with six parents viz., NRCHB-101, RH-749, Giriraj, RH-406, Pusa Mustard-31 and Kanti (Kranti were used as parent as well as check); whereas checks ACN-9, TAM-108-1 and BIO-902 were planted in randomized block design with three replications during *rabi* 2019-20 at the Research Field of AICRP (Linseed and Mustard), College of Agriculture, Nagpur. The data were recorded for days to first flower, days to maturity, plant height (cm), number of branches plant^{-1}, number of siliquae plant^{-1}, siliquae density on main branch, 1000 seed weight (g), seed yield plant^{-1} (g). The data were subjected to the statistical and biometrical analyses.

RESULTS AND DISCUSSION

The mean squares due to geneotypes were highly significant for all the eight characters studied. The analysis of variance for experimental design revealed significant genetic variability among them which allowed its exploitation of material for further analysis. Analysis of variance for combining ability indicated that mean squares due to both GCA and SCA were highly significant for seed yield and its contributing characters. The mean square due to GCA was higher magnitude than those due to SCA for days to first flower, days to maturity, plant height, number of siliquae plant^{-1} and siliquae density on main branch. The mean squares due to SCA were of higher magnitude than those due to GCA for number of primary branches plant^{-1}, 1000 seed weight and seed yield plant^{-1}. For all the characters studied, the predictability ratio was observed to be more than 0.50, but not closer to unity. This reveals that both GCA effects of parents, well as the SCA effect of crosses, should be considered for selecting the parents or crosses for their exploitation to recover transgressive segregates.

The potentiality of varieties as parents may be judge by comparing *per se* performance of F_1 values involving that parents and GCA. Based on these criteria among the six parents, NRCHB-101 recorded significant positive GCA effect for seed yield plant^{-1}, siliquae density on main branch, number of siliquae plant^{-1}, number of primary branches plant^{-1} and days to maturity and first flower. Same parent also had significant mean performance for siliquae density on main branch and *at par* over the mean for number of siliquae plant^{-1} and number of primary branches plant^{-1}. Similarly, parent Pusa Mustard-31 exhibited high significant GCA effect for seed yield/plant, 1000 seed weight, siliquae density on main branch and number of siliquae plant^{-1}. The parent Pusa Mustard-31 had significant mean performance for 1000 seed weight and *at par* over the mean for siliquae density on main branch. Considering *per se* performance and GCA effects, the parent NRCHB-101 and Pusa Mustard-31 were noted as good general combiners for seed yield and it attributing characters. Yadava *et al.* (2012) and Tele *et al.* (2014) also identified parents based on GCA effect and *per se* performance.

Among fifteen crosses studied, the cross combinations NRCHB-101 × Pusa Mustard-31 and Pusa Mustard-31 × Kranti exhibited significant negative SCA effects for seed yield and most of its contributing characters and also possessed significant mean for most of yield contributing characters. In these crosses involved one parent with highly significant or non-significant positive GCA effect for yield plant^{-1} and some yield contributing characters indicated the predominant role of additive gene action for yield components. So, two crosses namely NRCHB-101 × Pusa Mustard-31 and Pusa Mustard-31 × Kranti were found to be best crosses which can be forwarded to the next generation. Aghao *et al.* (2010) and Tele *et al.* (2014), also identified superior crosses based on SCA and *per se* performance and suggested the suitability of biparental matings in selected progeny and further selection in segregating generation in mustard.

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Table 1. Potential crosses identified on the basis mean performance, GCA effect and SCA effects

Cross	Character	Mean	SCA effects	GCA effects	
				P1	P2
NRCHB-101 × PM-31	Seed yield plant^{-1} (g)	12.37	-1.96**	1.08**	1.06**
	1000 seed weight (g)	5.08	-0.38**	-0.01	0.23**
	Number of siliquae plant^{-1}	352.53	-41.77*	40.04**	18.05**
	Primary branches plant^{-1}	5.40	-0.67**	0.23**	-0.20**
	Plant height (cm)	159.13	-6.75**	-11.33**	-4.83**
PM-31 × Kranti	Seed yield plant^{-1} (g)	12.72	-0.29	1.06**	-0.24
	1000 seed weight (g)	5.19	-0.09*	0.23**	-0.19**
	Number of siliquae plant^{-1}	296.03	-53.14*	18.05**	-5.09
	Primary branches plant^{-1}	5.40	-0.47*	-0.20**	0.03
	Plant height (cm)	154.20	-28.61**	-4.83**	5.61**

** = Significant at 1 % level. *= Significant at 5 % level.

Effect of green manure incorporation on yield of subsequent groundnut crop

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ABSTRACT

Field experiments were carried out during 2019 to 2021 at Oilseeds Research Station, Tindivanam to Study the effect of green manure incorporation on yield of subsequent groundnut crop. The result revealed that higher mean pod yield of (2710 kg/ha) was recorded in the treatment (M_2 S_3) Sunhemp incorporation with 75% RDF application. The pod yield was on par with the green manure crop daincha incorporated with 75 % RDF (M_3S_3). The treatment control recorded the lowest yield.

Keywords: Green manure incorporation-yield of groundnut crop.

Green manure crop cropping systems is the way to maximize the production of oilseeds in sole and sequential cropping systems. green manure crop is advent for sustainable land management, eco-friendly in conjunction with organic fertilizers to immense the potential of supplementing a part of N and other nutrients through efficient mineralization to the associated crops in green manure-based cropping systems (Kang et al. 1981 and Subba Reddy et al. 1991). It has many advantages like increased productivity, better use of available resources viz., land and nutrients

MATERIAL AND METHODS

The field experiment was conducted at Oilseeds Research Station, Tindivanm to Study the effect of green manure incorporation on yield of subsequent groundnut crop. The treatments consisted of Main and Subplots. Main plot treatments viz., M_1- Control (Groundnut), M_2-Sun hemp (incorporated at 45 DAS) followed by Groundnut, M_3-Daincha (incorporation at 45 DAS) followed by Groundnut, Subplot treatments were S_1-Control, S_2-50 % RDF, S_3-75 % RDF, S_4-100 % RDF. The size of the experiment was 4.5 x 5 m^2 and spacing adopted was 30 x 10 cm.The design of the experiment was split plot and randomized in three replications.

RESULTS AND DISCUSSION

The result revealed that higher mean pod yield of (2509 kg/ha) was recorded in the treatment (M_2 S_3) Sunhemp incorporation with 75% RDF application. The pod yield was on par with the green manure crop daincha incorporated with 75 % RDF (M_3S_3). Control recorded (1813kg/ha) the lowest yield. The sustainable groundnut production is possible by incorporation of green manure followed by groundnut crop.

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Table. Pod yield on effect of green manure incorporation on subsequent groundnut crop

Treatments	Pod yield (Kg/ha)				
	S_1	S_2	S_3	S_4	MEAN
M_1	1690	1828	1860	1874	1813
M_2	2150	2590	2710	2588	2509
M_3	2125	2460	2675.00	2535.00	2448
MEAN	1988	2292	2415	2332	
	M		S		M x S
SED	82.31		121.20		206.90
CD	228.55		296.56		450.81
CV	8.93		11.39		11.23

Genome-wide association study of tocopherols (*vitamin E*) in Indian mustard (*Brassica juncea*)

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ABSTRACT

A diverse set of 289 mustard accessions was used to establish variation for α-, γ- and total tocopherols in mustard germplasm. A large variation in our diversity panel for tocopherol isomers and total tocopherols. γ-tocopherols were observed to be more abundant than α-tocopherols in the mustard seeds. This tocopherol variation was used to identify the genetic loci related to tocopherols using GWAS. Various strong candidate genes such as *VTE2-2, SAHH2, PP5.2, PES1, ANT1* etc. involved directly or indirectly in the tocopherol biosynthesis pathway were identified through this method.

Keywords: GWAS, Indian mustard, Tocopherols, UPLC, Vitamin E

Tocopherols (vitamin E) are lipid-soluble micronutrients and have anti-oxidant properties. Rapeseed-mustard oil along with other vegetable oils are major dietary sources of vitamin E. There are four tocopherol isomers present in plants – α, β, γ, and δ-tocopherols, α-tocopherol is the most active form followed by β-tocopherol in humans (Bele et al. 2013). In plants, tyrosine and phytol, through various intermediates, are first converted to δ and γ-tocopherols, respectively which are further methylated to β- and α-tocopherols, respectively (Mène-Saffrané, 2017). Various genes have been identified for tocopherol biosynthesis in model plants and other crops ranging from *VTE1* to *VTE7*. This communication reports genome-wide association study for α-, γ- and total tocopherols in a large mustard diversity panel.

MATERIAL AND METHODS

A diverse set of 289 mustard accessions was used to establish variation for α-, γ- and total tocopherols in mustard germplasm. Two biological replicates each of 289 genotypes for consecutive 2 years were used. Tocopherols were extracted from ~80 mg seeds using heptane and α-tocopherol acetate (25.4 µM) was used as the internal standard. The extract was subjected to UPLC (ultra-high performance liquid chromatography) analysis in Acquity system equipped with a TUV detector using HILIC column in a normal phase application. The mobile phase used were 100% heptane and heptane: dioxane (9:1) in a ratio of 1:1. α-tocopherol acetate, α-tocopherol and γ-tocopherol were sequentially separated at retention times 0.9, 1.2 and 1.8 minutes, respectively at 292 nm wavelength. Tocopherols concentration was expressed in ‘mg/kg’ of seeds. For genome-wide association (GWAS) study, the tocopherol values were transformed to BLUEs (Best Linear Unbiased Estimates) and associations were computed with SNPs (single nucleotide polymorphism). A total of 330,749 SNPs were available for our analysis. GAPIT version 3 and various R packages were used for our analysis. Various algorithms – Blink, MLM, GLM, FarmCPU, MLMM were used and the best model was selected on the basis of quantile-quantile (Q-Q) plots. The association between SNPs and tocopherols were assessed on the basis of $-\log_{10}P$ values.

RESULTS AND DISCUSSION

We reported a large variation in our diversity panel for tocopherol isomers and total tocopherols. γ-tocopherols are observed to be more abundant than α-tocopherols in the mustard seeds. In our diversity panel, α-tocopherol (AT) content varied from 15.03 to 71.38 mg/kg (average 32.92 ± 7.90), γ-tocopherol (GT) levels ranged from 123.15 to 354.97 mg/kg (231.39 ± 38.52) and total tocopherols (TT) amounted to 150.17 to 398.90 mg/kg of seeds (264.31 ± 39.66). The ratio of γ-tocopherols to α-tocopherol (GT: AT) varied from 3.33 to 15.07, with an average value of 8.00 ± 2.06. This tocopherol variation was used to underpin the genetic loci related to tocopherols using GWAS. Various strong candidates such as *VTE2-2, SAHH2, PP5.2, PES1, ANT1* etc. involved directly or indirectly in the tocopherol biosynthesis pathway were identified in our study. These candidates could be used for marker assisted selection after their validation. This work was supported under the SERB DST Project “PDF/2020/002071” under National Post-Doctoral Fellowship Scheme awarded to Harjeevan Kaur.

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Management of sucking pests in castor with newer insecticides

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ABSTRACT

Newer insecticides were evaluated against major sucking pests *viz*., leafhopper and whitefly in a field experiment conducted at Tapioca and Castor Research Station, Yethapur, TNAU for two years (2021, 2022) during rabi season using castor hybrid YRCH 1. The treatments Thiacloprid 21.7 SC@1ml/l and Cyantranilprole 10.26 OD @ml/l were found superior and recorded significant control of leafhopper (2.48 leafhopper /3 leaves/plant) and whitefly population (1.00 /3 leaves/plant) respectively. The treatments Cynantraniliprole 10.26 OD and Thiacloprid 21.7 SC spray resulted in significantly higher seed yield 1568 kg/ha and 1542kg/ha respectively.

Keywords: Castor, Insecticides, Sucking pests

Castor is one of the industrially important non-edible oilseed crop. India is the major castor producing country in the world. Castor crop suffers from the damage of nearly 100 insect pests and among them defoliators and sucking pests are economically important (Basappa and Lingappa, 2001). Chemical pesticides are the important armory in pest management of castor. Newer molecules and formulations offer significant effect in terms of toxicity, pest suppression, safety to non-target organisms. Hence, the present experiment was focused to evaluate the newer insecticides against major sucking pests of castor.

METHODOLOGY

The field trials were conducted during 2021 and 2022 at Tapioca and Castor Research Station, Yethapur, to evaluate the efficacy of newer insecticides with five treatments and four replications in a randomized block design with a plot size of 4.5 m x 6.0 m using the castor hybrid, YRCH-1. The newer insecticides *viz*., Spinetoram 11.70% SC @ 1 ml/l , Thiacloprid 21.70% SC @ 1 ml/l, Cyantraniliprole 10.26% OD @ 1 ml/l and Profenofos 50EC @ 2 ml/l were selected against sucking pests in castor. Observations were recorded randomly on 10 selected plants per replication on leafhopper and whitefly population in 3 leaves per plant at 7 and 14 days after treatment.

RESULTS AND DISCUSSION

The pre-treatment population of leafhopper ranged from 34.05 to 37.78 leafhopper /3 leaves/plants. The leaf hopper population was reduced significantly at 14 DAT of second spraying in Thiacloprid 21.70 SC@ 1 ml/l (2.48 leafhopper /3 leaves/plant) followed by Cyantraniliprole 10.26 OD @ 1 ml/l (7.56 leafhopper /3 leaves/plant), whereas whitefly population was recorded low in Cyantranilprole 10.26 OD @1ml/l (1.00/leaf) followed by Thiacloprid treatment (2.20/leaf) at 14 DAT of second spraying. The population reduction over control in leafhopper was very high (95.17 %) in Thiacloprid 21.7 SC@ 1 ml/l treated plots followed by Cyantraniliprole 10.26 OD @ 1 ml/l (85.28%) over control (Table 1)

The plots received Cynantraniliprole 10.26 OD and Thiacloprid 21.7 SC spray resulted in significantly higher seed yield 1568 kg/ha, 1542kg/ha respectively and both are on par. It was followed by Spinetoram 11.7SC (1526 kg/ha) and Profenophos treated plots (1395 kg/ha). Highest cost benefit ratio of 1: 3.13 was realized with T_2-Thiacloprid formulation followed by T_3-Cyantraniliprole (1: 3.09) than control plot (Table 1). These results are in conformity with the findings of Suneel and Sunil (2018).

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Table 1. Evaluation of newer insecticides against sucking pests in castor (Pooled data of 2020-21 and 2021 -2022)

Treatments / Dose	Leafhopper (Number / 3 leaves/ plant)						ROC (%)	Whitefly population (Number/3 leaves/plant)						ROC (%)	Seed yield (kg/ha)	BC ratio
	1st spray		2nd spray					1st spray		2nd spray						
	PTC	14 DAT	PTC	7 DAT	14 DAT	Mean		PTC	14 DAT	PTC	7 DAT	14 DAT	Mean			
T_1 Spinetoram 11.70 SC @ 1 ml/l	35.28	18.7	21.14	10.93	12.61	11.77	77.08	21.57	7.62	10.5	2.95	4.19	3.57	93.61	1526	3.03
T_2 - Thiacloprid 21.70 SC @ 1 ml/l	36.02	7.35	12.82	2.94	2.02	2.48	95.17	26.24	4.70	7.70	2.00	2.40	2.20	96.00	1542	3.13
T_3 - Cyantraniliprole 10.26OD @ 1 ml/l	37.78	11.81	17.33	8.91	6.21	7.56	85.28	26.26	2.90	5.10	1.00	1.10	1.00	98.21	1568	3.09
T_4- Profenophos 50EC (2.0 ml/lit)	34.05	16.53	21.16	12.81	11.86	12.34	75.98	21.19	8.89	12.7	5.02	6.85	5.94	89.37	1395	2.85
T_5-Untreated control	35.56	48.78	48.07	51.61	51.12	51.37	-	26.62	42.6	48.6	53.3	58.5	55.9	-	1128	2.35
SE d	NS	1.64	2.14	1.87	1.63	1.75	-	NS	1.02	1.48	1.35	1.44	1.39	-	55.54	-
CD (P=0.05)	NS	2.83	3.40	2.68	2.29	1.63	-	NS	2.23	3.22	2.95	3.13	3.04	-	121.02	-

PTC - Pre treatment count ; DAT -Days After Treatment

'Development of High Oil Yielding Niger Variety for Gujarat State'

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ABSTRACT

Deveolpment of high oil yielding Niger variety GNNIG-4 was done by mass selection from mutated population of RCR-317 (15kr) after subjecting the population to various evaluation trials. The present high yielding Niger cultivar is suitable for *kharif* /late *kharif* season in Gujarat as sole or intercrop. It has greenish purple stem colour with more oil content (37.77%) and oil yield (205 kg/ha). It has medium maturity (127 days) with bold seed size (4.08 gm/1000 seed). The variety is resistant to *Alternaria* and *Cercospora* leaf spot and also resistant to leaf eating catrepillar and semilooper under field condition. In various multilocation and coordinated trials, the genotype NMBP-1907 consistently recorded best performance over the checks. Under rainfed conditions the genotype gave

543 kg/ha seed yield which was 43.65, 34.07 and 41.40 per cent higher than the check varieties GN-2, GNNIG-3 and IGPN-2004-1. With high yield potential, medium maturity, resistance to diseases and pest, high oil, the Niger variety NMBP-1907 was identified for release and notified in 2021 under the name "GNNIG-4" for *Kharif* rainfed condition of Gujarat State.

Keywords: GNNIG-4, High Oil, High Yield, Niger Variety

Niger is a minor oilseed crop of dry areas grown mostly by tribal in interior places which plays significant role in the food and nutritional security of the poorest of the poor tribal segment of Indian population, hence known as lifeline of tribal agriculture and economy. In Gujarat, it is traditionally grown in *kharif* season crop in South Gujarat regionparticularly in Kaprada, Dharampur talukas of Valsad districts, Vansda and some parts of chikhali of Navsari, parts of Vyara and songhad of surat district and in whole Dangs district an area of approximately 10000 ha with production of 3025 tonnes. Though an importance of niger seed oil for tribal farmers of hilly area of south Gujarat, its area under this region is getting drastically reduced year by year due to lack of high yielding cultivars, lack of improved packages of practices and erratic rainfall. Hence, a suitable high yielding with high oil containing and resistance to major pests and diseases was in demand for south Gujarat region.

In this context, All India Coordinated Research Project on Niger, Vanarasi, Tq. Vansda affiliated with Navsari Agricultural University, Navsari, Gujarat has developed GNNIG-4, tested in various multilocation and co-ordinated varietal trials for four years and released for *kharif* rainfed condition in Gujarat state.

MATERIALS AND METHODS

All India Coordinated Research Project on Niger functioning at Niger Research Station, Navsari Agricultural University, Vanarasi had concentrated to develop a better variety of Niger with high seed yield potential having more oil yield with disease resistance. For this purpose, collection, evaluation and selections of local germplasm of Niger were made and an attempt was made to create variability through mutation breeding with treatment of various mutagens to four varieties of niger viz., GN-2, JL-13, Dhrl-10 and RCR-317 at Bhabha Atomic Research Centre, Mumbai, India which resulted in development of a better genotype NMBP-1907 after continouous advancement and selection of desirable uniform population after M_6 generation which finally resulted in development of new variety GNNIG-4. GNNIG-4 (NMBP-1907) niger variety was developed by mass selection from mutated population of RCR-317 (15kr) which was subjected to evaluation in various multilocation trials at different centres across the country. It was tested in various station trial along with the check GN-2 (LC), GNNIG-3 (LC) and IGPN-2004-1 (NC) in the year (2016-18). Considering its promising performance, this genotype was promoted to rainfed multilocation trials and coordinated varietal trials as well. For rainfed condition the genotype was also tested at Vanarasi, Waghai, Vyara and Dediapada during *Kharif* (2018-2019). The performance of this genotype was consistently superior over the national check IGPN-2004-1 for yield. Due to the superior performance of NMBP-1907 under multilocation trials, the genotype was also tested in All India Coordinated Initial Varietal Traial during *Kharif* 2019-20 at 09 different locations. The performance of this genotype was consistently superior over the national check variety IGPN-2004-1 and JNS-9 for yield as well as oil content. Simultaneously, the genotypes also tested in adaptive trials at 30 farmers' field along with check varieties GN-2 (LC) and IGPN-2004-1 (NC) which has also recorded more yield over the check. It was therefore released for commercial cultivation for *Kharif* season of Gujarat State under the name "GNNIG-4". The statistical analysis was carried out by standard procedure given by Panse and Sukhatme [2].

RESULTS AND DISCUSSION

Performance of NMBP-1907 in different station trials conducted during 2016-18 at Vanarasi, the yield differences due to genotypes were significant. The culture NMBP-1907 gave grain yield of 434 kg ha^{-1} (Table 1) which was 28.02, 17.61 and 27.64 per cent higher than the checks GN-2, GNNIG-3 and IGPN-2004-1. In the overall multilocation trials (12 locations), the culture NMBP-1907 recorded 43.65, 34.07 and 41.40 per cent higher yield (543 kg/ha) than the local as well as national checks. In All India Coordinated Varietal trials conducted during Kharif 2019-20 at 09 locations, the genotype NMBP-1907 gave grain yield of 597 kg ha^{-1} which was 12.64 and 8.15 per cent higher than the check IGPN-2004-1 (530 kg/ha) and JNS-9 (552 kg/ha). During *Kharif* 2020-21, total 30 adaptive trials were conducted at farmers field in the different districts of Gujarat State in that the genotype NMBP-1907 recorded grain yield of 602 kg/ha which was 22.60 and 29.46 per cent higher yield than the checks GNNIG-3 (491 kg/ha) and IGPN-2004-1 (465 kg/ha). In 14 trials conducted on research field and 30 large scale demonstrations on farmers' field during 2016-17 to 2020-21, the genotype NMBP-1907 showed superior performance and gave 581 kg/ha mean grain yield over both the check varieties which was 29.68 per cent and 26.30 per cent gain over the checks GNNIG-3 and IGPN-2004-1, respectively (Table 1).

The screening for disease resistance was carried out under field conditions during 2019-20 and 2020-21 which revealed that the genotype NMBP-1907 was consistently resistant to *Alternaria* and *Cercospora* leaf spot and similarly, it has also shown resistance to semilooper and caterpillar (Table 2). The quality studies (Table 1) indicated that released genotype NMBP-1907 recorded higher oil content (37.77 %) than the check varieties GNNIG-3 (32.10%) and IGPN-2004-1 (32.40%). The oil yield productivity of newly developed niger variety is much better (205 kg ha^{-1}) and showed superiority over both checks. It had a medium maturity duration (127 days) than the check variety GN-2 (116 days), bold seeded with shining black colour, fertilizer responsive and disease resistance niger variety. Owing to the high yield potential, medium maturity, resistant to diseases and high oil content, the niger variety GNNIG-4 (NMBP-1907) was identified for released and notified in 2021 for *Kharif* rainfed condition of Gujarat State for commercial cultivation to the farmers.

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Table 1. Comparative performance of Niger variety GNNIG-4 at different locations of Gujarat.

Year	Name of Trial	Location	Released Variety NMBP-1907	GN-2	Checks GNNIG-3	IGPN-2004-1	C. D. at 5 %	C. V. (%)
2016-17	PET	NRS, Vanarasi#	299	347	-	-	59.79	8.17
% Increase over				29.31	33.14			
2017-18	SSVT	NRS, Vanarasi	431^{abc}	330	351	306	70.68	11.20
		HMRS, Waghai	436^{ac}	347	386	374	60.07	13.38
Mean(02)			434	339	369	340		
% Increase over				28.02	17.61	27.64		
2018-19	SSVT	NRS, Vanarasi	477^{abc}	296	334	317	81.1	12.64
		HMRS, Waghai	617^{abc}	490	413	486	101.22	11.99
Mean(02)			547	393	374	402		
% Increase over				39.18	46.25	36.06		
2019-20	LSVT	NRS, Vanarasi	504^{abc}	382	409	386	63.86	8.54
		HMRS, Waghai	509^{abc}	378	371	344	93.2	12.9
		RRRS, Vyara	518^{abc}	358	362	341	79.32	11.27
		KVK, Dediyapada	430^{ac}	277	342	258	100.09	18.35
Mean (04)			490	349	371	332		
% Increase over				40.40	32.07	47.59		
2020-21	LSVT	NRS, Vanarasi	694^{abc}	386	457	422	121.52	13.26
		HMRS, Waghai	709^{ac}	489	593	551	142.41	13.17
		RRRS, Vyara	522^{abc}	391	394	364	91.58	11.42
		KVK, Dediyapada	670^{abc}	412	445	459	116.84	12.17
Mean (04)			649	420	472	449		
% Increase over				54.52	37.50	44.54		
Over all mean (12 locations)			543	378	405	384		
% Increase over				43.65	34.07	41.40		
Oil content (%)			37.77	-	32.10	32.40		
% Increase over for oil yield (%)				-	57.69	65.32		
Adaptive field trial (30)			602	-	491	465		
% Increase over				-	22.60	29.46		

Data of NRS, Vanarasi is excluded due to below state average.

Table 2. Mean seed yield (kg/ha) performance of NMBP-1907 in coordinated varietal trial during 2019-20

Entry	*CVT* Locations (09)									CVT Mean	% Increase over
	Banglore	Chindwara	Chintapalle	Gumla	Jagdalpur	Kanke	Raichur	Semiliguda	Vanarasi		
NMBP-1907	782	370	847	347	417	1135	408	602	467	597	
IGPN-2004-1	618	347	872	435	458	714	285	732	307	530	12.64
JNS-9 (NC)	684	336	874	334	412	964	405	500	461	552	8.15

Table 3. Incidence of diseases and pests on NMBP-1907

Genotypes	**Disease** (0 to 9 scale)							
	***Alternaria* leaf spots** (*Alternaria* sp.)				***Cercospora* leaf spots** (*Cercospora guizoticola*)			
	2019	2020	**Mean**	Range	2019	2020	**Mean**	Range
NMBP-1907	3.0	6.0	**3-6**	1	4.0	7.0	**4-7**	1
GN-2(LC)	11.0	16.0	**11-16**	3	12.0	15.0	**12-15**	3
GNNIG-3 (LC)	10.0	12.0	**10-12**	3	10.0	14.0	**10-14**	3
IGPN-2004-1 (NC)	13.0	15.0	**13-15**	3	12.0	15.0	**12-15**	3
Genotypes	**Insect Pests**							
	Caterpillar (No./plant) (*Perigaea capensis*)				**Semilooper** (No./plant) (*Achae janata*)			
	2019	2020	**Mean**	Range	2019	2020	**Mean**	Range
NMBP-1907	0.0	1.0	**0.5**	1	0.5	1.0	**0.75**	1
GN-2(LC)	5.0	6.0	**5.5**	3	4.0	6.0	**5.0**	3
GNNIG-3 (LC)	4.0	6.0	**5.0**	3	4.0	4.0	**4.0**	3
IGPN-2004-1 (NC)	6.0	6.0	**6.0**	3	6.0	7.0	**6.5**	3

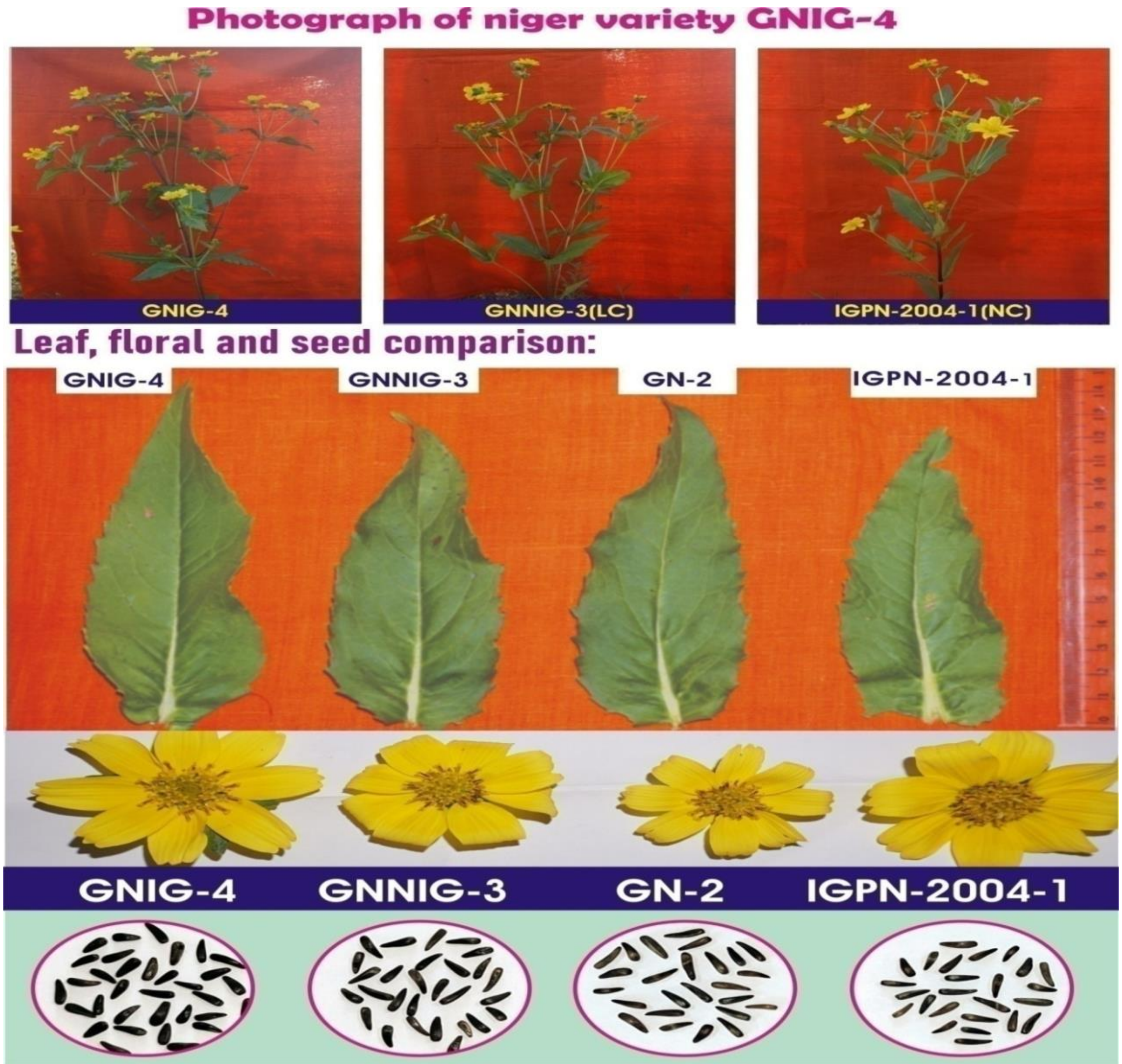

Plate-I. Showing plant, leaf, flower and seed specifications of Niger variety GNNIG-4 (NMBP-1907)

Enhancement of oil content in safflower (*Carthamus tinctorious* L.)

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ABSTRACT

A systematic breeding approach is applied to increase the oil content in safflower lines by crossing between elite GMU lines and Mexican lines. The range of oil content in elite GMU parental lines were 33-35% were as in Mexican lines the average oil content was 39%. The crosses were made, through transgressive segregation the oil content in F5-F6 generations was achieved up to 42%.

Keywords: Backcrossing, Oil content, Safflower, Transgressive segregation

A systematic breeding approach through back cross and transgressive segregation is adopted by breeders of IGKV, Raipur to enhance the oil content in safflower in crosses of elite germplasm lines with Mexican lines since 2017-18. Now the pipe line entries are in hand with 36 to 42 % oil content, with stable performance in experimental years. Simultaneously fatty acid profiling is also estimated year wise to study the behaviour of fatty acids in different generations of crosses of elite germplasm lines and Mexican lines. Because of which the oil was considered to be healthy to consume and there was even a time in the

USA where the safflower became the best oil for few years in the market (Han *et al.,* 2009).

MATERIALS AND METHODS

The indigenous elite lines RVS 12-13 (oil 35%, large capitulum, 40-60 seeds/capitulum), PKV Pink, NARI 119, GMU 3635, and two varieties A-1 and CG Kusum-1 were crossed with four Mexican lines EC 755665, EC 755664, EC 755686 and EC 755673. In F2 plants were selected on its thin hull basis and oil content. Selections for oil content were continued till F6 and progenies with high oil content and thin hull were selected in each generations.

RESULTS AND DISCUSSION

Crosses were made among elite germplasm lines, some varieties and Mexican lines to improve the oil content in crosses. Some crosses between Mexican to Mexican lines were also developed. F_1 s was grown in bulk to raise the F_2 generation. In F2 major emphasis of selections were based on the number of primary branches, number of seeds/capitulum, thin hull and oil content in single plant basis. 450 progeny rows were grown in F3 selection criteria were same up to F5. In F6 promising progeny were bulked and multiplied (Sahoo *et al*., 2022).

In each of the successive years, different crosses were made and by the same way progeny selection was applied and only few promising progenies with higher oil and yield were retained for further evaluation.

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S. No.	Parents	Oil content	S. No.	Crosses	Oil content
1	RVS 12-13	35%	1	RVS 12-13 X EC 755671 (F6)	38.56
2	GMU 6891	32%	2	RVS 12-13 X EC 755683 (F6)	38.62
3	NARI 119	35%	3	EC 755664 X EC 755686 (F5)	41.45
4	GMU 3635	34%	4	EC 755664 X A1 (F5)	42.33
5	A-1	29%	5	EC 755664 X CG Kusum-1 (F5)	39.61
6	CG Kusum-1	33%	6	EC 755665 X EC755664 (F5)	38.76
7	EC 755665	39%	7	NARI 119 X EC 755686 (F5)	37.72
8	EC 755664	40%	8	A1 X EC 755664 (F5)	40.47
9	EC 755686	38%	9	EC 755664 X RVS 12-13 (F5)	39.42
10	EC 755673	39%	10	EC 755686 X NARI-119 (F4)	39.55
			11	EC 755664 X GMU 3635 (F4)	41.45
			12	EC 755664 x GMU 6891 (F4)	41.21

Genetic variability studies in sesame (*Sesamum indicum* L.)

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ABSTRACT

The field experiment was conducted during summer, 2019-20 at Regional Agricultural Research Station, Polasa, Jagtial India. To access genetic variability, heritability and genetic advance for seed yield and its attributing traits in 18 genotypes of sesame. The present investigation was carried out to evaluate the sesame genotypes for variability on yield with yield attributing traits. Seed yield exhibited low heritability, coupled with low genetic advance as per cent of mean, GCV values representing the availability of less variability for this trait. 1000 seed weight and days to 50% flowering recorded high heritability coupled with moderate genetic advance as per cent mean. Results reveal that, these characters were under the governance of additive gene action and can be further improved through selection procedure.

Keywords: Genetic variability, Sesame

Sesame (*Sesamum indicum* L.) is one of the oldest oilseed crops and is widely cultivated in India and Worldwide. India is still leading country with maximum (25.8 %) production from the largest (29.8 %) area and highest export (40 %) in the world. It is grown in India with an area of 15.80 lakh ha, 1.74 lakh tonnes production and 478 kg ha^{-1} productivity (www.indiastat.com, 2018-19). Sesame occupies an area of 30,800 ha in Telangana (Department of Agriculture reports 2022). The objective of this study was to estimate the extent of genetic variability in genotypes of sesame (*Sesamum indicum* L.) under summer conditions.

MATERIALS AND METHODS

The experiment was laid out at Regional Agricultural Research Station, Polasa, Jagtial, during summer 2019-20. The research station is situated in Northern Telangana Zone, India at 18º 48 N latitude, 78º 56́ E longitude and 281m altitude of mean sea level. The experiment was laid out in Randomized Block Design (RBD) with 18 genotypes. Each genotype was sown in eight rows of each three meters length, with inter-row spacing of 30 cm and intra row spacing of 15 cm. All the standard package of practices were followed during crop growth period. Genotypic and phenotypic variability, genetic advance and heritability in a broad sense were estimated in 18 genotypes at Regional Agricultural Research Station, Polasa, Jagtial during Summer 2019-20.

RESULTS AND DISCUSSION

Studies on various variability parameters of 18 genotypes for 7 traits are presented in Table 1. Days to 50% flowering recorded low genotypic and phenotypic coefficients of variation (3.04 and 3.12 per cent respectively. It recorded high heritability (89.3 per cent) coupled with moderate genetic advance as percent of mean (12.8 per cent). This is similar to the earlier findings of Rajitha (2019). It indicates that this trait is governed by additive gene interaction and this trait can be improved by simple selection. 1000 seed weight recorded low genotypic coefficient of variation and phenotypic coefficient of variation for *i.e.,* 7.64 per cent and 7.83 per cent. It recorded high heritability (95.3 per cent) with moderate genetic advance as per cent of mean (15.37 per cent). These results were similar with the findings of Madhu (2020). It indicates that the trait is less influenced by environment and selection may be effective. Among 18 entries tested, JCS RF4 (988 kg/ha) culture recorded significantly higher yield as compared to check, Swetha (841 kg/ha). Further, promising sesame genotypes are being evaluated in next year in a larger area and then evaluate under multilocation testing trial at different locations.

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Table 1: Estimation of variability and genetic parameters in *Sesamum indicum L.*

	Days to 50% flowering	Days to maturity	Plant heig height (cm) (cm)	Number of Branches/plant	Number of capsules/plant	1000 seed weight (g)	Yield (kg/ ha)
GCV %	6.57	3.04	6.24	17.97	10.29	7.64	3.44
PCV %	6.96	3.12	12.91	25.23	15.57	7.83	9.39
h^2 (Broad Sense)	89.30	95.50	23.30	50.70	43.70	95.30	13.40
Genetic advance as % of mean 5%	12.80	6.13	6.21	26.37	14.02	15.37	2.60

Genetic divergence for crop improvement in Sesame (*Sesamum indicum* L.)

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ABSTRACT

Genetic divergence in 92 accessions of sesame was evaluated by using Mahalanobis D^2 statistics to identify the potential parents in the hybridization programme. The genotypes were grouped into twelve clusters suggesting a considerable amount of genetic diversity in the material. The traits *viz.,* number of primary branches per plant, number of capsules per plant and seed yield per plant contributed maximum towards the divergence and emphasis should be given for these traits for improving yield potential in sesame.

Keywords: Genetic divergence, Mahalanobis D^2 statistic, Sesame

Sesame (*Sesamum indicum* L.) is considered as the queen of oilseeds because of its high oil content, high content of polyunsaturated fatty acids, oleic, and linoleic acid and excellent oil stability. Globally consumption of sesame is steadily increasing mainly due to changing consumer's consumption patterns and increasing health awareness. Consequently, the demand of sesame seeds is higher. It is predicted that vegetable oil consumption will be doubled, and sesame oil consumption may be 100 million MT by 2030 (Daisy *et al*, 2020). Therefore, the demand for genetic studies of oil-rich crops will increase to improve oil content. For this the strengths of available germplasm has to be evaluated to identify potential genotypes. Success of the breeding programme largely depends upon the knowledge of genetic variability present in a given crop species for the characters under improvement. As such, before commencement of any breeding programme it is necessary to have thorough knowledge on variability present in the available genetic material. D^2 statistics is a potent tool to quantify the extent of genetic divergence among parents, which ensures high heterotic effects and more variability in the segregating generations and is further enhanced by its applicability to estimate the relative contribution of the various traits to genetic divergence.

MATERIALS AND METHODS

The material for study consisted of 92 genotypes, sown in randomized complete block design (RBD) with two replications at Regional Agricultural Research Station, Tirupati during *Rabi* 2020-21. Each genotype was raised in 3m length with spacing of 30 X 10 cm by following the recommended package and practices appropriately throughout the cropping season. Observations were recorded on days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of capsules per branch, capsule length, test weight and seed yield per plant. The genetic diversity among 92 genotypes for 8 traits was estimated by using Mahalonobis (1936) D^2 statistics by using window stat software.

RESULTS AND DISCUSSION

In the present study, based on relative magnitude of D^2 values, 92 genotypes of sesame were grouped into twelve clusters and the average inter cluster distance varied from 18.36 in cluster XII to 224.76 in cluster XII (Figure 1). The maximum inter cluster distance was observed between cluster IV and VI (224.76) followed by cluster IV and V (237.25), cluster IV and X (193.71), cluster IV and XII (26.74), cluster XI and XII (168.97) and so on. This indicated considerable amount of divergence within and between clusters. Such highly divergent, high performing genotypes would be of great use in recombination breeding programme in order to get high heterotic recombinants. The characters contributing most to the divergence should be given emphasis while identifying the parents for hybridization. The highest contributors in this regard were number of primary branches/plant (46.42 %), number of capsules/plant (27.59%) and seed yield/plant (8.39 contributed towards the divergence (Table 1). Similar results were reported by Bharathi and Thirumala Rao (2016).

From the present study, emphasis should be given towards selection based on number of primary branches/plant, number of capsules/plant, and seed yield/plant for improving seed yield. Crossing involving genotypes from diverse group *viz.* Hima, YLM 66, CUMS-17 from cluster IV with genotypes IC 205039 form cluster VI and IC132408 from cluster V etc. may generate breeding material with high diversity and is likely to produce desirable transgressive segregants for further crop improvement.

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Table No-1. Per cent contribution of different characters towards divergence

Character	No of times ranked first	Contribution (%)
Days to 50% flowering	33	0.79%
Days to maturity	207	4.95%
Plant height (cm)	220	5.26%
Number of primary branches per plant	1943	46.42%
Number of capsules per plant	1155	27.59%
Capsule length (cm)	149	3.56%
100 seed weight (g)	128	3.06%
Seed yield per plant (g)	351	8.39%

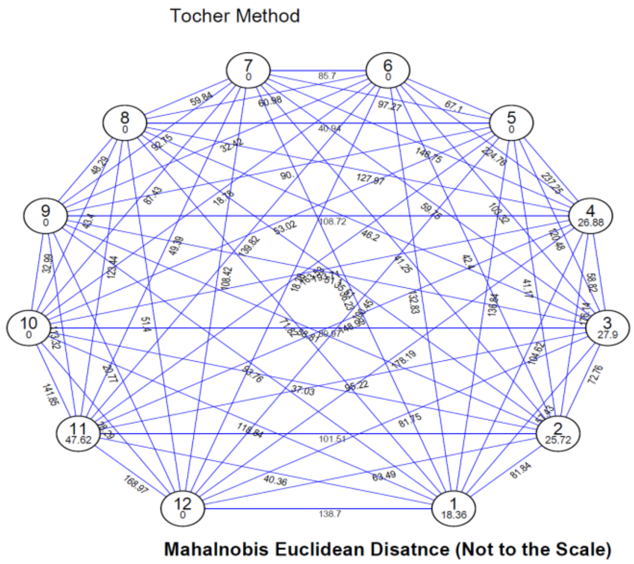

Fig No-1. Average inter and intra cluster distances of 92 sesame genotypes

Secondary metabolite analysis in the broad host range plant pathogenic fungus *Sclerotinia sclerotiorum*

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ABSTRACT

Secondary metabolites are known to play a vital role in host-pathogen interaction wherein little is knownabout the secondary metabolites secreted by *S. sclerotiorum* in axenic culture. In this study, we predicted the genomic repertoire of the metabolites in an Indian isolate 'ESR-01' of the *S. sclerotiorum* and analysed the secondary metabolites secreted by pathogenically diverse Indian isolates of the *S. sclerotiorum* in axenic culture through untargeted high-resolution UPLC-QTOF-ESI/MS. We also investigated the phylogenetic correlation among these isolates based on metabolic profiling with the pathogenicity and ITS-based diversity analysis of the pathogen published earlier.

Keywords: Brassica, Sclerotinia sclerotiorum, Secondary metabolites, UPLC-QTOF-ESI/MS

The *Sclerotinia sclerotiorum* (Lib.) de Bary, causing stem rot disease in *Brassica* is a broad host rangepathogen known to infect more than 400 plant species belonging to 278 genera of 75 families, including various economically important crops including rapeseed-mustard and causes 10-80% of yield loss worldwide (Boland and Hall, 1994). The secondary metabolites (SMs) secreted by the pathogen at different stages of their interaction with the host serve diverse functions that include facilitation of the infection, escape from the host defense, signaling for cascading the infection, and nutrient uptake for survival and proliferation of the pathogen inside the host. Among them, some of the SMs secreted by the necrotrophs are broad-spectrum in action whereas many of them are host-specific (Allan *et al.*, 2019). The present study examined the SMs profile of the six isolates of *S. sclerotiorum*, belonging to three different pathogenicity groups.

MATERIALS & METHODS

Two each from the highly virulent (HV; ESR-18, ESR-25), virulent (V; ESR-01, ESR-05), and moderately virulent isolates (MV; ESR-04, ESR-42) of the *S. sclerotiorum* were selected for metabolite profiling. The 500 mL broth culture of these isolates grown in the dark at 22° ± 2℃ for 10-days with continuous shaking at 120 rpm were filtered with muslin cloth and the cell-free culture filtrate was extracted with 3 x 100 mL of ethyl acetate. 10 mL saturated sodium hydrochloride solution was added to each extract and shaken vigorously. The upper ethyl acetate layer was filtered out and passed throughanhydrous sodium sulfate (20 g) to remove any traces of water. Liquid-liquid partitioning was followed to extract maximum secondary metabolites as described by Kundu *et. al*., (2016). Extracted ethyl acetate from the culture filtrates was evaporated under reduced pressure below 40°C in a rotary evaporator (Heidolph, Germany) for obtaining the different amounts of the semisolid residues *viz*. 56 mg (ESR- 01), 32 mg (ESR-04), 42 mg (ESR-05), 13 mg (ESR-25) and 67 mg (ESR-42). These extracts were subjected to six UPLC-QTOF-ESI-MS analyses for the separation and identification of the major secondary metabolites.

RESULTS AND DISCUSSION

The total ion chromatogram (TIC) of ethyl acetate extract obtained through UPLC-QTOF-ESI-MS of the six different *S. sclerotiorum* isolates revealed various characteristic peaks (S1-S6) corresponding to their molecular and adduct ions. With the manual simulation of the UPLC-MS peaks, ten different metabolites namely, (i) sclerin, (ii) sclerotinin B, (iii) sclerone, (iv) bostrycoidin, (v) botcinin D, (vi) botcinin A, (vii) gliovirin, (viii) melanin, (ix) scleramide, and (x) botcinic acid were putatively identified. Four of the metabolites sclerin, sclerone, melanin, and sclerotinin B have already been known in *S. sclerotiorum* whereas the six other metabolites have been found and reported for the first time secreted by *S. sclerotiorum*. Further, the comparative analysis of the identified secondary metabolites in six different isolates was delineated as shown in Table 1.

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Table 3. Comparative metabolite profiling in six different isolates of *S. sclerotiorum* using UPLC-QTOF-MS

Metabolites	ESR1	ESR4	ESR5	ESR18	ESR-25	ESR42
Sclerone	197.1319	197.1319	197.1319	197.1319	-	197.1319
Sclerin	-	235.1713	-	235.1713	235.1713	235.1713
Sclerotinin B	256.2719	256.2719	-	256.2719	-	256.2719
Bostrycoidin	285.3492	-	-	-	-	-
Melanin	336.1815	-	336.1815	-	-	336.1815
Botcinin D	-	367.1489	367.1489	367.1489	-	367.1489
Botcinic acid	-	403.1438	-	403.1438	-	403.1438
Botcinin A	-	426.2267	426.2267	-	426.2267	426.2267
Gliovirin	-	503.3604	503.3604	503.3604	-	503.3604
Scleramide	-	-	713.5579	713.5579	-	713.5579

Genetic diversity analysis in sunflower (*Helianthus annuus* L.) germplasms

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ABSTRACT

Evaluating genetic diversity in germplasm resources is a prerequisite for any effective breeding program. To classify sixty-six sunflower germplasm and seven checks, the study was conducted during 2020. The analysis of variance revealed significant differences among the genotypes for all characters. Divergence analysis using hierarchical cluster analysis (HCA) has been performed to effectively determining genetically distant parents, which could be used for hybridization. The HCA based on first three PCs grouped the lines into 8 clusters, where cluster IV had maximum number of genotypes. Additionally, it signifies that cluster I and cluster VIII are highly diverse, whereas cluster V and VI are less diverse.

Keywords: Diversity, Genotypes, Hierarchical cluster analysis, Sunflower

The sunflower (*Helianthus annuus* L.,) is the second-largest oilseed crop in the world after soybean. It is a member of the Asteraceae/Compositae family. Has a consistency and a high concentration of unsaturated fatty acids. Around the world, sunflowers have been successfully cultivated in a range of environments. It is a crop that is extensively cross-pollinated, has a high production potential, and can adapt too many environmental circumstances. Which genetically distant parents should be utilised for hybridization has been demonstrated to be beneficial utilising divergence analysis using hierarchical cluster analysis (Choudhary *et al*., 2015).The goal of sunflower breeding is to produce hybrids or cultivars that are disease resistant and have high yields, oil content, and oil quality. The breeder must choose parents with the greatest genetic diversity and the potential to combine favourable traits in order to accomplish this goal. Sunflower germplasm diversity is often investigated to ascertain crop variability, assess the germplasm for breeding programmes, or identify necessary variability for morphological and agronomic features.

MATERIALS AND METHODS

The current study was conducted at Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore to characterize sixty-six sunflower germplasm accessions along with seven checks. The evaluation and characterization of the accessions were carried out during *kharif* 2020 in augmented block design. The observations were recorded from each accession for eight traits *viz*, Days to 50% flowering, Days to Maturity, Plant height (cm), Head diameter (cm), Hundred Seed (g), Volume weight /100ml (g), Oil content (%) and Yield /plant (g). To assess genetic diversity among lines, hierarchical cluster analysis was carried out, the statistical data analysis was performed using the R studio.

RESULT AND DISCUSSION

The results showed highly significant difference among sunflower genotypes for all the traits which indicate the presence of considerable genetic variation among sunflower germplasm.

Cluster analysis assists in grouping of genotypes based on genetic diversity among the genotypes. Hierarchical cluster analysis done in sixty six sunflower genotypes and seven checks were grouped into 8 clusters based on PCs, more than 1 eigen values and Principal factor scores (PF scores) for different traits. The cluster analysis showed that cluster I includes 3 genotypes and 1 check; cluster II consists of 10 and 2 checks; cluster III had 2 genotypes and 2 checks; cluster IV contain fifteen genotypes; cluster V had 4 genotypes; cluster VI contain 13 genotypes; cluster VII includes 9 genotypes and 2 checks; cluster VIII had 9 genotypes. The cluster IV contain highest genotypes and lowest genotypes observed in cluster I and V, can be used in crossing for crop improvement.

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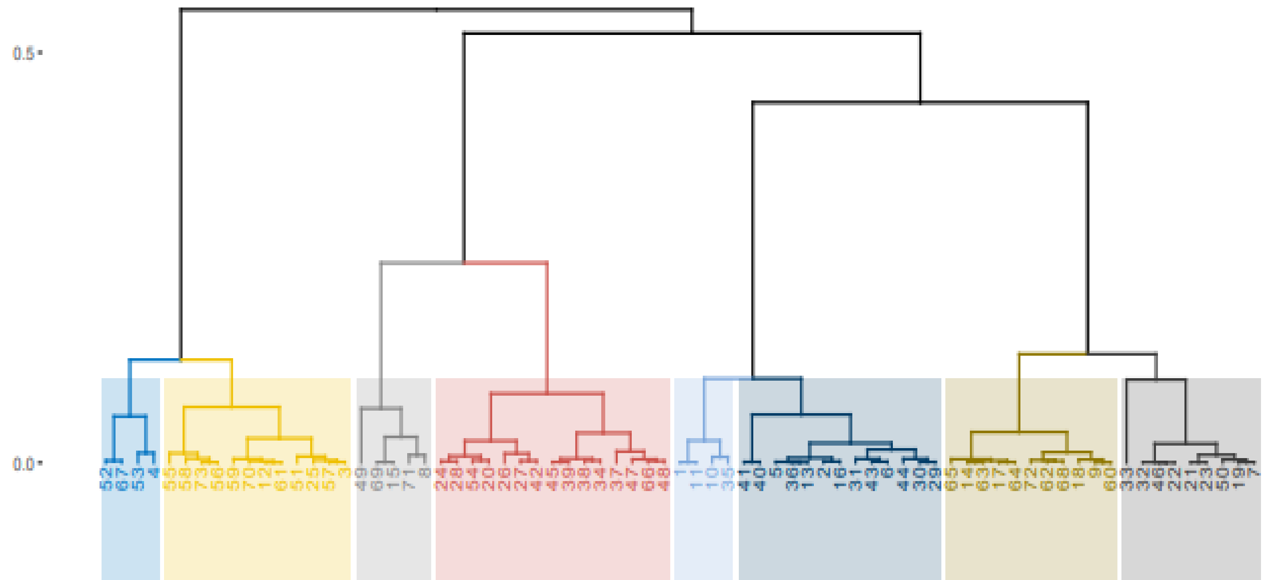

Fig 1: Hierarchical clustering of genotypes and checks

Identification of *A. tenuissima, A. solani, A. burnsii* and *A. gossypina* as new members of *Alternaria* population in Karnataka on sunflower

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ABSTRACT

Alternaria species, large-spored *A. helianthi* and small-spored *A. Alternate,* are serious threat to sunflower cultivation. Severity of the disease is increasing over the years revealing, infection of many species of *Alternaria* on sunflower. Insight into their population on naturally infected leaves divulges the species that are aggressive. Morphological and molecular analysis, revealed association of new species on sunflower in southern Karnataka. Sequence analyses of SSU, GAPDH, *endo*PG and OPA10-2 showed that *A. tenuissima, A. solani, A. burnsii* and *A. gossypina* were associated and pathogenic. These were distinguished at microscopic and genetic level disclosing host shift mechanism and occurrence of new species.

Keywords: Alternaria species, Sunflower

Alternaria leaf blight is a major disease of sunflower causing average yield and oil loss in India. Several species of *Alternaria* are associated with leaf blight leading to disease severity. The present investigation was to know the complexity of associated species in sunflower.

MATERIALS AND METHODS

Sunflower leaves infected by *Alternaria* species were collected, isolated and identified through morpho-taxonomical and molecular (ITS and *Alt a1*gene) characterization. SSU, GAPDH, *endo*PG and OPA10-2 genes were sequenced for new species**.**

RESULTS AND DISCUSSION

Morphological, cultural and sequence comparison of ITS and *Alt a1* indicated that the cluster representatives are species of *Alternaria*. *A. helianthi* and *A. alternata* were most prevalent and reported. Whereas, *A. tennuissima*, *A. solani*, *A. burnsii* and *A. gossypina* were identified and reconfirmed through sequencing of SSU, GAPDH, *endo*PG and OPA10-2 genes. The studies were in accordance to Liu *et al*., 2019 and Praveen, 2021.

Colony, conidial and molecular characterisation of new species of *Alternaria* on PDA

Species	Colony characteristics	Margin	Conidial characteristics	Conidial length(µm)	Conidial width(µm)	Beak length (µm)	Accession number
A. tenuissima	Olivacious green to grayish black; fluffy mycelial growth, zonate.	Regular	Short chains of 2-4, smooth, obclavate, elongated, oval, tapering gradually to a beak, deep to dark olive-buff to buffy brown in color.	9.32 - 45.12	4.67-11.8	4.3-6.71	OP799747
A. solani	Had consistent colour from light grey to brownish, zonate.	Regular	Solitary, golden brown, muriform, with beaks.	15.38-80.4	6.55-13.79	9.3–26.58	OP793641
A. burnsii	Smooth with light reddish white mycelium, zonate.	Regular	Brown to dark brown chains, obclavate to pyriform with varied beak length	13.8-55.1	6.9-22.2	3.59-14.7	OP830810
A. gossypina	Light green to grey at centre covered with white raised mycelium, zonate.	Irregular	Dark brown, obclavate, with upto 9 transverse and usually 1 or 2 longitudinal septa, with septal constriction	32-46	5.88-29.7	9.3 -27.1	OP830838

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Assessment of combining ability and heterosis for yield and its component traits in Indian mustard [*Brassica juncea* (L.) Czern & Coss.]

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ABSTRACT

Line × tester analysis was carried out to estimate heterosis and combining ability effects of 32 Indian mustard hybrids. Three lines, namely, RH 30-OA, RH 115-OA, and RH 832-OA, as well as two testers, Ogura 17 and Ogura 101 were discovered to be good general combiners with significant positive general combining ability (GCA) effects for seed yield/plant and component traits. Specific combining ability (SCA) effects for seed yield/plant were significantly positive for RH 30-OA × Ogura 101 and RH 832-OA × Ogura 72 crosses which exhibited significant economic heterosis compared to the standard check DMH 1.

Keywords: Combining ability, Gene action, Heterosis, Indian mustard, Line x tester analysis

India fulfills roughly 57% of its total edible oil demand through imports which costs nearly $100 million in foreign exchange every year (Singh *et al*., 2021). Rapeseed-mustard is a major oilseed crop in India and covers 6.70 million ha, with a total production of 10.21 million tonnes. To keep up with the burgeoning population and the rising demand for vegetable oils, the productivity of oilseed crops needs to be raised. Development of commercial hybrids seems to be best approach for quick genetic gain and breaking the yield barriers in Indian mustard, because heterosis breeding offers a yield benefit of 19–40% over the best pure line types (Sodhi *et al*., 2006).

MATERIALS AND METHODS

The present investigation was carried out at the Oilseeds Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, India during Rabi season of 2021-22. The experimental material consisting of 32 crosses along with 12 parents (eight Ogura CMS lines and four testers with Ogura fertility restorers R gene) and two checks. Each line was grown in paired rows of 4.0 m length with three replications in Randomized Complete Bock Design (RCBD) at the spacing of 45 × 15 cm. All the recommended package and practices were adopted to raise a good crop. Analysis of variance (ANOVA) and estimation of combining ability effects was performed as suggested by Fisher (1930) and Kempthorne (1957), respectively.

RESULTS AND DISCUSSION

ANOVA showed highly significant ($P < 0.01$) difference among all the genotypes for the studied traits. The highest GCA was shown by three lines (RH 832-OA, RH 30-OA, and RH 115- OA) and two testers (Ogura 17 and Ogura 101) for seed yield per plant in a positive direction (Table 1). SCA was observed highest for seed yield per plant in the following crosses: RH 30-OA× Ogura 101, RH 115-OA × Ogura 101, RH 832-OA × Ogura 17, and RH 832-OA × Ogura 101(Table 2). These four crosses were also found significant for Standard Heterosis over DMH-1 forseed yield per plant.

The values of GCA/SCA variance <1 indicated the preponderance of non-additive gene effects for most of the traits. The development of F_1 hybrids by selecting the most combiner parent is suggested for utilizing the non-additive gene effect for these traits. In terms of heterotic effects for both seed yield and oil content, the two best hybrids were RH 30-OA × Ogura 101 and RH 832-OA × Ogura 101. Besides, heterosis for seed and oil yield, these two crosses also expressed significant heterotic effects for most of the yield attributing and agronomically desirable traits.

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Table 1: GCA of parents for seed yield and its component traits in Indian mustard

Parents (Lines + Testers)		DM	PH	NPB	NSB	TSW	SYP	OC
Lines	RH 30-OA	1.89*	5.59*	0.78*	3.00**	0.05	2.68**	-0.23
	RH 115-OA	1.72*	-2.91	-0.64	-2.42**	-0.03	1.24**	0.44
	RH 119-OA	2.89**	2.84	-0.05	0.25	0.23**	-3.20**	-0.66*
	RH 121-OA	0.80	-5.66*	-0.64	-2.50**	-0.57**	-1.94**	-0.01
	RH 427-OA	-0.28	13.34**	-0.28	-2.08**	0.34**	-1.25**	-0.54
	RH 555-OA	-1.36	-9.82**	-0.05	0.17	0.13**	-1.63**	0.74*
	RH 0749-OA	-2.20**	-5.90*	-0.80*	-2.25**	0.20 **	-1.83**	-0.47
	RH 832-OA	-3.45**	2.51	1.11**	5.83**	-0.38**	5.93**	0.74*
	SE (±) Lines	1.45	3.22	0.17	0.43	0.05	1.16	0.14
Testers	Ogura 17	-0.28	-0.61	-0.14	0.46	0.15**	1.52**	-0.16
	Ogura 24	0.34	-3.28	-0.30	-0.21	-0.27**	-2.48**	-0.11
	Ogura 58	-0.07	2.01	-0.09	-2.17**	-0.58**	-4.18**	0.28
	Ogura 101	0.01	1.89	0.53*	1.92**	0.70**	5.14**	-0.01
	SE (±) Testers	0.92	2.04	0.11	0.27	0.03	0.73	0.09

*and **Significant at *P ≤ 0.05 and P ≤ 0.01, respectively*. DM-Days to maturity; PH-Plant height (cm); NPB-Number of primary branches/plant; NSB-No. of secondary branches/plant; TSW-1000-seed weight (g); SYP-Seed yield/plant (g); OC-Oil content (%)

Table 2: SCA of different crosses for seed yield and itscomponent traits in Indian mustard

Crosses	DM	PH	NPB	NSB	TSW	SYP	OC
RH 30-OA × Ogura 17	0.20	-0.22	-0.70	0.63	0.59**	-2.77**	0.45
RH 30-OA × Ogura 24	0.57	-4.22	1.80**	3.96**	-0.40**	-0.77	-0.27
RH 30-OA × Ogura 58	-2.34	4.49	-0.74	-3.08*	-0.38**	-2.49**	0.17
RH 30-OA × Ogura 101	1.57	-0.05	-0.36	-1.50	0.20*	6.02**	-0.34
RH 115-OA × Ogura 17	-1.64	-7.39	0.05	-0.96	-0.20*	-8.32**	0.05
RH 115-OA × Ogura 24	0.07	9.61	0.55	4.04**	-0.32**	4.41**	-0.24
RH 115-OA × Ogura 58	1.49	-5.01	0.01	-0.67	0.59**	-0.92	-0.20
RH 115-OA × Ogura 101	0.07	2.78	-0.61	-2.42	-0.07	4.83**	0.40
RH 119-OA × Ogura 17	0.20	10.20*	-0.20	-1.29	-0.15	2.18**	-0.65
RH 119-OA × Ogura 24	-0.43	-6.80	-0.36	-2.29	1.07**	-0.52	0.22
RH 119-OA × Ogura 58	-0.01	3.24	0.43	1.67	-0.22*	2.26**	0.57
RH 119-OA × Ogura 101	0.24	-6.64	0.14	1.92	-0.70**	-3.93**	-0.14
RH 121-OA × Ogura 17	1.95	2.03	0.05	-0.54	0.20*	5.16**	0.56
RH 121-OA × Ogura 24	-0.01	3.70	0.55	0.46	-0.22*	-2.17**	0.21
RH 121-OA × Ogura 58	-0.59	-8.47	-0.66	0.75	0.12	-0.57**	-0.02
RH 121-OA × Ogura 101	-1.34	6.03	0.05	-0.67	-0.11	-2.42**	-0.75
RH 427-OA × Ogura 17	-0.30	-0.30	0.80	2.71*	-0.04	2.63**	-2.28**
RH 427-OA × Ogura 24	-0.26	-9.59	0.64	-0.29	0.10	2.77**	2.00**
RH 427-OA × Ogura 58	0.16	3.86	-0.91	-1.67	-0.07	0.01	-0.53
RH 427-OA × Ogura 101	0.41	-5.80	-0.53	-0.75	0.02	-5.41**	0.80
RH 555-OA × Ogura 17	0.78	-9.14	-0.86	-3.88**	-0.50**	-3.79**	0.65
RH 555-OA × Ogura 24	0.49	9.24	-0.70	-0.54	-0.40**	1.64*	-0.54
RH 555-OA × Ogura 58	-0.09	5.70	1.09	2.42	0.30**	2.55**	0.07
RH 555-OA × Ogura 101	-1.18	-3.39	0.47	2.00	0.59**	-0.40	-0.17
RH 0749-OA × Ogura 17	-2.39	8.95	0.55	-0.79	0.26**	-0.82	0.79
RH 0749-OA × Ogura 24	-0.34	-8.01	-0.61	0.88	0.16	1.82**	-1.03
RH 0749-OA × Ogura 58	2.07	2.45	-0.16	-0.17	-0.54**	2.49**	-0.52
RH 0749-OA × Ogura 101	0.66	-1.47	0.22	0.08	0.12	-3.49**	0.77
RH 832-OA × Ogura 17	1.20	-1.80	0.30	4.13**	-0.15	5.72**	0.45
RH 832-OA × Ogura 24	-0.09	2.91	-1.86**	-6.21**	0.01	-7.18**	-0.34
RH 832-OA × Ogura 58	-0.68	0.36	0.93	0.75	0.21*	-3.34**	0.47
RH 832-OA × Ogura 101	-0.43	-0.22	0.64	1.33	-0.06	4.81**	-0.57
SE (±) SCA	2.89	6.43	-0.70	0.85	0.1	2.31	0.27

Machine learning algorithm for soybean leaf disease detection

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ABSTRACT

Agriculture is now the primary source of income for nearly 45% of India's population. This makes it important to aid farmers with crop cultivation, protection, and harvesting. Soybean is one of the most widely grown plants in India, especially in the states of Madhya Pradesh and Maharashtra. But soybean crops are prone to diseases like yellow mosaicand anthracnose, amongst others. We propose hybrid deep learning algorithm to detect diseases in soybean plant leavesusing computer vision techniques. In the experimentation, various classification algorithms were compared using accuracy.

Keywords: Machine learning, Leaf disease detection, Soybean

Disorders in crops have long been a major source of anxiety for farmers. The potential for agricultural output to be negatively impacted is high. But in agriculture, it would be very helpful to be able to find the real problem by making a precise and accurate diagnosis. Leaf-based image categorization algorithms have shown outstanding results [1]. Automatic diagnosis of plant diseases can help farmers monitor large fields of plants and identify diseases using machine learning. Manual disease diagnosis is less accurate and time-consuming than machine-learning image processing [2].

MATERIALS AND METHODS

The proposed pipeline is as follows:

1. Semantic segmentation
2. Feature extraction
3. Classification

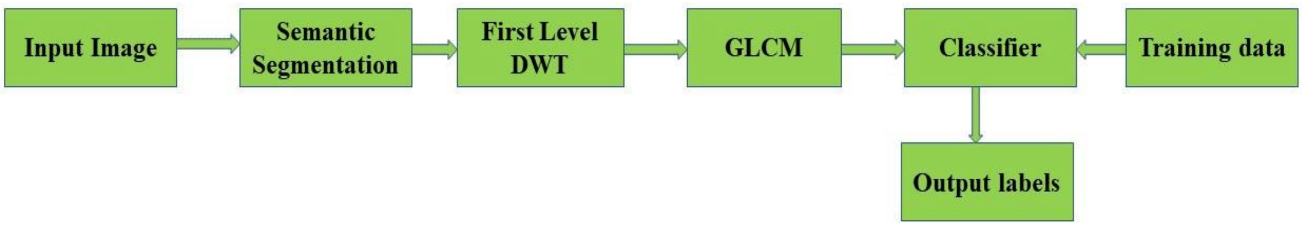

Figure 1: Pipeline of proposed method

SEMANTIC SEGMENTATION

The elimination of the unnecessary background improves the quality of the extracted feature vector. For the segmentation task, a model with U-Net architecture and ResNet-30 as the backbone is used, which is initialized with pre-trained Image-Net weights [2].

FEATURE EXTRACTION

The segmented image is then decomposed using the discrete wavelet transform, and the GLCM (Gray Level Co- Occurrence Matrix) is computed for the obtained coefficients as shown in Figure 2. The contrast, correlation, energy, and homogeneity of each GLCM matrix are passed as features to the classifier for labelling. Some of the diseases can be distinguished based on the color of the image. It was experimentally observed that passing the number of pixels, in the brown range, helped improve the classification accuracy. The number of brown pixels is calculated by thresholding the hue and chroma values [3].

Discrete Wavelet Transform (DWT)

The discrete wavelet transform is good for removing noise from images and making them smaller because it makes it possible to represent images with fewer coefficients. The image is decomposed using the db4 wavelet.

Gray Level Co-occurrence Matrix (GLCM)

GLCM is a second-order statistical texture analysis method. It examines the spatial relationship among pixels and defines how frequently a combination of pixels is present in an image.

CLASSIFICATION

The classification algorithms, like the Support Vector Machine (SVM), Decision Tree, K-Nearest Neighbor (KNN), along with a proposed hybrid deep learning model based on neural network were used for the multi-class classification.

DATASET

The dataset considered includes images taken from the ICAR-Indian Institute of Soybean Research, Indore, Madhya Pradesh, India. The dataset consisted of images of leaves which were either healthy or infected with anthracnose, dried diseased, insect and yellow mosaic. 80% of the images were allocated for training purposes, with the rest for testing andvalidation.

RESULTS AND DISCUSSION

Various classification algorithms like the SVM, Decision Tree, KNN, and proposed hybrid deep learning method were used to identify the diseases in the test images, using the obtained feature vector. The training and testing accuracy for each algorithm is shown in Table 1, with the proposed hybrid deep learning method resulting in the maximum training and testing accuracy.

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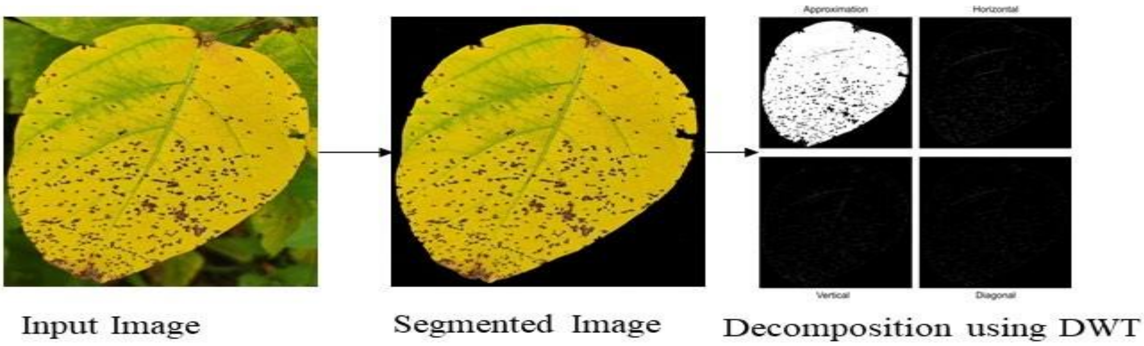

Figure 2: Steps of decomposition of segmented image using DWT.

Table 1 Training and testing accuracy of classification algorithms.

Classification Algorithm	Training Accuracy	Testing Accuracy
SVM	0.7297	0.5
Decision Tree	0.8648	0.4
KNN	0.7837	0.7
Proposed Hybrid Deep Learning	0.8108	0.73

Influence of integrated nutrient management on growth, yield and quality of mustard (*Brassica Juncea* L.)

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ABSTRACT

A field experiment was conducted during *rabi* 2020- 2021 at Experimental Farm, Agronomy, Oilseeds Research Station with objectives of to study the influence of integrated nutrient management on growth, yield and quality of mustard. The experiment was laid out in Randomized Block Design with 8 treatments each with three replications. The results of the experiment indicated that combined application of RDF + Vermicompost @ 2.5 t/ha

(T_3) observed significantly maximum growth parameters, dry matter, yield attributes and yield. The application of RDF + Vermicompost @ 2.5 t/ha (T_3) recorded the significantly highest oil content. The application of RDF + Vermicompost @ 2.5 t/ha (T_3) obtained maximum net returns. Highest B:C ratio was obtained with the application of RDF + Vermicompost @ 2.5 t/ha (T_3).

Keywords: FYM, Gypsum, Micronutrients, Mustard, Integrated Nutrient Management, Vermicompost

Indians are suffering from a great shortage of edible oils. The gap between production and consumption is more. There is deficiency of secondary and micronutrients in Indian soils. Productivity of mustard is very low because it is mainly grown in rainfed condition and inadequate fertilizer deficiency of essential plant nutrients. Addition of FYM directly adds organic carbon and helps to stimulate the growth and activity of microorganisms. Application of different sulphur fertilizers significantly increases seed yield of mustard crops ranging from 2.5 to 26.7% (Ahmad *et al.,* 2005). Vermicompost application improves physical, chemical and biological properties of soil (Nagavallemma *et al*., 2004). The application of poultry manure stimulates the soil microbial growth and activity, subsequent mineralization of plant nutrients and increases soil fertility and quality. Beneficial effect of gypsum on yield and yield attributes of mustard may be ascribed to beneficial role of sulphur and Ca present in gypsum, not only improves biotic activity but also helps to improve physico-chemical properties of soil. Although a lot of studies on nutrient management in mustard has been undertaken but studies on integrated nutrient management are quite meagre. Hence, present studies were planned to evaluate options of different organic and inorganic sources of sulphur and micronutrient fertilizers for mustard.

MATERIALS AND METHOD

A field experiment at Experimental Farm, Oilseeds Research Station, Latur during (*Rabi)* 2020- 2021. The experiment was laid out in Randomized Block Design with 8 treatments each with three replications. The treatments were T_1 - Control, T_2 - RDF + FYM @ 5 t/ha, T_3 - RDF + Vermicompost @ 2.5 t/ha, T_4 - RDF + Poultry manure @ 5 t/ha, T_5 - RDF + Elemental sulphur @ 20 kg/ha, T_6 - RDF + $ZnSO_4$ @ 20 kg/ha, T_7 - RDF + $FeSO_4$ @ 20 kg/ha and T_8 - RDF + Gypsum @ 500 kg/ha. The gross and net plot size was 5.4 m x 4.5 m and 4.5 m x 3.9 m, respectively. Crop was raised as per the recommendation of VNMKV, Parbhani. Data obtained on various variables were analysed by "analysis of variance method" (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

The results of the experiment indicated that combined application of RDF + Vermicompost @ 2.5 t /ha (T_3) observed significantly maximum growth parameters viz., plant height (157.9 cm), number of branches (14.07), number of leaves (43.73), leaf area (41.06 dm^2) and dry matter (79.40 g) compared to control (t1) (114.88), (10.30), (33.13), (31.92 dm2) and (62.90) respectively. T_3 - RDF + Vermicompost @ 2.5 t/ha recorded significantly highest number of silique/plant (438.93) , length of silique (4.73 cm), number of seeds/silique (17.93), seed yield/plant (25.40 g), straw yield/plant (51.80 g), test weight (5.25 g) and seed yield (2051 kg/ha), straw yield (5778 kg/ha) and biological yield (7879 kg/ha), but statistically remained at par with T_2 - RDF + FYM @ 5 t/ha (394.13), (4.33 cm), (17.20), (24.33 g), (49.67 g), (5.16 g), (1846 kg/ha), (5225 kg/ha), (7071 kg/ha) respectively and T_8 - RDF + Gypsum @ 500 kg/ha (390.93), (4.20 cm), (17.07), (23.93 g), (48.87 g), (5.07 g), (1812 kg/ha), (5168 kg/ha), (6980 kg/ha) respectively. The application of RDF + Vermicompost @ 2.5 t/ha (T_3) recorded highest oil content (40.96%) and oil yield (840 kg/ha). The application of RDF + Vermicompost @ 2.5 t/ha (T_3) obtained maximum net returns (39139 Rs/ha). Highest B:C ratio (1.87) was obtained with the application of RDF + Vermicompost @ 2.5 t/ha (T_3).

Table 1. Influence of integrated nutrient management on Number of silique plant^{-1}, Seed yield (kg ha^{-1}), Straw yield (kg ha^{-1}), Test weight (g), Oil content (%), Oil yield (kg ha^{-1}) and Net Monetary Returns (NMR) (Rs. ha^{-1}).

Treatments	Number of silique/plant	Seed yield (kg/ha)	Straw yield (kg/ha)	Test weight (g)	Oil content (%)	Oil yield (kg/ha)	NMR (Rs./ha)
T_1 - Control	332.13	1174	3966	4.18	38.22	449	14935
T2 - RDF + FYM @5 t/ha	394.13	1846	5225	5.16	40.18	742	34238
T3 - RDF + Vermicompost @ 2.5 t/ha	438.93	2051	5778	5.25	40.96	840	39139
T4 - RDF + Poultry manure @ 5 t/ha	360.07	1493	4672	4.55	39.88	595	18258
T5 - RDF + Elemental sulphur @ 20 kg/ha	352.93	1464	4615	4.38	41.44	607	23872
T6 - RDF + ZnSO4 @ 20 kg/ha	369.07	1590	4974	4.86	39.90	634	28429
T7 - RDF + FeSO4 @ 20 kg/ha	359.73	1481	4621	4.49	38.76	574	25291
T8 - RDF + Gypsum @ 500 kg/ha	390.93	1812	5168	5.07	40.16	728	33336
SE ±	16.41	92	224	0.24	1.77	27.72	3789
CD at 5%	49.76	280	680	NS	NS	84.08	11493
General mean	374.74	1614	4877	4.74	39.94	646	27188

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Horticulture – A repository of speciality oils

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ABSTRACT

There are a number of vegetable oils used in the world by the people in their day to day life for cooking, medicines, fuel...etc of which sunflower oil, safflower oil, sesame oil, palm oil, rape seed oil account for the largest percentage. There are also other oils which are derived from the horticultural crops though used in a small quantity by a small section of people possess an immense value. They are used for a wide range of purposes like medicine, cosmetics, cooking, pesticides, fungicides, perfumes…etc. Different crops produce different kinds of oils used for different purposes. Horticultural crops like fruit crops, vegetable crops, ornamentals, spices, plantations, medicinal and aromatic crops are used for extracting the oils. As the cost of a small amount of these oils is too high, it is a fetching business for the farmers to commercialize the production of these crops.

Keywords: Horticulture, Oils, Purpose and commercialize, Quantity

Globally four crops *viz.*, oil palm, soybean, rapeseed and sunflower account for majority of the edible oils produced and consumed. These oils are mostly used for culinary preparations. Apart from these there are certain oils derived from horticultural crops. These oils may be the derivatives of leafs, fruits, seeds, roots, barks, stems, flowers…etc of vegetables, fruit crops, ornamentals, spices, medicinal, plantations and aromatic crops. Though they account for a low percentage both in terms of production and also usage, they have many uses for the mankind. These oils may be essential oils which are volatile in nature and horticultural oils mainly used for pest and disease controls. Vegetable oils can be classified in several ways, for example: By source: most, but not all vegetable oils are extracted from the fruits or seeds of plants, and the oils may be classified by grouping oils from similar plants, such as "nut oils". By use: oils from plants are used in cooking, for fuel, for cosmetics, for medical purposes, and for other industrial purposes. The common classes of oils in use are edible oils, oils as bio-fuels, drying oils and others. The main objective of producing and using oils from horticultural crops are., being eco-friendly without any harmful residues., processed even individually without much labour and to protect human and plant health.

MATERIALS AND METHODS

There are various methods specifically designed for different crops and the different parts of a single plant. Steam distillation, Gas chromatography, cold pressing of the pulp or juice, ohmic heating, use of oxidants, solvent extraction, subcritical oil extraction, hydraulic fracturing, or fracking, bridge pressing or spindle pressing and wide range of chemicals are also used for extraction like diethyl ether, n-pentane, alcohols which are used as solvents. When the oil is used as a pesticide or fungicide, it's possible to dilute a bottle of concentrate and apply with a sprayer or use ready-to-spray formulations. The latter option is simpler to use but will be more expensive. Check the label for intolerance of oils.

RESULTS AND DISCUSSION

The various kinds of oils produced from horticultural crops are used for various purposes of the day to day life. few of the examples are, edible oils like coconut oil, olive oil, palm oil, nut oils like almond oil, cashew oil, hazel nut oil, macadamia oil, pecan nut oil, pistachio oil, wal nut oil and a number of oils are used as food supplements, for their nutrient content or medical effect like acai oil, grape seed oil, blackcurrant seed oil, borage seed oil evening primrose oil and some other edible oils are amaranth oil, apricot oil, argan oil, artichoke oil, avocado oil, babassu oil, ben oil, borneo tallow nut oil, buffalo gourd oil, carob pod oil (algaroba oil), coriander seed oil, grape seed oil, hemp oil, kapok seed oil, lallemantia oil, meadow foam seed oil, mustard oil (pressed), okra seed oil (hibiscus seed oil), from the seed of the hibiscus esculentus, perilla seed oil, pequi oil, pine nut oil, poppy seed oil, prune kernel oil, pumpkin seed oil, quinoa oil, ramtil oil, tea oil, thistle oil. a number of the oils mentioned above are used for biofuel (biodiesel and straight vegetable oil) in addition to having other uses. A number of oils are used only as biofuel. Algae oil, copaiba, honge oil, jatropha oil, jojoba oil, milk bush, petroleum nut oil. Drying oils that dry to a hard finish at normal temperatures which are used as the basis of oil paints, and in other paint and wood finishing applications like dammar oil, poppy seed oil, stillingia oil, tung oil, vernonia oil which can be used to make epoxies for manufacturing adhesives, varnishes and paints, and industrial coatings. A few other oils which are not used as edible oils are amur cork tree fruit oil, balanos oil, bladderpod oil, brucea javanica oil, burdock oil (bur oil) candlenut oil (kukui nut oil), carrot seed oil (pressed), chaulmoogra oil, crambe oil, cuphea oil jojoba oil, lemon oil, mango oil, mowrah butter, neem oil, orange oil, palm kernel oil, rosehip seed oil, sea buckthorn oil, shea butter, snowball seed oil (viburnum oil), tall oil, tamanu oil and tonka bean oil (cumaru oil).

CONCLUSION

Due to the high economic value of worldwide trade of fresh horticultural produce, a considerable number of investigations are done on these crops with special emphasis on oils produced from them. The research and study on the oils produced by horticultural crops is in its grass root level as most of us are aware of only a few oils, further research on the oils extracted from horticultural crops is most important and farmers must be encouraged to grow these crops stressing the importance of the oils extracted from them to commercialize the horticultural crops for oil extraction.

Storability, longevity and rancidity: A genomic perspective on evolutionary constraints in major oilseeds

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ABSTRACT

Limited longevity and accelerated chemical decomposition during storage are major problems found in oilseeds. In the present study the genomic composition of rancidity prone soybean and sunflower are compared with oil seeds with fairly good storability like sesame and olive. The chromosomal location, gene duplications, syntenic relationships, cis-element architecture and protein-protein interactions were studied with respect to 250 genes affecting lipid decomposition like lipases, lipoxygenases and oleosins. The expansion of lipoxygenases and phospholipaseD genes in soybean and sunflower indicate the importance of gene duplication in functional divergence. Moreover the effect of strong purifying selection in lipid decomposition genes was evident in shaping the genomic diversity.

Keywords: Lipase, Lipoxygenase, Oilseeds, Oleosin, Rancidity

Plant-based edible oils are rich in triacylglycerols (TAGs) and constitute a major share of human dietary consumption. However, the lipid rich seeds have limited longevity and are prone to chemical decomposition leading to loss of germination and viability during storage. Lipid oxidation during storage leads to loss of essential fatty acids meanwhile producing free radicals and peroxides, ultimately resulting in irreversible damage to membranes, proteins, DNA and cell repair mechanisms. Moreover, rancidity development as a consequence of this the most important factor contributing to reduction in oil quality and quantity during storage. The major players involved in this cascade are lipases like phospholipaseD and triacylglycerol lipase (TGAL); lipoxygenases (LOXs) and oleosins which are the major surface proteins modulating the size and stability of oil bodies (OB) containing TAGs. The mobilization of lipid reserves stored in OBs during germination by lipases and lipoxygenases make them a boon for germination while becoming a bane for lipid stability. In this context we investigated the genomic architecture of lipases, lipoxygenases and oleosins in major oilseed crops like soybean, sunflower, sesame and olive with wide differences in long term storability and rancidity development.

MATERIALS AND METHODS

The gene sequences for the study were obtained from Soybase (https://www.soybase.org/), Phytozome (https://phytozome-next.jgi.doe.gov/) and sesame pan-genome (Yu et al. 2019). The protein sequences were aligned using CLUSTAL X ver 2.1 and were subjected to Bayesian phylogenetic inference using MCMC by BEAST ver 2.6.6 (Bouckaert et al. 2019). The syntenic relationships between all four genomes and the non-synonymous/synonymous (Ka/Ks) mutation ratio were probed with MCScanX using TB tools. Protein-protein interaction network was visualized with the help of STRING ver 11.5 (https://string-db.org/). The cis-element identification was done by subjecting upstream 2000bp sequences from all the genomes to PLANT CARE (https://bioinformatics.psb.ugent.be/webtools/plantcare/html/) and comparing with the reported Arabidopsis cis-elements.

RESULTS AND DISCUSSION

Gene copy numbers for all the categories were much lesser in sesame and olive when compared to more rapidly deteriorating soybean and sunflower. There was an expansion of multi-intronic lipoxygenase and phospholipaseD genes in soybean and sunflower compared to sesame and olive. This expansion was confirmed phylogenetically and involved eight and seven intron genes in LOX and nine intron genes in phospholipase D resulting in unique homologs with wide variation in protein parameters. Although the number of genes detected in soybean was much higher than sesame, the exon number per gene was similar; 8.76 and 8.64 respectively. Maximum number of introns noticed for single gene was 23 in olive phospholipase D gene *Oeu031987.1*.The oleosin genes were more conserved within species with most of them being intron less and having molecular weight of 73-258kDa. All of the studied TGAL genes had 3 introns although difference in molecular weight was prominent. Sequence conservation was evident within the order Lamiales involving sesame and olive even though more duplicates were accounted for soybean and sunflower.

The collinearity percentage between sunflower and soybean was 17.34% compared to 23.77% between sesame and olive. In sunflower 78% of the studied genes were dispersed duplicates whereas 43% of soybean genes were single copy genes. Majority of the lipases, lipoxygenases and oleosins were under purifying selection in olive and sunflower while none of the studied loci in soybean exhibited significant selection effects. However, all of the oleosin genes in sesame were under positive selection. The age for LOX genes was calculated as 5-150 MYA while the oleosin genes under positive selection evolved 40-70MYA. ABRE elements had important roles to play in the functioning of LOX and TGAL genes while STRE elements were crucial for phospholipase D and oleosin genes. MYB and MYC elements were common in all the four categories. The protein-protein interaction studies indicated that in soybean which is more prone to rapid deterioration under storage, the fatty acid metabolism was combined with oxidative stress response leading to senescence under Jasmonic Acid (JA) mediated signaling (Mir *et al.* 2018; Ruan *et al*. 2019). Sesame which is less prone to rancidity had different interaction scenario where the role of oleosins were limited. Here the same category genes were involved with stress response and starch synthesis as well as release of fatty acids from germinating seedlings in addition to JA mediated signaling. The study of key genes involved in lipid oxidation, stress response and germination indicate the role of accelerated evolution through gene duplication leading to functional differentiation and enhanced adaptation.

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Impact assessment of front line demonstration of safflower on farmers' fields

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ABSTRACT

AICRP on Safflower, VNMKV, Parbhani conducted 160 demonstrations on safflowers during Five consecutive years from 2017–18 to 2021–22. The critical inputs were identified in existing production technology through meetings and discussions with farmers. Uncontrolled weeds, ignorance about fertilizers and lack of plant protection measures, were the predominant identified causes of low productivity of safflower. The average results of Five years study revealed that the Seed yield under demonstration plots was 1290 Kg/ha as compared to 994 kg /ha in traditional farmer practices plots. The results clearly indicate the positive effects of FLDs over the existing practices. Percentage increase Seed yield over farmer practice was found 30%.

Keywords: Frontline demonstrations, Safflower

Safflower is grown in dry and semi-arid areas characterised by its strong tap root system through which it can draw water from deeper soil layers and is drought tolerant. Safflower seed contains 24-36% oil content. Safflower oil is traditionally a linoleic type with 71–75% linoleic acid and is a polyunsaturated edible oil. Oleic safflower oil is highly preferred in the food, pharmaceutical, biofuel production, paints, lubricants and cosmetics industries (Yesilyurt*et al*., 2020, Nogales-Delgado *et al*., 2021). However, Safflower crop have given the importance by the government because vast yield gap exists between potential yield and yield under real farming situation. AICRP on Safflower, VNMKV, Parbhani in co-ordination with ICAR-IIOR, Hyderabad made intensive efforts on training about scientific cultivation, demonstration on new variety and other interventions. The present study was conducted to impact assessment of front line demonstration on safflower crop. Front Line Demonstration (FLD) on Safflower Crop is an applied approach to accelerate the dissemination of proven technologies at farmer's fields in a participatory mode with an objective to explore the maximum available resources of crop production and also to bridge the productivity gaps by enhancing the production in national basket along with to increase socio-economy of farmers. Front line demonstration (FLD) is a long term educational activity conducted in a systematic manner in farmers' fields to worth of a new practice/technology. Farmers in the district are still producing crops based on the knowledge transmitted to them by their forefathers leading to a grossly unscientific agronomic, nutrient management and pest management practices.

MATERIAL AND METHODS

Assessment of gap in adoption of recommended technology before laying out the frontline demonstrations (FLD's) through personal discussion with selected farmers. The awareness programme (preseason training) was organized for selection of farmer's and skilled development about detailed technological intervention with improved package and practice for successful cultivation. Critical inputs for the technologies to be demonstrated (Table 1) were distributed to the farmers after the training like improved high yielding variety, recommended chemicals and literature and regular visit, monitoring and pest and disease advisory services management by the AICRP On Safflower, VNMKV, IIOR scientist to the demo farmers. Finally field day was conducted involving demonstration holding farmers, other farmers in the village, Scientists from University, officials from Department of Agriculture and local extension functionaries to demonstrate the superiority of the technology for each crop. Crop yield was recorded from the demonstration and control plots for the crops at the time of harvest. The most feasible way by which this could be achieved is by demonstrating the recommended improved technology on the farmer's fields through front line demonstrations with the objectives to work out the input cost and monetary returns between front line demonstration and farmers methods, to identify the yield gaps between farmer's practices and front line demonstrations.

The basic information were recorded from the farmer's field and analyzed to comparative performance of frontline demonstrations (FLD's) and farmer's practice. Detailed package and practices with technological intervention for recommended practice. It was also observed that farmer's mostly didn't use fungicides, Bio-fertilizers, weedicide and not maintain proper plant population.

RESULTS

Problems faced by the farmers in safflower cultivation were documented during the study, Famer 's did not get labor for timely harvesting, less MSP of safflower, because of labor shortage and less MSP farmer ignore the crop production technology and consider the crop only up to own consumption. The improved package and practices is more important with technological intervention for productivity and profitability of safflower. Detailed package and practices with technological intervention for recommended practice (Table 1). It was also observed that farmer's use injudicious and mostly didn't use fungicides. Similar observations were reported by (Singh et al., 2011).

The seed yield and percent Increase of safflower in demonstrated field's and farmer's practice is presented in table 2. Data revealed that average seed yield of demonstrated field's was higher from farmer's practice in all years. The results revealed that average seed yield of safflower frontline demonstrations was1290 Kg ha^{-1} as compared to 994 Kg ha^{-1} in traditional farmer practices plots. Average seed yield increase of 30%. The above finding was in accordance with Singh et al., (2011)

CONCLUSION

Appropriate agronomical management practices with improved varieties are necessary to realize profitable yields from safflower. Selection of varieties has wide options for safflower and should be selected to specific requirement of farming situations. Thus, for adoption of complete package of practices balanced fertilizer use not only increase crop yield but also improves farmers profit.

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Total no.1. Total no. of FLDs conducted during the period

Technology	No. of FLDs Safflower					
	2017-18	2018-19	2019-20	2020-21	2021-22	Total
Whole Package	30	30	--	--	--	10
Seed treatment			05	10	05	30
Farm mechanization			--	--	05	05
PDM			--	10	05	25
Intercropping			--	05	05	20
Variety/hybrid			05	--	05	20
Fertilizer management			05	05	--	20
Life saving irrigation	--	--	05	20	--	25
Spacing	--	--	05	--	--	05
Total	30	30	25	50	25	160

Table No.2. Frontline demonstration assigned and conducted including TSP:-

Year	No, of FLDs assigned	No, of FLDs Conducted	Average yield obtained in IP	Average yield obtained in Farmers field	Major impact of FLD in the region (% increase in yield)
2017-18	30	30	1326	1043	27.20
2018-19	30	30	1234	1002	23.00
2019-20	25	25	1293	1009	28.10
2020-21	50	50	1362	982	40.10
2021-22	25	25	1233	935	32.06
Total/Av.	160	160	1290	994	30.09

Evaluation of elite soybean genotypes for yield and rust resistance in Southern Zone of India

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ABSTRACT

The genotype x environment interaction (GEI) is an important aspect of plant breeding program as it decides the general and specific adaptation of a variety to the varied environments. Higher magnitude of GEI were noted in soybean with significant influence on yield. In the present study fourteen genotypes were evaluated at six locations in Southern Zone of India (Adilabad, Bangalore, Bidar, Dharwad, Kasbe Digraj and Pune) during *Kharif* 2017, 2018 and 2019. Across locations, DSb 34 recorded 21 % and 18 % increased yield over zonal check (DSb 21) and rust susceptible check (JS 335), respectively. DSb 34 also exhibited highly resistant reaction to rust disease at hotspot location and can be used as donor in soybean disease resistance improvement.

Keywords: Soybean, Yield, Rust

Soybean is an important oilseed crop ranks first both in area and production in India which is known as ‘Wonder crop’ of 21st century due to its nutritional aspects. In India, it occupies an area of 12.18 m.ha with the production of 13.12 m.t and productivity of 1077 kg/ha (Anon., 2022). Soybean production has intensified in India, a trend that is expected to continue due to its market value. Soybean yield is a complex quantitative trait controlled by many genes and determined by multiple interactions between genes and environment. Yield greatly affected by environmental conditions especially day length of different latitude. Photoperiod is the leading climatic factor in determining soybean adaptation to different climatic conditions. Due to photoperiodic sensitivity, the cultivation area of each soybean cultivar was restricted to a very narrow range of latitudes to attain its highest yield. Also outbreak of diseases is major impediment in achieving higher productivity. Among the diseases, soybean rust incited by pathogen *Phakopsora pachyrhizi*, is major disease and reported yield losses of > 30 per cent are noted which may go up to 100 per cent in congenial environment (Sarbhay and Pal, 1997). Therefore, development of rust resistant and high yielding varieties is of prime importance. Hence, in the present study, a set of elite genotypes from different centers were evaluated for grain yield potential in different locations of Southern Zone of India over three years in addition to assessing reaction against rust at hotspot.

MATERIAL AND METHODS

A set of fourteen genotypes including a rust resistant (DSb 21) and highly susceptible (JS 335) check were sown in randomized block design at six locations in Southern Zone of India (Adilabad, Bangalore, Bidar, Dharwad, Kasbe Digraj and Pune) over three years (2017, 2018 and 2019) during *Kharif*. Genotypes were evaluated for yield along with disease reaction to rust under natural ephiphytotic conditions. The severity of rust was scored between 65-90 days after sowing based on pe rcent leaf area infected by using 0-9 scale (Mayee and Datar, 1986) and data was analyzed using standard statistical procedures for individual locations and combined analysis on weighted mean over locations.

RESULTS AND DISCUSSION

Among the locations, Pune has higher mean seed yield in all the three years (Table 2). Dharwad and Kasbe Digraj have recorded mean yield of around 200 kg/ha across genotypes in all the three years. Across the locations and the years, DSb 34 recorded higher seed yield 2703 kg/ha followed by KDS 992 (2610 kg/ha) and MACS 1493 (2603 kg/ha). DSb 34 has recorded 21 % higher over rust resistant check DSb 21 (2244 kg/ha) and 18 % over JS 335 (2276 kg/ha). In addition, DSb 34 exhibited highly resistant reaction to rust with disease grade of 1 along with check DSb 21. Seven genotypes were moderately susceptible and four genotypes were susceptible whereas JS 335 exhibited highly susceptible reaction (Table 2).

Owing to rust resistance nature of DSb 34 with a pedigree of DSb 23 x JS 95-60 is highly resistant to rust and higher seed yield. This genotype was also reported to be early maturing reported by Harshiya Banu *et al*., (2022) with a maturity duration of 85-90 days which is on par with JS 335 and 5-8 days early compared to DSb 21. Therefore, DSb 34 is ideal for cultivation under rainfed conditions and can also be used in intercropping by the farming community in the Southern Zone of India.

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Table 1 Details of elite soybean genotypes used in the study

Genotypes	Contributing centre	Trait of interest
DSb 34	UAS, Dharwad, Karnataka	Earliness, rust resistant and high yielding
MACS 1493	ARI, Pune	High yield
KDS 992	MPKV, Rahuri	Bold seeded (15.8 g/100g seed)
RSC 11-07	IGKV, Raipur	High yield
AMS 100-39	PDKV, Akola	High yield
NRCSL 1	IISR, Indore	Yellow Mosaic Virus resistant and high yield
BAUS 102	BAU, Jharkand	High yield
AMS 2014-1	PDKV, Akola	High yield
SKF-SP-11	Mandsur, MP	High yield
NRC 132	IISR, Indore	India’s first lipoxygenase-2 free variety
DSb 21 (C)	UAS, Dharwad, Karnataka	Rust resistant and high yield
RKS 18 (C)	MPUAT, Udaipur, Rajasthan	Moderately resistant to bacterial pustules and soybean mosaic virus, but susceptible to rust.
JS 335 (C)	JNKVV, Jabalpur	High yielding, resistant to bacterial pustule, bacterial blight and tolerant to green mosaic and susceptible to rust and YMV
JS 93-05 (C)	JNKVV, Jabalpur	Earliness, seed longevity and resistant to major diseases and insect pests

Table 2 Performance of elite soybean genotypes for yield over the years and rust resistance reaction at hotspot location, Dharwad

Varieties	Adilabad			Bangalore			Bidar			Dharwad			Kasbe Digraj			Pune			Mean	Rust
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019		
DSb 34	1654	3287	3241	3333	3259	3222	2790	1582	1259	2884	2809	2681	2321	2253	1884	3753	3858	3282	2703	1 (HR)
MACS 1493	1012	3495	3250	3605	2867	2296	3457	1073	1528	2672	2222	2269	2148	2307	1750	4272	3966	3690	2603	7 (S)
KDS 992	1309	3071	3324	3877	3111	3250	2222	1034	1616	1799	2593	2389	2420	2577	2000	4025	3873	3352	2610	5 (MS)
RSC 11-07	2889	3302	3319	2914	3215	2440	2568	1319	1759	2222	1960	2079	2395	1914	1102	3383	3627	3204	2496	5 (MS)
AMS100-39	2019	2207	3069	3259	2622	3028	2370	1559	1542	2751	2207	2398	1778	2153	1727	3383	3704	3259	2461	5 (MS)
NRCSL 1	1333	3210	2125	3111	2222	2023	2543	1698	1676	2857	2423	1083	2346	1829	1144	3284	3634	3292	2277	5 (MS)
BAUS 102	1284	3194	2426	3407	2993	2907	2593	887	1495	1984	2184	2306	2321	1821	1083	3877	3681	3458	2385	5 (MS)
AMS2014-1	1259	3117	2889	3284	2281	2407	2914	1289	1620	2460	2029	1019	2148	1898	1065	3802	3573	3296	2300	5 (MS)
SKF-SP-11	1975	3241	2787	3580	2533	2792	2593	1667	1389	2328	1836	1634	2247	2029	1139	3136	3279	2222	2333	7 (S)
NRC 132	1951	3071	2495	3136	2593	2542	2691	1042	1394	2143	2207	1597	1778	1613	1116	4049	3110	3329	2274	5 (MS)
DSb 21 (C)	1753	1914	2208	2346	2970	2866	2346	1435	944	2831	2816	2509	1926	1975	1338	2864	2963	2889	2244	1 (HR)
RKS 18 (C)	1728	1844	2083	3654	3044	2176	3654	1505	1463	2063	2060	1968	1802	1752	1097	3259	3356	3440	2286	7 (S)
JS 335 (C)	2444	2508	2495	2469	2763	2606	2469	1605	1454	2354	2230	2153	1556	1721	1056	3111	3318	3403	2276	9 (HS)
JS 93-05 (C)	2099	2323	2370	2741	3081	2565	2741	1682	1431	2011	1860	1949	1407	1898	1106	2321	2654	3028	2160	7 (S)
MEAN	1531	2902	2754	2691	2786	2610	2691	1391	1450	2068	2223	2021	2039	1978	1331	3280	3429	3269		
CD (0.05)	197.5	385.8	328.7	395.1	340.7	393.5	395.1	254.6	217.6	343.9	231.5	268.5	444.4	285.5	194.4	419.8	177.5	189.8		
CV (%)	7.9	9.25	8.3	9.06	12.08	10.51	9.06	16.94	10.41	10.86	7.27	9.29	14.09	10.1	10.25	8.19	3.7	4.07		

HR = Highly Resistant, MS = Moderately Susceptible, MR =Moderately Resistant, S=Susceptible, HS=Highly Susceptible

Interspecific hybridization in niger *(Guizotia abyssinica* l.f. cass)

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ABSTRACT

The study presents the results of successful establishment and interspecific hybridization of cultivated Niger (*Guizotia abyssinica*) with one of its wild allies, *G. scabra.* Out of four accessions of wild species collected from Kenya, two accessions (P3: EC1077609 and P4: EC1077610) could be successfully established that were used in interspecific crosses. Direct and reciprocal crosses were made (JNS-28 x P3; JNS-28 x P4) and adequate quantity of F_1 seed was obtained in crosses of wild x cultivated. Morphological analysis of the F_1 hybrids showed the vigorous nature of the interspecific hybrids and the results are presented.

Keywords: Interspecific hybridization, Niger

Niger (*Guizotia abyssinica* L.f. Cass) is a minor oilseed crop that belongs to the Asteraceae family and is primarily grown in Ethiopia and India (Geitnet and Sharma, 1996). The genus *Guizotia* has six species *viz*., *G. abyssinica* L.f. Cass, *G. scabra* (vis.) Chiov. subsp. *scabra*, *G. scabra* (vis.) subsp. *schimperi* Baagoe, *G. arborescens* I. Friis, *G. reptans* Hutch, *G. villosa* Sch. Bip and *G. zavattarii* Lanza (Baagoe, 1974). The controlled introgression of advantageous genes from related taxa in to the crop gene pool has been successfully employed in many crop species (Hauser *et al.,* 1998). Earlier studies have reported the crossability between the cultivated and wild species of Niger (Murthy *et al*., 1993; Dagne, 1994) and the present study describes the F_1 hybrids between *G. scabra* and cultivated Niger (JNS-28).

MATERIALS AND METHODS

Seed material of four accessions of *G. scabra* subsp. *scabra* was obtained from Kenya. Out of the four accessions planted, only two accessions were successfully established (P3: EC1077609 and P4: EC1077610) in the research farm of ICAR-IIOR, Rajendranagar, Hyderabad. The data on days of flowering, plant height, number of branches, number of capitula, number of ray florets, and number of seeds were recorded. The established accessions were individually crossed with an Indian accession (cv. JNS-28).

RESULTS AND DISCUSSION

Data on days of flowering, plant height, number of branches, number of capitula, number of ray florets, number of seeds were recorded from the two well-established genotypes of *G. scabra* (P3: EC1077609 and P4: EC1077610) and the control variety, JNS-28 (Fig 1). The two genotypes of *G. scabra* were then crossed with JNS-28. Five F_1 hybrids developed *viz.,* two from the cross of P3 x JNS-28 and three from the cross of P4 x JNS28. Compared to cultivated niger, wild species (P3 and P4) had more capitula (280 – 470), were tall in height (100 – 128cm), had longer flowering duration (100 – 132 days) (Fig. 1). The F_1s were vigorous than the parents and had a much longer flowering period, tall height, more number of capitula that can be useful in promoting apiary and tourism. It is interesting to note that the wild species and hybrids were completely free of insect and pest attack including powdery mildew. Sibbing is being done due to self-incompatibility and the F_2 might result in useful transgressive segregants for various qualitative and quantitative traits for exploitation in the breeding programmes.

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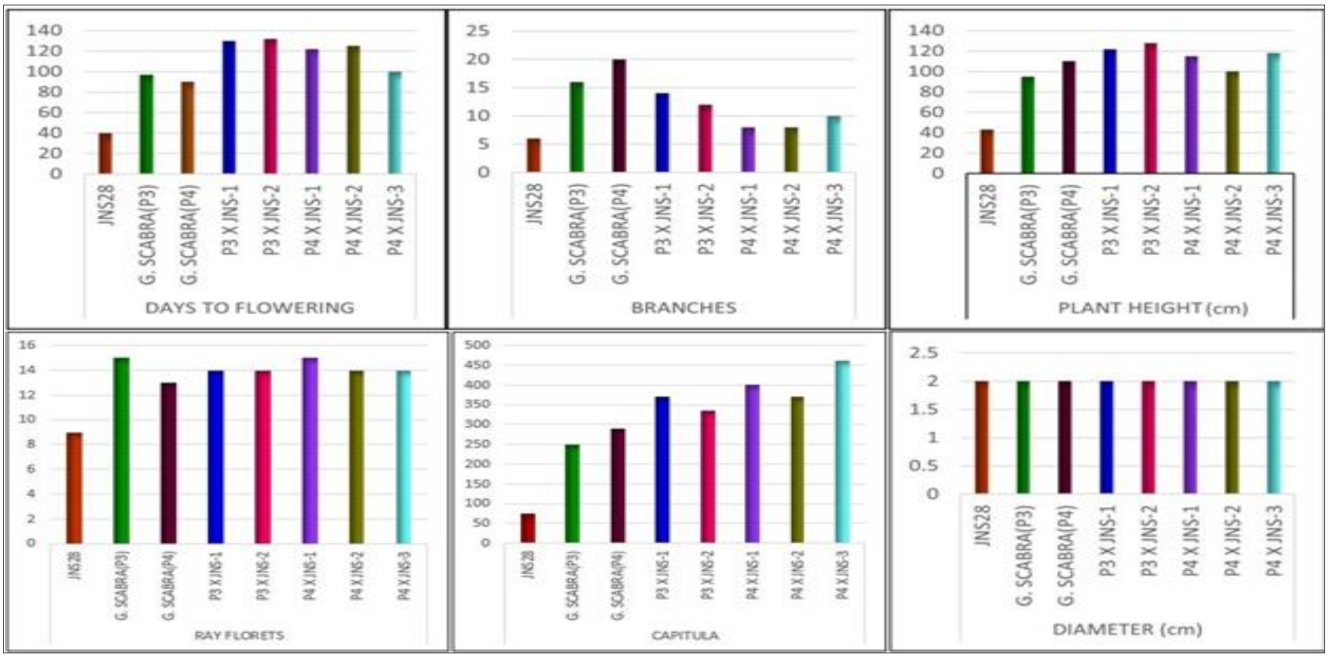

Fig 1. Mean performance of F_1 hybrids as compared to their parents

Effect of varied fertilizer levels on productivity and economics of sunflower based cropping systems

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ABSTRACT

A field experiment was conducted during 2018-19 to 2020-21 to study the effect of different preceding crops and fertilizer levels on yield and economics of *rabi* sunflower at Agricultural Research Station, Tornala, Professor Jayashankar Telangana State Agricultural University. The results revealed that, among different cropping systems, Greengram – sunflower cropping system recorded significantly higher sunflower equivalent yield (2202 kg ha^{-1}), gross (Rs.1,26,948 ha^{-1}) and net returns (Rs. 68,659 ha^{-1}), whereas, foxtail millet – sunflower recorded higher B:C ratio (2.21). Among fertilizer treatments, 100% RDF (75:90:30 $N:P_2O_5:K_2O$ kg ha^{-1}) recorded higher sunflower equivalent yield, gross returns, net returns and B:C ratio (2054 kg ha^{-1}, Rs.1,18,064 ha^{-1}, Rs. 57,082 ha^{-1} and 1.94), respectively.

Keywords: Cropping system, Equivalent yield, Fertilizer level, Sunflower

Sunflower is a short duration, fast growing and day neutral plant, thus, it is a potential edible oilseed crop having wider adaptability across diverse cropping system and climatic conditions. The information regarding to the preceding crop to be cultivated before sunflower is unavailable. Besides, cereal-cereal cropping sequences are more exhaustive and put heavy demand on soil resources as compared to cereal-legume and cereal-oilseed sequences (Reddy and Suresh, 2009). Diversifying the cropping system with oilseed as a component crop improves the production potential of the system. Hence, the present study is taken to assess sunflower crop as component under crop diversification with emerging/ new cropping systems in terms of productivity and profitability in Telangana state.

MATERIAL AND METHODS

The field trial was conducted in ‘C’ block of Agriculture Research Station, Tornala, Siddipet district during *kharif* and *rabi*, 2018-21. The experimental trial was laid out in a split plot design in which main plot comprising different cropping systems (Greengram-Sunflower, Maize- Sunflower, Redgram- Sunflower and Foxtail millet- Sunflower) and sub plots of three different fertilizer treatments *i.e.*,100% RDF (75:90:30 $N:P_2O_5:K_2O$), 100% STCR (132:16:41 $N:P_2O_5:K_2O$) and 50% STCR (66:8:20.5 $N:P_2O_5:K_2O$), respectively and replicated thrice. During *kharif* season, following crops (Greengram, Maize, Redgram and Foxtail millet) were sown and immediately after the harvest of the *kharif* crop, sowing of *rabi* sunflower (DRSH-1) was taken up. All the agronomic practices were followed as per the recommendation of PJTSAU.

RESULTS

In the present study (2018-21), Greengram – sunflower cropping system has resulted in significantly higher sunflower equivalent yield (2202 kg ha^{-1}) over maize – sunflower (1979 kg ha^{-1}) and foxtail millet – sunflower (1963 kg ha^{-1}) and redgram – sunflower (1535 kg ha^{-1}). Among fertilizer levels, application of 100% RDF (75:90:30 $N:P_2O_5:K_2O$ kg ha^{-1}) to sunflower resulted in significantly higher sunflower equivalent yield (2054 kg ha^{-1}) over 50% STCR (1748 kg ha^{-1}), but, onpar with that of 100% STCR (1946 kg ha^{-1}).

Further, Greengram-sunflower cropping system accrued maximum system gross returns (Rs.1,26,948 ha^{-1}), net returns (Rs.68,659 ha^{-1}), whereas, foxtail millet – sunflower cropping system recorded higher B:C ratio (2.21) when compared with other cropping systems. Application of 100% RDF treatment to sunflower has observed highest system gross returns (Rs.1,18,064 ha^{-1}), net returns (Rs. 57,082 ha^{-1}) and B:C ratio (1.94) and lowest was recorded in 50% STCR gross returns (Rs.1,00,424 ha^{-1}, Rs. 39,442 ha^{-1} and 1.65) respectively.

CONCLUSION

Greengram-sunflower with 100% RDF (75:90:30 $N:P_2O_5:K_2O$ kg ha^{-1}) with to *rabi* sunflower was found to be potential and profitable cropping system in Telangana.

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Evaluation of soybean genotypes against collar rot disease caused by *Sclerotium rolfsii* Sacc.

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ABSTRACT

Collar rot caused by S. rolfsii is one of the economical diseases of soybean that can cause up to 30-40% yield loss in India. A total of 18 soybean genotypes were screened artificially during 2021 at ICAR-IISR, Indore, to study the virulence among the fungal isolates as well as to identify the resistance sources. Based on pathogenicity, Indore isolate (SRI) was found to be more virulent than Assam isolate (SRA). On the basis of percent emergence (PE) and the disease indices - root weight of inoculation (RWI) and ratio of root weight (RRW), genotypes JS 335, JS 20-34 and MACS 1620 were resistant against SRI whereas RSC 10-52 and JS 335 were found to be potential donors for resistance against SRA.

Keywords: Collar rot, Resistance, Soybean and Virulence

Among the biotic stresses in soybean, collar rot caused by *Sclerotia rolfsii* Sacc. is one of the potential threats in India, that can cause up to 30-40% yield loss (Sharma *et al.,* 2014). This disease is prevalent across India and predominant under low lying water-logged conditions. Deploying genetic resistance can be an economical and eco-friendly mode of managing this disease. Therefore, current study was undertaken aiming at identifying resistant/partial resistant soybean genotypes and also to study the variability in virulence pattern of the two isolates of the pathogen *S. rolfsii* Sacc.

MATERIALS AND METHODS

Soybean genotypes used in the study: The current experiment was carried out during the year 2021 under glasshouse condition at ICAR-Indian Institute of Soybean Research, Indore. Total eighteen soybean genotypes (JS 20-98, MACS 1520, NRC 86, NRC 128, VP 1165, JS 21-72, MAUS 732, CAT 146, JS 95 -60, JS 335, JS 20-34, JS 97-52, AMS MB 5-18, MACS 1620, JS 20-69, JS 20-29, RSC 10-52, and RVS 2001-18) which are genetically diverse and developed at different breeding centers have been used. One Kg of sorghum grain was soaked overnight in distilled water and afterward treated with hot water for 1-2 hr. About 100 g of grain containing reagent bottles were autoclaved and cooled. Pure cultures of *S. rolfsii* isolated as above from Indore and Assam were transferred to the reagent bottles in aseptic condition separately and incubated at 27± 1°C for 7 days so as to multiply the inoculums. After 7 days, the fungus was observed to be fully grown, the infected sorghum grains were mixed into the sterilized black soil. About 10g of infected sorghum grains were mixed with 1 kg of sterilized soil. Thus, infested soil was used to fill the plastic trays. The experiment was carried out in completely randomized design with three inoculated replications and one replication was kept as un-inoculated control for comparisons. Ten seeds of each genotype were sown for each replicate and the trays were maintained well-watered throughout the experiment. Same procedure was followed for both Indore isolate (SRI) and Assam isolate (SRA). Control was common for both the isolates. After 14 days of sowing, disease assessment was carried out in terms of percent emergence against collar rot infection, Root Weight of Inoculation (RWI) and Ratio of Root Weight (RRW) (Lin *et al*. 2018).

RESULTS AND DISCUSSIONS

In the current study, in case of SRI, the highest emergence (35%) was observed in the genotype JS 335, followed by JS 20-34 (25%) and MAUS 732 (21.42%). RWI was highest in case of MACS 1620 (0.040) followed by JS 335 (0.031) and JS 20-34 (0.024) while, RRW was highest in case of JS 20-34 (0.894) followed by MACS 1620 (0.775) and JS 335 (0.766). In terms of percent emergence, JS 335 was found to be partial resistant; however, in terms of RWI MACS 1620 was found to be partial resistant and in terms of RRW JS 20-34 was found to be partial resistant to Indore isolate of the pathogen. Overall, JS 335, JS 20-34 and MACS 1620 were found to be potential donors for resistance against SRI In case of SRA, the highest emergence (80.00%) was observed in the genotype RSC 10-52, followed by JS 21-72 (46.15%) and MACS 1520 (42.85%). RWI in case of SRA was highest in case of JS 335 (0.055) followed by RSC 10-52 (0.052) and NRC 86 (0.047) and RRW was highest in case of JS 335 (1.385) followed by JS 97-52 (1.288) and MAUS 732 (1.201). In terms of percent emergence, RSC 10-52 was found to be partial resistant, in terms of RWI JS 335 was found to be partial resistant and in terms of RRW JS 335 was found to be partial resistant to Assam isolate of the pathogen. Overall, RSC 10-52 and JS 335 were found to be potential donors for resistance against SRA. Through mean percent emergence, mean RWI and mean RRW, it was found that SRI was more virulent than SRA. These three disease indices can be employed in identification of potential resistance donors and in identifying QTL governing collar rot resistance. Virulent isolate - SRI can be used in carrying out QTL mapping studies.

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Occurrence of castor diseases in Tamil Nadu and screening of castor parental lines for wilt resistance

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ABSTRACT

Castor is an important industrial oilseed crop. The survey conducted during 2021-2022 in castor growing area of Tamil Nadu indicated that wilt and gray mold are the major disease. The wilt disease incidence ranged from 10.2 to 25.4 per cent and gray mold disease severity ranged from 37.8 to 62.2 PDI. The screening of castor parental line for wilt resistance in wilt epiphytic condition revealed BCS 3, ICS 253, ICS 309 and IPC 46 found promising for wilt resistance and they can be utilized for the development of wilt resistant castor hybrids.

Keywords: Castor, Gray mold, Parental lines, Wilt

Castor (*Ricinus communis* L.) is a major industrial non-edible oilseed crop grown all over the world. Wilt disease is caused by *Fusarium oxysporum* f. sp. *ricini* and gray mold caused by *Botrytis ricini* are the important diseases causing significant yield loss. Exploitation of host resistance in hybrid development is the sustainable way for the management of disease. Hence, the present experiment was formulated to asses castor diseases in Tamil Nadu and to evaluate the promising castor parental lines developed from AICRP programme for resistance to wilt disease.

METHODOLOGY

Random survey was conducted in castor growing areas of Tamil Nadu during India 2021-22. Gray mold disease severity was recorded in primary, secondary and tertiary spikes using 0-9 scale and expressed in PDI. Wilt disease incidence was recorded and expressed in percentage. Field experiment was conducted in 2021–2022 at Tapioca and Castor Research Station, TNAU, Yethapur to screen for wilt resistance in twelve parental lines obtained from ICAR-IIOR along with the checks 48-1 and JI 35 in the wilt sick plot maintained with pathogen load of $2x10^3$ cfu/g of soil. The wilt incidence was recorded at 30 days interval up to 150 days and expressed in percentage.

RESULTS AND DISCUSSION

Survey conducted in different castor growing regions (Salem, Trichy and Namakal districts of Tamil Nadu) during *Kharif* season indicated the prevalence of gray mold and wilt disease. The wilt incidence ranged from 10.2 to 25.4 per cent and gray mold disease severity ranged from 37.8 to 62.2 PDI in the surveyed area. In screening of parental lines for wilt resistance under sick plot condition, four lines *viz*., BCS 3, ICS 253, ICS 309 and IPC 46 recorded less than 20 % of wilt incidence followed by three lines *viz*., ICS 258, IPC 41 and IPC 44 with less than 40 % wilt incidence, while the susceptible check JI 35 recorded higher wilt incidence (90.7 %). Shaw *et al*., 2017 reported that reaction of F1 indicated that the nature of resistance in 48–1, CI-1 and AP48 is recessive whereas it was dominant in AP42. Patel and Pathak, 2011 reported that both parents should be wilt resistance to develop wilt resistant progenies.

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Table 1. Screening of promising parental lines against Fusarial wilt disease in castor

parental lines	Wilt incidence (%)				
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
BCS 1	0.0	0.0	35.0	39.0	51.3
BCS 2	0.0	5.5	45.1	49.7	82.3
BCS 3	0.0	0.0	2.8	2.8	5.3
BCS 4	3.3	3.3	13.3	42.8	73.1
ICS 253	0.0	0.0	5.3	5.3	6.7
ICS 258	2.5	2.5	8.1	10.9	27.6
ICS 309	0.0	0.0	2.8	2.8	7.9
IPC 41	3.3	3.3	5.1	13.6	36.4
IPC 42	0.0	0.0	9.1	11.2	41.4
IPC 43	0.0	2.5	35.9	51.3	89.7
IPC 44	0.0	4.7	6.7	11.8	23.8
IPC 46	0.0	0.0	0.0	11.1	13.7
JI 35	12.7	21.0	41.6	54.5	90.7
48-1	0.0	0.0	3.3	3.3	6.1

Selection of elite genotypes of Indian mustard (*Brassica juncea* L.) through AMMI, GGE biplot and MTSI

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ABSTRACT

Forty-five Indian mustard genotypes were evaluated under four environments. Significant G × E interaction leads to stability analysis using AMMI, GGE biplot and MTSI. GGE biplot identified G43 as a vertex genotype in E_1 and E_2; G41 in E_3 and E_4 for seed yield and G16 in E_1 and E_2; G11 in E_3 and G13 in E_4 for oil content. AEC illustrated that G27 and G30 were most stable for seed yield and G14 for oil content. Environment, E_1 and E_4 were more discriminating whereas E_1 and E_3 were more representative for seed yield and oil content, respectively. MTSI identified promising genotype G42, G43, G45, G40, G41 and G44. According to AMMI, E_1 and E_2 were potential whereas E_3 and E_4 were poor environment. Genotypes G39, G2, G18 and G6 for seed yield whereas G45 and G9 for oil content were broadly adapted to all environments.

Keywords: AMMI, GGE biplot, IPCA, MTSI, Mustard, Stability

Mustard is the second most important source of edible oil in India after groundnut which occupies prime importance in Indian economy. In the present scenario of climate change, it is essential to breed genetically superior mustard, variety/hybrids possessing harmonious combination of desirable parameters which can perform consistently better under varied environmental conditions. Keeping the above in view, the present investigation was carried out in order to identify most stable high-yielding genotypes for a rational breeding program in Indian mustard.

MATERIALS AND METHODS

Forty-five Indian mustard genotypes were evaluated under four environments created through different dates of sowing and row to row spacing *i.e*. timely sown, normal spacing (E_1), timely sown, reduced spacing (E_2), late sown, normal spacing (E_3), late sown, reduced spacing (E_4) during *Rabi* 2021-22. Data were recorded for fourteen characters and subjected to joint analysis of variance. Pooled analysis of variance was calculated using ADEL-R (Pachesco *et al*., 2017), AMMI analysis, GGE biplots and MTSI were calculated using R Studio, R version 4.0.3 by using 'agricolae' and 'metan' R packages.

RESULTS AND DISCUSSION

After observing significant G × E interaction for all the traits, phenotypic stability was analyzed using AMMI model, GGE biplot and MTSI. GGE biplot of Which-won-where pattern showed two mega environments for seed yield per plant and identify G43 as a high yielding vertex genotype for E_1 and E_2 while G41 for E_3 and E_4. Likewise, for oil content three mega environments depicted G16 in E_1 and E_2, G11 in E_3 and G13 in E_4 as a high oil containing and stable genotypes. An average environment coordination view illustrated that G27 and G30 were most stable genotypes while G5 and G41 were least stable with above average mean performance for seed yield per plant. Similarly, for oil content G14 was most stable while G38 and G16 were considered as least stable genotypes. Discriminating power view of biplot decipher that E_1 and E_4 were more discriminating whereas representativeness decipher E_1 and E_3 as more representative environment for seed yield per plant and oil content, respectively.

In the AMMI, E_1 and E_2 were considered as potential environment whereas E_3 and E_4 as poor environment for both the traits. Genotypes G39, G2, G18 & G6 and G45 & G9 were broadly adapted to all environments with near to average mean seed yield and oil content, respectively. The first two principal component interaction of the AMMI 2 biplot accounted for 87.5% and 94.5% of the G+G×E interaction variation for the said traits, respectively. For seed yield per plant the genotype G43, G5 and G11 in E_1, E_2 and E_4 while for oil content G15 in E_1 and E_2 and G26 in E_3 and E_4 were vertex genotypes, respectively.

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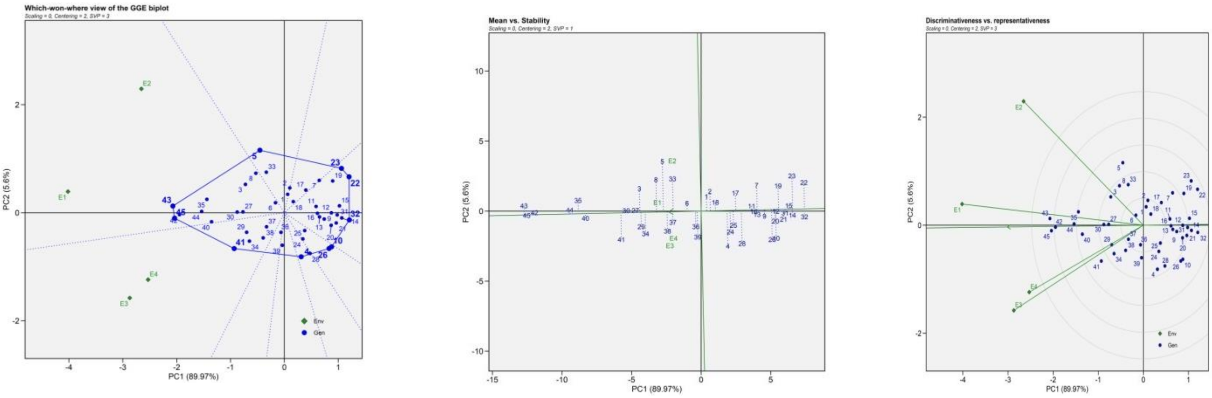
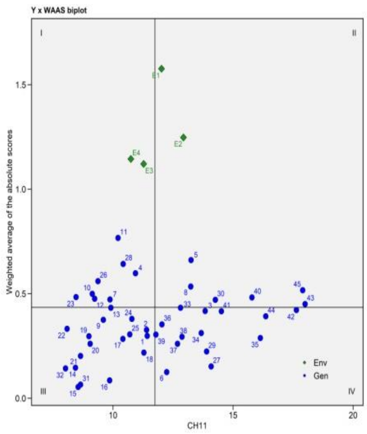


Fig a-c: (a) Which-won-where view of 45 genotypes (b) Average environment coordination (AEC) view of the GGE-biplot based on environment-focused scaling (C) GGE biplot view of the discriminativeness and representativeness for seed yield

Y × WAASBY biplot identify best genotypes with higher mean performance with great stability from second and fourth quadrant. Application of MTSI applied to identify promising genotype G42, G43, G45, G40, G41 and G44 with higher phenotypic stability and mean performance of all interactive traits.



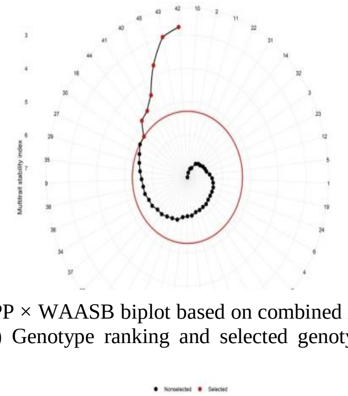


Fig d-e: (d) SYPP × WAASB biplot based on combined interpretation of productivity and stability (e) Genotype ranking and selected genotypes for multi trait stability

Evaluation of sunflower (*Helianthus annuus* L.) germplasm lines for genetic diversity

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ABSTRACT

In the present investigation, estimation of the genetic diversity among thirty five germplasm lines of sunflower was undertaken by using Mahalanobis D^2 analysis. Based on the relative magnitude of D^2 values, the experimental material was distributed into six clusters. Out of six clusters, cluster I was the largest comprising of nineteen lines. Single plant yield, plant height, volume weight together contributed maximum (82.85 %) to the total genetic divergence. Maximum inter cluster distance was exhibited between clusters II and IV. The greater the distance between two clusters, the wider the genetic diversity among the genotypes of these clusters. Hence, hybridization between the genotypes from these clusters would produce high heterotic recombinants.

Keywords: Cluster, Cluster mean, D^2 analysis, Genetic diversity, Sunflower

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops in India contributing major portion of edible oil requirements. Knowledge of the exiting genetic diversity in the germplasm is essential for undertaking recombination breeding. Keeping in view, the present investigation was carried out to estimate the genetic divergence among the germplasm lines of sunflower using Mahalanobis D^2 statistic.

MATERIAL AND METHODS

The field experiment was conducted by using thirty five germplasm lines in a Randomized Block Design with two replications during *kharif*, 2019 at Agricultural Research Station, Tornala, Telangana. Data was recorded on eight characters *viz*., Days to 50 % flowering (days), plant height (cm), head diameter (cm), days to maturity (days), single plant yield (g), 100-seed weight (g), volume weight (g/100 ml) and oil content (%) as per the standard procedures and subjected to the analysis of genetic divergence using Mahalanobis D^2 (1936) statistics following the procedure given by Rao (1952).

RESULTS AND DISCUSSION

The analysis of variance revealed the existence of significant differences among the genotypes for all the traits. Total experimental material under study was distributed into six clusters, based on relative magnitude of D^2 values. Out of six clusters, cluster I was the largest with nineteen lines, followed by cluster II with twelve genotypes. Maximum inter cluster distance was exhibited between clusters II and IV (12.76) followed by clusters I and VI. (12.71). Further, hybridization between the genotypes from the clusters with greater distance inturn will produce high heterotic hybrids.

Out of the eight characters studied, three characters namely single plant yield (59.66 %), plant height (11.93%) and volume weight (11.26 %) together contributed maximum (82.85 %) to the total genetic divergence. Thus, it is suggested that these traits should be given importance in further breeding programmes to develop hybrids with superior oil content.

A wide range of variation was observed in cluster means for all the traits under study. Among the six clusters, Cluster VI expressed highest mean value for four characters *viz.*, plant height (134.00), head diameter (14.70), 100- seed weight (5.50) and single plant yield (36.90). The promising germplasm lines from different clusters with high mean values for different traits may be directly used for adaptation or may be used as parents in future hybridization.

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Exploitation of biotic inducers and hyperparasites as potential biological control against foliar diseases in peanut

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ABSTRACT

Field experiments were conducted to study the efficacy of biotic inducers namely salicylic acid (SA), methyl jasmonate (MeJA) and Beta amino barbutric acid (BABA) and Plant growth promoting microbes *viz*., *Trichoderma asperllum* and *Bacillus subtilis*, hyperparasite (*Spharellopsis filum*) along with fungicide (carbendazim) against foliar diseases of groundnut. In the study, vacuum seed infiltration application along with foliar spray of biotic inducers @ 30, 45 and 60 days after planting significantly reduced the late leaf spot (23.8) while *S. filum* recorded least rust incidence (11.21) and also increased the pod yield compared to fungicide and untreated control. The induced defense enzymes namely phenol (46 µg of catechol / g of fresh tissue**)** and Phenyl alanine ammonia lyase (1.754nmol/min/g) was also high in biotic inducers and *S. filum* treated plants followed by *B. subtilis* treated peanut plants.

Keywords: Biocontrol agent, Biotic inducers, Late leaf spot, Peanut, Rust diseases and management

Groundnut (*Arachis hypogaea* L.), is an important oilseed crop grown in tropical and subtropical regions of the world. It is a valuable source of protein and edible oil for human as well as feed for animals. During the cultivation, several biotic stresses *viz.,* leaf spots and rust diseases which leads to drastic yield loss and routinely managed by judicious application of fungicide (Mondal and Badigannavar, 2015). Hence, to have an eco-friendly management technique, Salicylic acid (SA), Methyl jasmonate and Beta amino barbutric acid have been studied along with *B. subtilis*, *T. asperllum* and *S. filum*. SA and MeJA is an important signaling molecule for plants to cope with biotic or abiotic stress (Muhae-Ud-Din *et al.,* 2020) and also involved in endogenous signal-mediated local and systemic plant defense responses against pathogens. The present investigation was laid out to identify the effective and safer molecules to minimize the severity/incidence of foliar diseases of groundnut.

MATERIALS AND METHODS

To study the efficacy of plant defense inducers (SA, MeJA, BABA) which were compared with biocontrol agents and fungicide. A field experiment was conducted to find out the efficacy of plant defense inducer namely SA, MeJA, BABA each @ 50 ppm, *B. subtilis*, *T. asperllum* (each @ 4g/kg) and *S. filum* @ 10ml/kg of seed as vaccum infiltrated seed treatment and foliar application @ 30 and 45 DAS has been tested for the management foliar diseases at the Dept. of Oilseeds, TNAU, Coimbatore during *Rabi* 2022 using Groundnut var. VRI 2.

RESULTS AND DISCUSSION

The result showed that seed treatment using seed infiltration technique with biotic inducers (SA+ MeJA+ BABA) @ 50 ppm recorded higher seed germination (95%) and vigour index (4892.5) followed by *B. subtilis* (93%) compared to control (73.33%). The seed treatment followed by three sprays of SA+ MeJA+ BABA @ 50 ppm recorded lower disease incidence of late leaf spot and rust under field conditions compared to carbendazim (1%). Among the different treatments tested, T1-seed treatment followed by foliar application of SA+ MeJA+ BABA @ 50 ppm at 30,45 and 60 days after sowing showed less disease severity of late leaf spot (8.43) and rust (11.21) with highest yield of 2461 kg/ ha compared to other treatments and control (Table 1). The induced defense enzymes namely phenol (46 µg of catechol / g of fresh tissue**)** and Phenyl alanine ammonia lyase (1.754nmol/min/g) was high in biotic inducers and *S. filum* treated plants followed by *B. subtilis* treated plants. Our results in accordance with Zheng et al. (2020) found that, exogenous SA application induced defense response and multi-signaling pathway in Tetraploid Potato SD20**.** Hence, it could be used as a potential biological control technique to fight against foliar disease which also activate defense priming.

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Table 1. Evaluation of plant defense inducers and biocontrol agents for the management of foliar diseases of groundnut

Treatments	Germination %	Vigour index	Leaf spot (PDI)	Rust (PDI)
T_1 : Seed treatment with salicylic acid (SA + MeJA+ BABA) @ 50 ppm + foliar application @ 50ppm on 30,45 and 60 DAP	95 .0^{a}	4892.5^{a}	8.43^{a}	18.43^{b} (25.41)
T_2 : Seed treatment *T. asperlllum* 4g/kg + foliar application @ 30,45 and 60 DAP	88.0^{d}	3652.00^{d}	25.68^{e}	32.21^{d} (34.57)
T_3 : Seed treatment *B. subtilis* 10g/kg + foliar application @ 30,45 and 60 DAP	93.0^{b}	4231.50^{b}	20.34^{d}	29.32^{c} (32.76)
T_4 : Seed treatment *S. filum* @10 ml /kg + foliar application @ 1% 30,45 and 60 DAP	90.0^{c}	3780.00^{c}	19.53^{c}	11.20^{a} (19.54)
T_5 : Seed treatment of Carbendazim @ 2g/kg + foliar spray 500 ppm at 30,45 and 60 DAP	80.0^{e}	2262.00^{e}	11.35^{b}	14.52^{b} (21.45)
T_6 : Control	73.33^{f}	2016.57^{f}	37.64^{f}	65.10^{f} (53.80)
S.E		45.84	0.19	0.45
CD @ 5%		102.14	0.44	1.05

Values are mean of three replications and the values in parenthesis are arcsine transformed value

Exploration of biotic inducers through seed infiltration technique for the management of phyllody in sesame caused by *Candidatus* Phytoplasma

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ABSTRACT

This study aimed to evaluate the efficacy of biotic inducers for the management of phyllody disease in sesame, as well as in analyzing the defense enzyme activity. The field trial experiments were conducted with the biotic inducers [salicylic acid (SA), methyl jasmonate (MeJA), and beta amino butyric acid (BABA)] in individually (50 ppm, 100 ppm and 150 ppm) and in combination. Concerning biotic inducers, SA 50 / 100 ppm pre-seed treatment and exogenous application at 30th, 45th and 60th DAS resulted in no/less phyllody disease incidence and added significant value by increasing defense enzyme activity (PO, PPO, PAL and SOD).

Keywords: Exploration, Phyllody, Seed infiltration, Sesame

Several approaches have been adopted for the management of phyllody disease in sesame. Unfortunately, there is no adorus impact despite the vast host range, polyphagous insect vectors, unavailability of resistant sources and lack of environmentally acceptable and effective insecticides. Hence, attempts were made to use biotic inducers [salicylic acid (SA), methyl jasmonate (MeJA), and beta amino butyric acid (BABA)] in individually (50 ppm, 100 ppm and 150 ppm) or in combination for the management. Many reports showed that the plant defense inducers induce resistance against many pathogens/biotic stress by activating some of the defense enzymes like Peroxidase (PO), polyphenol oxidase (PPO), superoxide dismutase (SOD), Phenylalanine ammonia lyase (PAL) etc. According to Singh *et al.* (2004), salicylic acid triggered a series of events that prevented viral proliferation and cell-to-cell and long-distance transmission in plants. With this background information, the present study was conducted for phyllody disease management and the activation of defense enzymes using biotic inducers as seed treatment and foliar application under field conditions.

MATERIALS AND METHODS

The field trials were conducted for the standardization of biotic inducers at various ppm's and their combination. The first field trial was conducted in the Department of oilseeds, TNAU, Coimbatore. Second field trial was conducted in the Tharamangalam village, Salem district of Tamil Nadu. The plots were maintained in a randomized block design (RBD) consist of 13 treatments with 3 replications. Through seed infiltration technique, the seeds were treated with inducers at various ppm and their combination. In each treatment plot, infiltrated seeds were sown at the appropriate spacing of (30×30cm). The inducers primed seedlings were foliar sprayed with SA (50, 100 and 150 ppm), MeJA (0.1, 0.3 and 0.5 mM), BABA (50, 100 and 150 ppm), and combined (50ppm of SA + 0.1 mM of MeJA + 50 ppm of BABA), Methyl dematon 25 EC and *Bacillus subtilis* Bbv 57 on 30th, 45th and 60th day after sowing. Untreated plants were maintained as control. Accordingly, the activity of defense enzymes (PO, PPO, PAL and SOD) were also analyzed based on the methods (Ref: Biochemical methods by Sadasivam S and Manickam A).

RESULTS AND DISCUSSION

The result of the study showed that priming (through seed infiltration technique) followed by foliar spraying of salicylic acid was shown to be the most effective among other biotic inducers with regard to disease incidence. Further, SA 50 ppm and 100 ppm treatments (less / no disease incidence) were found to be significantly more effective than the control. Our results were correlated with the Muhae-Ud-Din *et al.* (2020) reported that treatment with salicylic acid individually and in combination with methyl jasmonate resulted in the management of wheat dwarf bunt caused by *Tilletia controvers* Kuhn. In addition, the seedlings treated with SA 50 ppm and SA 100 ppm also triggers the defense enzymes (PO, PPO, PAL and SOD) which conferring resistance against phyllody as compared to other treatments. In addition to disease control, treatments such as MeJA at 0.5 Mm enhanced the number of capsules (313 capsules / plant) and seed yield (46.24g / plant) when compared to control. According to Asghari *et al.* (2020) reported that spraying of pomegranate with 0.5 mM MeJA increased the fruit yield, weight and productivity. Among the inducers tested, Salicylic acid (50ppm and 100ppm) was found to effective in controlling phyllody disease in sesame crop.

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Effect of biotic inducers on number of capsules and seed yield of sesame seedlings under field conditions (a - Treatment; b – Control)

Evaluation of different tillage and intercropping systems in castor under rainfed conditions

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ABSTRACT

The field experiments were conducted in 2020-21 and 2021-22 at Tapioca and Castor Research Station, Tamil Nadu Agricultural University, Yethapur. The pooled result of the two-year study of different tillage practices in castor based legume intercropping systems in rainfed, there was no significant difference among tillage practices relevant to growth, yield attributing characters, seed yield and biomass yield, numerically higher values were registered under conventional tillage practices over minimum tillage. The higher seed yield of both base (1152 kg/ha) and inter crop (481 kg/ha) were recorded in conventional tillage practices over minimum tillage. With respect to inter cropping, higher base crop (castor) yield of 1058 kg/ha was recorded under castor + groundnut inter cropping system which was observed to be on par with sole castor (1020 kg/ha) and castor + greengram (907 kg/ha). The highest. Moreover, the maximum benefit-cost ratio was recorded in castor + groundnut (1:3) intercropping, over sole castor cropping.

Keywords: Conventional tillage, Intercrop, Legume, No tillage

The basic concept of intercropping systems involve growing together two or more crops with the assumptions that two crops could exploit the environment better than one and ultimately producing higher yields, the reason being that the component crops differ in resources use and if growing together, they complement each other and make better overall use of resources. This practice leads to some advantages like, economy of land, insurance against aberrant weather, production of higher yields and higher economic returns, build up or maintenance of soil fertility and diversification of farm produce. Due to its importance, a great deal of research had been done on different tillage practices and intercropping system but still needed to locate the best tillage practices and intercropping system for sustainable castor crop production and soil reserves. This experiment was planned to evaluate different tillage systems and legume based intercropping systems in terms of better crop yield and profitability of castor crop under rainfed conditions.

MATERIALS AND METHODS

A field experiment was conducted to evaluate the effect of different tillage practices and intercropping system on yield of hybrid castor at Tapioca and Castor Research Station, Tamil Nadu Agricultural University, Yethapur during *Kharif* 2020-2021 and 2021-22 season. The experiment was conducted in split plot design with three replications with comprised of conventional tillage and minimum tillage as main plot and legume based inter cropping system @ 1:3 ratio *viz.,* Castor + Greengram, Castor + Cowpea, Castor+ Groundnut and Sole Castor as subplot treatments. The intercrop viz., Groundnut, Greengram and Cowpea were sown in-between castor row with spacing of 0.3 m between the row and 0.10 m between the plants. Biometric observations were recorded at different growth stages viz., 90 and 135 DAS stages respectively. The produce from net plot area after thoroughly sun drying was weighed for recording biological yield. After threshing and winnowing the weight of seed of main and intercrop from each net plot area was recorded in kg plot^{-1} and then converted into kg ha^{-1}. Stalk / straw yield (kg ha^{-1}) was obtained by subtracting the seed yield from biological yield.

RESULTS AND DISCUSSION

Highest seed yield and biomass yield were significantly highest with sole castor followed by castor + groundnut (1:3) and castor + greengram (1:3). This might be due to relatively less inter row competition in sole castor and better use of resources like water, nutrients, space and sunlight ultimately resulted into higher number of spikes per plant and number of capsules per spike which showed positive correlation with seed yield. These finding are in close conformity with the findings of Kumavat *et al*. (2016). Substantial yield reduction was noticed in castor + cowpea inter cropping system (837 kg/ha) due to severe competition between castor and cowpea particularly for space and nutrients which resulted in lower plant height of castor and reduction in No. of productive branches plant^{-1}. Chand and Sujatha (2000) reported similar result that castor + sesame intercropping recorded lower seed yield. Regarding biomass yield, higher biomass addition through inter crop was recorded in castor + groundnut inter cropping system (8083 kg/ha) which was followed by solo castor (7742 kg/ha). The lowest biomass addition of 6350 kg/ha was recorded under castor + greengram inter cropping. The pooled data (Table 1) revealed that although significant reduction in the seed yield of base crop and intercrops in different intercropping treatments was recorded, yet the recovery in the seed yield in treatment like castor + groundnut (1:3) and castor + greengram (1:3) was higher which leads to higher castor equivalent yield than sole castor. Castor equivalent yield was significantly higher in castor + groundnut (1:3) and castor+ greengram (1:3) over sole castor in intercropping systems which might be due to higher yield of groundnut and greengram as well as less reduction of castor seed yield in this intercropping system. Similar results reported by Sharma and Singh (2014). The higher equivalent yield showed higher biomass production and efficient use of available growth resources under intercropping then sole cropping. Similar trend was observed earlier (Ganvir *et al.*, 2004) when castor intercropped with groundnut.

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Table 1. Influence of tillage practices and intercropping on yield attributes and yield of castor based inter cropping system (Pooled data of 2 years)

Treatment	Seed/Pod yield (kg/ha)		Biomass yield (kg/ha)		CEY (kg/ha)	Oil yield (kg/ha)	Net Returns (Rs/ha)	BCR
	Base crop	Inter crop	Base crop	Inter crop				
Main Plot: Tillage Practice								
M_1. Conventional Tillage	1152	481	8951	3620	1633	526	32106	2.10
M_2. Minimum Tillage	1013	436	8463	3391	1449	472	26950	2.00
S.Em.±	51.5	31.1	316	320	89.2	25.3	-	-
CD (p=0.05)	110.7	NS	NS	NS	NS	NS	-	-
Sub Plot: Intercropping								
S_1. Sole Castor	1089	-	7742	-	1089	436	31367	2.19
S_2. Castor+Green gram (1:3)	916	447	7120	3420	1404	381	44453	2.44
S_3. Castor+Cowpea (1:3)	837	562	6350	4110	1399	350	43671	2.38
S_4. Castor+Groundnut (1:3)	1018	975	8083	5023	1993	463	67039	2.65
S.Em.±	56.2	30.1	392	310	110.4	21.1	-	-
CD (p=0.05)	181	93.0	908	968	118.7	52.6	-	-
Interaction (M at S)								
S.Em.±	103.0	60.1	496.1	452.7	196.1	47.2	-	-
CD (p=0.05)	198.2	117.4	768.9	704.1	402.1	91.0	-	-

Advances in rapeseed mustard disease management

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ABSTRACT

India is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural economy of the country. Oilseeds are among the major crops that are grown in the country apart from cereals. Among the nine annual oilseeds cultivated in India, the share of Rapeseed-mustard is about 25% of total area and 27% of total production. With the share of 39% in total vegetable oil production which stands at first position. During last 5 years, compound annual growth rate (CAGR) of Rapeseed-mustard production and productivity at National level increased by 10.42 and 8.46%, respectively. Among different biotic stresses, insect-pests, diseases (Sclerotinia stem rot, white rust, downy mildew, Alternaria blight, powdery mildew) and weeds, cause yield loss upto 30-40% in different regions of the country. Plant diseases are considered as risks because they constantly contribute to significant yield, economic, and environment losses worldwide. Therefore, the early and accurate detection, monitoring, and assessment of plant diseases is important and necessary for farmers, managers, and decision makers.

Keywords: Disease management, Rapeseed mustard

Some of the diseases are endemic, and causes substantial damage every year. Under favorable environments, some of the diseases may become epidemic resulting in considerable damage to the crops. Uses of fungicides are considered the most effective means to control the plant diseases. However, with growing concerns about their ill effects on human and soil health and environment, the focus has now shifted from chemical to eco-friendly approach for the management of plant diseases. This approach, which is based on the minimal use of chemical fungicides, is now envisaged as one of the efficacious ways for effective management of diseases of field crops including rapeseed-mustard.

An integrated approach involving a combination of host plant resistance, cultural, chemical and biological measures need to be adopted for disease management of rapeseed mustard. Keeping in view the options available for designing an effective and environment compatible disease management strategy for the crops, conceptual models, primary and secondary decision-making tools need to be used effectively. Cultural practices *viz*., field sanitation, clean cultivation, timely sowing, adjusting the date of sowing keeping in view occurrence of the disease in the particular area, destruction of disease debris after the harvesting, deep summer ploughing, use of proper dose of fertilizers particularly nitrogenous, timely and proper irrigation and crop rotation at least for three years with non–Brassica crops play significant role in minimising the primary inoculum. Disease prediction models wherever developed can be of great help in the timely deployment of disease management practices. However, analysis of host-pathogen-environment interaction for developing disease forecasting models is need of time. Use of fungicides, bioagents, botanicals, organic amendments etc. as worked out for various diseases needs to be adopted at recommended doses proved useful for containing the disease losses. With the existing concerns about the environment, human health and development of fungicidal resistance in the pathogen, biological control is an attractive alternative for plant disease management that reduces the amount of, inoculum and disease-producing activity of the pathogen.

One of the most effective, economical and environment friendly approach to control plant diseases is the development of genetically resistant cultivars through conventional plant breeding methods along with modern biotechnological approached viz., marker assisted breeding (MAB), genome editing etc. Quantitative trait loci (QTLs) mapping and genetic analysis of different diseases will be useful in marker-assisted selection and development of disease resistant varieties in rapeseed-mustard.

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Microsatellite loci-based genetic relatedness holds key to parental selection for Sesame *(Sesamum indicum* L.) improvement

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ABSTRACT

Microsatellite-based DNA-level diversity and genetic relatedness assessments empower parental selection in sesame crop improvement. A panel of 70 sesame varieties that were analyzed for 40 microsatellite loci got grouped into 5 distinct cluster based on Jaccard's coefficient at genetic distance of 0.2. Nei coefficient analysis deciphered the presence of the maximum genetic distancebetween cluster 1 and cluster 5. The members of cluster 1 can be crossed with that of cluster 5 to get better allelic combinations. The findings of the present help selecting parental lines from a panel of 70 varieties for sesame crop improvement program.

Keywords: Genetic distance, Microsatellites, Sesame, Simple sequence repeats (SSRs)

Controlled cross-pollination provides an opportunity to create de novo gene combinationswhich can be employed in developing varieties and hybrids towards genetic improvement of crop species including sesame. The gene combination and the resultant variability among subsequent segregating populations and vigor as well as heterosis of the resultant hybrid primarily depend on not only parental genetic compositions but also on their genetic relatedness (Cheng and Liao, 2022). As morphological manifestation of genetic composition is always translucent due to interaction between gene and environment, DNA-level variability study helps bypassing the environmental effect in understanding genetic variability and relatedness. Therefore, microsatellite-based approach (or simple sequence repeats, SSRs) is one of the promising techniques to decipher genetic relatedness in sesame. In the present study, 40 SSR markers were employed to decipher DNA-level diversity and genetic relatedness among 70 released varieties ofsesame.

MATERIALS AND METHODS

A panel of 70 sesame varieties were raised in the field and genomic DNA was isolated using Doyle and Doyle (2019) method with minor modifications. Forty microsatellite markers optimized and validated by Kumaraswamy *et al* (2020) were employed for analysis of DNA-level variability within the panel. PCR amplificons were resolved on 4% agarose gel and alleles in terms of amplicon sizes were scored and the resultant allele matrix was used as an input file for analyzing the genetic relatedness according to Jaccard's coefficient and pairwise comparison was made usingNei's coefficient.

RESULTS AND DISCUSSION

Microsatellite-based DNA-level diversity and genetic relatedness assessments empower parental selection in sesame crop improvement (Cheng and Liao, 2022). A panel of 70 sesame varieties that were analyzed for 40 microsatellite loci got grouped into 5 distinct cluster based on Jaccard'scoefficient (Jaccard, 1912) at genetic distance of 0.2. Nei coefficient (Nei, 1973) analysis deciphered the presence of the maximum genetic distance between Cluster 1 and Cluster 5 (TABLE 1). Further, closer the cluster number, lesser the genetic distance and closer the genetic relatedness. If any members of cluster 1, for instance, is crossed with that of cluster 5, it is possibleto get better allelic combinations and, therefore, the heterotic effect. The findings of the present help selecting parental lines in sesame crop improvement programs involving a panel of 70 varieties.

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Table 1 Sesame varieties belonging to five distinct groups according to their genetic relatedness.

Clusters/ Groups	Genotypes/ Varieties/ Members
Group 1	Thilothama, Thilak, Tarun, N-32, Amrit, T-78, Smarak, Savitri, Shubra, Swetha Til, Kanak, JTS-8, Krishna, JLT-7, JLT-408, IIOS-1101, GJT-5,TKG-306, AKT-101, Paiyur
Group 2	E-8, DS-5, AKT-64, Phule Til-1, GT-2, GT-3, HT-1, Hima, GT-4, DSS-9
Group 3	TMV-7, RT-46, TMV-6, TMV-4, TMV-3, Usha, TSS-6, RT-372, RT-351,TKG-308
Group 4	Nirmala, Uma, YLM-66, YLM-17, YLM-11, TKG-55, Punjab Til-2, Tilarani, VRI-1, Vinayak, VRI-2, VRI-3
Group 5	GT-1, HT-2, PKDS-11, RT-346, RT-127, RT-125, RT-103, Pragati, Rajeshwari, Punjab Til-1, Prachi, PKDS-8, Rama

Soil organic carbon build up in sesame under soybean-sesame cropping systems in response to organic management modules

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ABSTRACT

Field experiments were conducted in deep Vertisols at ICRISAT farm in a fixed plot with eight nutrient management options with complete organic package to understand the soil organic carbon build-up since 2018 for soybean (cv. Basara) - sesame (cv. Swetatil) cropping system have shown that application of castor cake has maintained a soil organic carbon content indicating that the castor cake may be utilised as an organic nutrient source for sesame crop under vertisols of Hyderabad, Telangana.

Keywords: Soil organic carbon, Soybean-sesame cropping systems

Sesame (*Sesamum indicum* L.) is an important oilseed crop grown mostly under rainfed conditions during kharif. India exports about 2.5 lakh tonnes of seed valued at Rs.1000 crore. Globally sesamum is exported in the form of seed. Organic sesame seeds are small flat creamy white seeds in appearance, containing oil-soluble and water-soluble antioxidants such as sesamin, sesaminol, sesamolin, and sesaminol glucosides. Organic sesame seeds are used for producing cooking oil, in baking industry, for making soaps and margarines, preservation, and confectionery. Globally, higher usage of organic sesame seed in various food products, bakery products, animal feed products, cosmetics, and medicines are the prime growth drivers of global organic sesame seed market.

METHODOLOGY

Field experiments were conducted in deep Vertisols at ICRISAT farm in a fixed plot with eight nutrient management options with complete organic package to understand the soil organic carbon build-up since 2018 for soybean (cv. Basara) - sesame (cv. Swetatil) cropping system. The nutrient management modules comprised of 100% RDF (FYM* + Rock phosphate) + PSB; 100% RDF (Green leaf manure Glyricidia sp. + Rock phosphate) + PSB; 100% RDF (Castor oilcake + Rock phosphate) + PSB ; 100% RDF (Neem oilcake + Rock phosphate) + PSB ; 100% RDF (FYM + vermicompost + Goat manure) + Rock phosphate) + PSB; 50% inorganic + 50% organic (through FYM + Rock phosphate); 100% RDF through Urea, SSP, MOP alongwith an absolute control in a randomised block design replicated thrice. FYM was applied as *Trichoderma viride* compost and the nutrient management was on equal nitrogen basis. The balance of phosphorus supplied through organic sources (available form) was applied through rock phosphate based on total phosphorus content. Potassium was not applied separately except treatments involving inorganic nutrient sources. Recommended fertiliser dose of 30:30:20 kg NPK/ha and 20:60:20 kg NPK/ha for sesame and soybean as recommended for the state of Telanagana was followed for all the nutrient calculations. Fresh *Glyricidia* loppings were collected every season from ICRISAT, Hyderabad farm were applied as per the recommended blanket fertiliser dose in the specified treatment. A spacing of 45 x 15 cm and 45 x 5 cm was followed for sesame and soybean respectively. Before the start of the experiment an exhaust crop of maize (cv. DHM 117) was raised to make the fertility gradient uniform and removal of any toxic residues from the previous cropping history. A plot size of 45 m^2 was maintained for each experimental unit. The following organic BMPs were followed *viz*., seed treatment with *Trichoderma viride* 4g/kg, cultivation of sorghum and daincha along the border, prophylactic spray with neem oil / neem formulations at fortnightly interval, “T” perch for predation of insect larvae, Panchagavya spray @ 3% two times at 15 days interval and nutrient supplementing bio fertilizers *viz*., PSB, KSB, Rhizobium for both the crops wherever applicable. Fresh panchagavya was prepared as and when required in the farm itself.

RESULTS AND DISCUSSION

Two crops of sesame was successfully raised (2019 and 2020) while only one soybean crop was successful during 2019 and 2020 crop failed due to excess rains. Among the nutrient management modules, application of castor cake has maintained a soil organic carbon content of 0.81 after the harvest of sesame while the control recorded a soil organic carbon content of 0.59 only. The initial soil organic carbon content was 0.42 during 2018.Thus it could be concluded that the castor cake may be utilised as an organic nutrient source for sesame crop well responds to organic nutrient management modules under vertisols of Hyderabad, Telangana.

A comparative study of various detection methods to assess seed borne mycoflora in different linseed genotypes

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ABSTRACT

A total of 11 associated mycoflora were detected by various incubation methods *i.e., Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus,Fusarium* spp., *Alternaria* spp., *Colletotrichum* spp. *Rhizopus* spp., *Penicillium* spp., *Trichoderma* spp., *Cladosporium* spp., and *Curvularia* spp. Agar plate method gave the highest frequency of associated mycoflora. Linseed genotype SLS -93 showed highest frequency of associated mycoflora with minimum germination percentage.

Keywords: Detection methods, Linseed genotypes, mycoflora

Presence of seed-borne mycoflora may cause both pre- and post-emergence death of grains, may cause discoloration and shrivelling may have an impact on seedling vigour, which reduces germination percentage and the production of toxin in infected seeds are all possible effects of seed-borne pathogens. Therefore, an attempt was made to conduct the current research on evaluation of seed health, *i.e.,* mycoflora associations and their impact on germination in different linseed genotypes was undertaken at College of Agriculture, IGKV, Raipur, India.

MATERIAL AND METHODS

Following standard methods were used in the frequency evaluation of seed mycoflora of linseed Dry seed examination, Standard blotter method , 2,4-D method (ISTA, 1985) Washing test and Agar plate method (Muskett and Malone, 1941)**, ,** Deep freeze method (Limonard, 1968) **,** Roll paper towel method (Yaklich, 1985).

The frequency of the mycoflora was calculated by the following formula:

$$\frac{\textit{No.of seeds containing a particular fungus}}{\textit{Total seeds examined}}\times 100$$

RESULTS AND DISCUSSION

Under washing test, highest number of surface mycoflora was recorded in genotype SLS-93 *i.e.,* 19×10^{-3}. A total of 11 associated mycoflora were detected *i.e., Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus,Fusarium* spp., *Alternaria* spp., *Colletotrichum* spp. *Rhizopus* spp., *Penicillium* spp., *Trichoderma* spp., *Cladosporium* spp., and *Curvularia* spp by various incubation methods (*viz*, standard blotter method, agar plate method, deep freeze method, rolled paper towel, 2,4-D blotter method). Agar plate method gave the highest frequency of associated mycoflora as compared to all the other incubation methods.In incubation methods too, SLS -93 showed highest frequency of associated mycoflora with minimum germination percentage.

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Table 1 Comparative efficacy of different incubation methods to detect seed borne mycoflora in different linseed genotypes

		Associated mycoflora in different incubation method									
	Methods	***A. niger***	***A. flavus***	***Fusarium* spp**	***Alternaria* spp.**	***Rhizopus* spp.**	***Cladosporium* spp.**	***Colletotrichum* spp.**	***Penicillium* spp.**	***A. fumigatus***	***Trichoderma* spp.**
No. of cfu× 10^{-3}	Washing test	13.0	16.0	14.0	10.0	9.0	11.0	-	-	-	-
Total mycoflora frequency (%)	Standard blotter method	52.5	40.0	20.0	15.0	22.5	2.50	-	-	-	-
	Agar plate method	67.5	55.0	30.0	37.5	10.0	12.5	12.5	12.5	2.5	15
	Roll paper towel method	48.5	29.0	13.0	13.0	17.0	5.50	5.50	3.0	-	1.5
	Deep freeze method	40.0	25.0	17.5	15.0	15.0	12.5	-	10.0	-	-
	2,4 D method	30.0	27.5	17.5	10.0	20.0	10.0	-	7.50	-	10

Development of *in-vitro* seed germination assay for *Orobanche aegyptiaca Pers.* L. to assess the Mustard-Orobanche interaction

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ABSTRACT

Orobanche aegyptiaca Pers. L. has emerged as a serious constraint to the mustard cultivation in India. *Orobanche* seed germination requires induction by stimulants present in root exudates of mustard plants. An efficient *In-vitro* assay is important for understanding the Mustard-*Orobanche* interactions and evaluation of germplam lines of Indian mustard for *Orobanche* tolerance. In this study, an efficient and robust method was standardized for *Orobanche aegyptiaca* seeds germination rate determination under *In-vitro* conditions. The developed assay is simple and accurate which yields reproducible results for germination bioassays of *Orobanche* seeds.

Keywords: Brassica juncea, Indian mustard, MTT, Orobanche, Seed germination

Indian mustard (*Brassica juncea*) is an important oilseed crop accounting for 27.04 mha of cultivated area and production of 33.42 mt with the productivity of 1236 kg/ha. However, its production is severely affected by *Orobanche aegyptiaca pers.* L, a dominant parasitic weed of this crop (Sheoran *et al.* 2014). It is an obligate holoparasite which obtains essential nutrients through haustoria connected with the host vascular system and therefore strongly competing with the mustard plants for water, mineral nutrition. The ability of the parasite to produce a tremendous number of tiny seeds that may remain viable in the soil for more than 10-15 years makes its management strenuous (Jat and Singh 2018). Moreover, controlling these parasitic weeds, either by preventing seed germination through biocontrol agents or by promoting seed germination in the absence of host plants by cropping false hosts in order to reduce the seed bank of the soils requires a rapid and reliable bioassay of seed germination allowing a high-throughput screening of molecules, root exudates or plant extracts. Therefore, in this study, a highthroughput 96-well plate germination assay coupled with spectrophotometric reading of methylthiazolyldiphenyl-tetrazolium bromide (MTT) reduction was standardized for the induction of *O. aegyptiaca* seed germination. This assay measures the reduction of yellow MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) to an insoluble blue formazan product by mitochondrial succinate dehydrogenase enzyme in presence of GR24/root exudates of Indian mustard. Following extrapolation, the results of this assay were expressed in terms of number of germinated/non-germinated cells. The assay can be utilized to study Orobanche-Mustard interactions.

MATERIAL AND METHODS

Seeds of *O. aegyptiaca* were collected in 2021 from ICAR-DRMR, Bharatpur, on *Orobanche*-parasitized Indian mustard (*Brassica juncea* L.). GR24 was procured from Phyta Labs, Germany. Seeds of *Brassica juncea* (L.) varieties were grown in hydroponic conditions and root exudates were collected after 7-8 weeks. MTT was prepared at 0.5 g per 100 ml in distilled water then filtered at 0.2 µm (Axiva) and stored at 4°C in the dark.

RESULTS AND DISCUSSION

In this study, we standardized an *In-vitro* method for *Orobanche aegyptiaca* seeds germination rate determination based on a spectrophotometric reading of tetrazolium salt (MTT) reduction. Germination assay was standardized in 96-well plates using *O. aegyptiaca* seeds and various GR24 concentrations from 10^{-5} to 10^{-12} mol L^{-1} and root exudates of Indian mustard. The proposed assay was divided in five steps 1) seed sterilization, seed distribution and conditioning in 96 well PCR plates, 2) seed germination stimulation and incubation (with GR24 and root exudates of Indian mustard 3) MTT reduction and visualization under microscope 4) solubilization of formazan salts and absorbance reading and 5) extrapolation of absorbance values for determination of germination rate. The relationship between germinated seeds per well or germination percentage and absorbance was linear. Therefore absorbance was converted into germination efficiency expressed as either germinated seed number per well. In Conclusion, The developed assay is simple and accurate and can be adapted for mass screening of germplasm lines of Indian mustard or mutagenised population. Identified lines can be utilized for detailed investigations on Mustard-*Orobanche* interactions and also for identification of genes/molecules responsible for production of germination stimulants.

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Status of population genetic structure and distribution of *Bemisia tabaci* genetic groups in vegetable crops and others in India

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ABSTRACT

Whitefly, *Bemisia tabaci* is one of the polyphagous pests infesting wide variety of crop plants and is vectors of plant viruses belonging to begomivruses whose transmission efficiencies have been reported to be varying. Therefore, we have conducted a series of extensive surveys during 2019-21 to monitor and collect *B. tabaci* populations across the country and studied the distribution of its genetic groups. Further, PCR amplification, purification, cycle sequencing and partial CO-I gene sequencing has been done to understand population genetic structure and the distribution of genetic groups *B. tabaci* in India. Data analysis revealed a total of 11 genetic groups of which Asia II-3, Asia II-6 & Asia III were new to India reported for the first time from Chhattisgarh, Andhra Pradesh and Maharashtra for the first time in India. These studies will help farmers and other stakeholders to effectively manage whitefly and whitefly borne begomoviruses for increased vegetables and in turn vegetable oil production.

Keywords: Genetic structure, Vegetable crops

The whiteflies are polyphagous insect pests causing severe economic damage in over 60 crop plants as a phloem sap sucking pest and as a vector of >100 plant viruses. Wider host adaptability, broad host range, small size and cryptic species status have facilitated whiteflies to emerge as efficient vector of begomoviruses that cause huge economic losses globally in particular in India. Very interestingly, its populations differ biologically with respect to insecticide resistance, virus transmission and host range (Ellango et al., 2015; Naveen et al., 2017). In India, a total of nine distinct genetic groups have been identified including one invasive group. However, the sample size representing each state is very low. Some important states like Chhattisgarh, Odisha, Jharkhand and all north eastern states (7 states) were not covered in the study. The transmission efficiencies vary with different genetic groups and strains of begomoviruses. Therefore, it is very essential to study the population genetic structure of B. tabaci in areas where it not done as there is a possibility for occurrence of new genetic groups of economic importance and also to revisit whether any changes have happened its populations in the country.

MATERIALS AND METHODS

A total 1225 whitefly samples were collected manually from 20 different states of the country using standard protocol covering fourteen different host plants including vegetables. Whiteflies were collected into cryovials containing absolute ethyl alcohol using aspirator and were brought to laboratory for further studies. Total genomic DNA from individual sample was isolated and further PCR amplification of the COI gene, cycle sequencing, purification and gene sequencing were done by following the standard protocol. The genetic data was analysed and used for interpretation of the results.

RESULTS AND DISCUSSION

A total of >509 mt COI gene sequences were generated, edited and analysed using standard analytic tool MEGA 6.0 and compared with references sequences to identify genetic groups. Genetic group names were assigned based on the similarity with the reference sequences reported across world. A total of 11 distinct genetic groups, Asia 1, Asia I India, Asia II-1, Asia II-3, Asia II-5, Asia II-6, Asia II-7, Asia II-8, Asia II-11, Asia III, MEAM-1 of which Asia II-3, Asia II-6 & Asia III were new to India reported for the first time. We report three new genetic groups, Asia II-3, Asia II-6 and Asia III from Chhattisgarh, Andhra Pradesh and Maharashtra. Asia I mostly recorded in central and northern states while Asia III was recorded exclusively in Chhattisgarh and Andhra Pradesh. Asia II-7 is widely distributed in South and Central India. However, MEAM-1 most popularly known as Biotype B has been widely distributed across the regions. These studies will help farmers and other stakeholders to effectively manage whitefly and whitefly borne begomoviruses for increased vegetables and in turn vegetable oil production.

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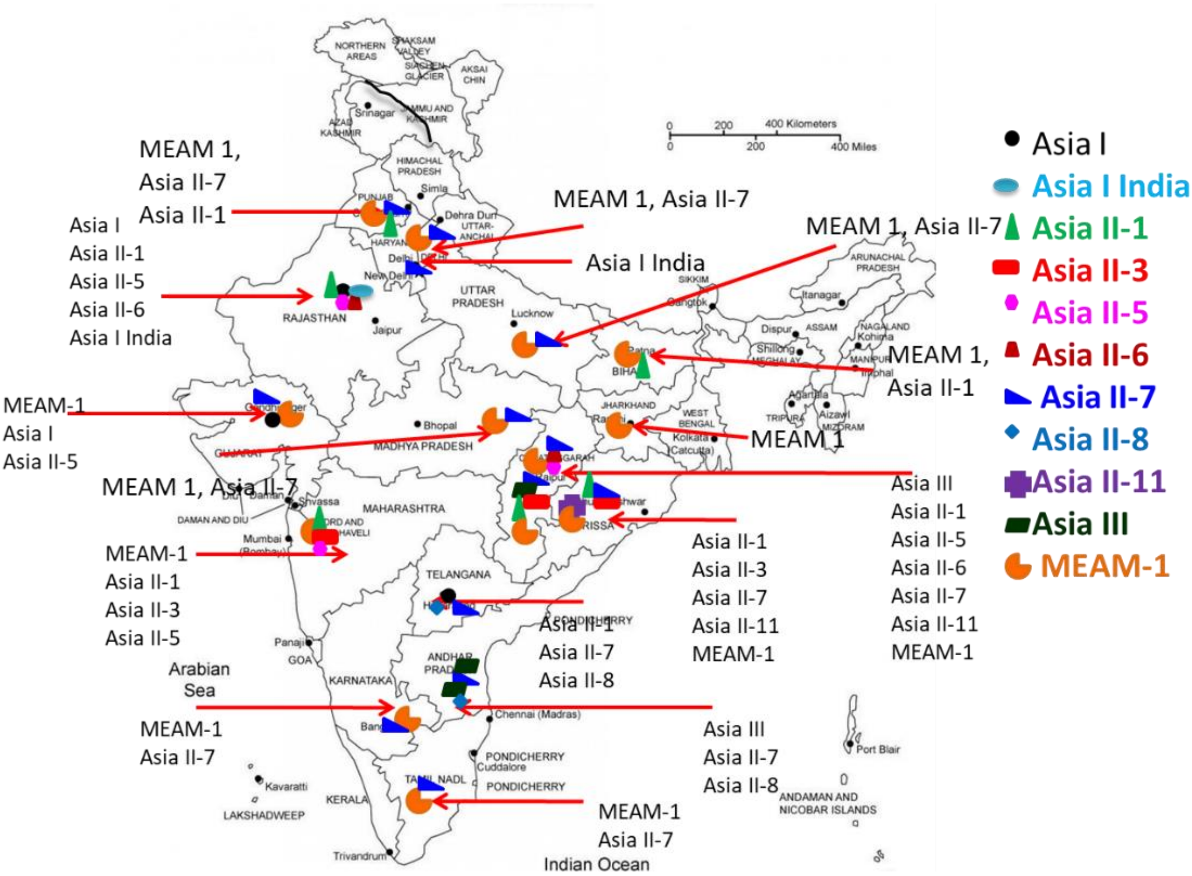

Thermotolerance of sunflower inbreds using temperature induction response technique

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ABSTRACT

A lab experiment was conducted with 47 sunflower inbreds to evaluate the thermal tolerance at seedling stage using TIR technique. The seedlings are subjected to high temperature stress (HT) with three different temperature treatments control, induction treatment (IT) and lethal treatment (LT). Survival percentage, total seedling length, plumule length, radicle length, seedling weight and seedling vigor index were effected both in IT and LT but the effect was more pronounced in lethal. Based on seed vigor index and percent reduction of total seedling length, inbreds were classified into tolerant, moderately tolerant and susceptible.

Keywords: Sunflower, Temperature induction response, Thermal tolerance

Sunflower is sensitive to abiotic stresses, such as moisture, salinity, and heat (Rauf *et al*. 2012). The optimal temperature for germination and growth is 25–30°C, while temperatures exceeding 30°C pose stress on the plant (Qadir *et al.*, 2007). HT results in irreversible damage to function and development. The magnitude of heat stress effect rapidly increases as temperature increases above a threshold level. It is hypothesized that induced seedlings of tolerant genotypes showed a high survival percentage and recovery growth after high temperature stress (challenging stress) compared with susceptible genotypes.

MATERIALS AND METHODS

The lab experiment was designed in factorial CRD with 47 genotypes in three replications. The seedlings of 0.5 cm radicle length (48h old) were used for all treatments *viz*., control (25^{o}C), IT (35^{o}C for 1h, 40^{o}C for 2h and 45^{o}C for 1h), lethal temperature of 49^{o}C for 2h and allowed to recover for 72 h at room temperature (25^{o}C). The screened genotypes were grouped into three categories using Normal Z distribution based on seed vigor index and percent reduction of total seedling length.

RESULTS AND DISCUSSION

At LT, the mean survival (31%) was reduced as compared to induction level (62 %). Inbreds CMS 135B (33%) and CMS 144B (37%) has recorded lowest reduction in survival percentage compared to checks under IT and LT. At LT the mean radicle length (1.6 cm) was reduced as compared to induction level (2.9 cm). The percent reduction in radicle length was more in LT (77%) when compared to IT (62%). Inbreds CMS 275B (14%) and NDL 6B (19%) has recorded lowest reduction in radicle length under IT and LT.

The mean plumule length was 8.3cm in control, 4.3cm in IT which further reduced to 2.6 cm at LT. Inbreds ARM 240B has recorded the lowest reduction (1%) in plumule length under IT while CMS 144B has recorded lower reduction (29%) in plumule length compared to checks (8-77% in IT and 53-81% in LT). The mean total seedling length was 15.9 cm in control, 7.2 cm in IT which further reduced to 4.1 cm in LT. Inbreds CMS 275B (16%) under IT and NDL 6B (44%) under LT has recorded lowest reduction in TSL compared to checks. Inbreds NDL 3B (42%) under IT and CMS 144B (70%) under LT has recorded lowest reduction in SVI compared to checks. The mean seedling weight (SWT) at LT (0.9 g) was reduced compared to IT (1.33 g). Inbreds CMS 58B has recorded lowest reduction in SWT compared to checks in IT and LT.

CONCLUSION

Seedlings exposed to acclimation temperature prior to challenge with lethal temperature have better growth recovery and a reduced percent mortality than those seedlings subjected directly to severe temperature. Based on the Z distribution analysis tolerant, moderately tolerant and susceptible inbreds were identified. Inbreds NDL -3B & 6B, CMS 144B and 59B were found tolerant while DSF2B, 17B, 58B, 59B, 122B, 144B, 275B and NDL 3B, were found moderately tolerant.

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RLC-171 (*Varsha Alsi 2*), the most recent and promising linseed variety for *Rainfed* condition of Himanchal Pradesh, Jammu &Kashmir, Punjab, Jharkhand, Uttar Pradesh, Assam, Bihar and Nagaland

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ABSTRACT

Linseed (*Linum usitatissimum* L.) 2n = 30, belongs to the genus *Linum* of the family Linaceae, Which is a self pollinated crop. India ranks third in area under linseed followed by Canada, China whereas, in production it stands fifth.

Keywords: Promising linseed variety, Varsha Alsi-2

It is grown for oil in tropical and subtropical countries and in Asian parts of USSR, whereas in European countries *viz.*, Canada, Argentina, Poland, European parts of USSR and in China, it is cultivated for both its oil and fiber.

The oldest regions of linseed cultivation are reported to be in Asia and on the Mediterranean coast. Linseed is extensively grown in the countries of the temperate zone as well as in those of the tropical zone. The yield in India is the lowest in the world, the major linseed growing states are Madhya Pradesh, Chattisgarh, Maharashtra, Uttar Pradesh, Bihar, Rajasthan, Orissa, Karnataka, West Bengal, Assam, Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Punjab and Nagaland. In India, Madhya Pradesh, Chattisgarh and Uttar Pradesh together contribute to the national linseed production to the extent of about 60 per cent. Linseed occupies a greater importance among oilseeds owing to its various uses and special qualities. It is grown mainly for seed used for extracting oil in rainfed conditions. The oil content of the seed varies from 33-47%. Linseed oil is an excellent dyeing oil used in manufacturing paints and varnishes, oilcloth, waterproof fabrics and linoleum and as edible oil in some areas. Linseed cake is a very good manure and animal feed. Dual-purpose linseed straw produces fibre of good quality. Linseed is also used in making paper and plastics. That is why it is also known as plastic crop.

In lndia, the crop is grown in the *rabi* season from September-October to February-March. Linseed can be grown on different kinds of soils, except the sandy and badly drained heavy clays or clay loams. It does well on clay loams, deep clayey black soils of central and peninsular India and on the alluvium loams of the Indo-Gangetic plains. Owing to development of improved linseed varieties and refinement of package of practices for different situations of linseed cultivation, there has been a steady but slow increase in the yield of linseed over a long period. The present national average yield in is about 450 kg/ha. In India Rainfed linseed is grown in 70 percent area under seventeen major states i.e. Andhra Pradesh, Bihar, Jharkhand, Chattisgarh, Orissa, Madhya Pradesh, Maharastra, Gujarat, Punjab, Hisar, Uttaranchal, Uttar Pradesh, Rajasthan, Karnataka, Tamilnadu and West Bengal covering arid, semi-arid and dry sub-humid regions. Hence, promising technologies for Rainfed Linseed based Production System in India has been given to cope up with the low yield scenario of India for rainfed situation of linseed.

In the view of these above mentioned points, the varietal research on rainfed linseed has been delivered to the rainfed farmers of linseed; a RLC-161 was developed by crossing of parents Ayogi x GS-234. RLC-161ranked first for seed yield over national check (T-397) and zonal check I Sheela tested in the All India Coordinated Research Project on Linseed breeding trials during 2016-17, 2017-18 and 2018-19 in eight locations of Himachal Pradesh, Punjab, Jammu & Chattisgarh.

RLC-171was developed by crossing of parents POLF-22 x JRF-5 through pedigree method.t ranked first for seed yield over national check (T-397) and zonal check I (Priyam), &Zonal check-II(Shekhar) tested in the All India Coordinated Research Project on Linseed trials during 2018-19, 2019-20 & 2020-21 in Zone-I, Zone-II & Zone-III at 58 locations.

Based on three years (2018-19 to 2020-21) performance in *Rainfed* condition over **23** locations of. zone I &II, **RLC-171** recorded seed yield of**1175**kg/ha which was 11 **%**, superior over National Check T-397(**1060** kg/ha) and **14.7%** superior over Zonal checks-I &II i.e. Priyam&Shekhar(**1024** kg/ha); on overall basis. **RLC-171** recorded **33**% oil content and **403** kg/ha oil yield which is **+6.5**% and +**26**% higher oil % & oil yield kg/ha than National Check T-397 (**31**% oil &**319.3** oil yield kg/ha); **+6.5**% higher oil yield than Zonal Checks – I/IIi.ePriyam / Shekhar (**369** oil yield kg/ha). Omega 3 content is considered to be of prime importance if we discuss linseed. For omega 3 contents, it was seen that RLC 171 recorded 50.15 % omega-3 which is +9.02% higher omega-3 content than Zonal Checks –I/II Priyam & Shekhar.

From agronomy evaluation, trials conducted for the variety showed that recorded 848 kg/ha seed yield at 50% RDF : 1001 kg/ha at100% RDF & 867 kg/ha at 150% RDF seed yield.which is about 5.5, 6.06 %, & 6.25% higher seed yielder over national check T-397 at 50% RDF, 100%RDF & 150% RDF , respectively during 2020-21. It had 12%, 21.90, 6% & 5% higher net monetary return over national check T-397 at 50% RDF, 100%RDF & 150% RDF, respectively during 2020-21in multi location in agronomy trial. Whereas 11%,10% &12% higher net monetary return over zonal checks (Shekhar& JLS-5) at 50% RDF, 100%RDF & 150% RDF, respectively during 2020-21.

RLC-171showed moderately resistant to wilt: resistant to rust whereas, susceptible to alternaria blight & powdery mildew underUniformDisease Nursery (UDN) Trial. It was seen to have moderate resistance to rust, Susceptible to *Alternaria blight*& powdery mildew whereas, highly susceptible to wilt under artificial conditions. In uniform pest nursery trials (UPN) from 2018-19 to 2020-21 RLC-171 showed moderately resistance (20.6%) to bud fly based on 3years from 2018-19 to 2020-21 in *rainfed* condition. Based on three (2018-19 to 2020-21) year performance RLC-171 showed resistant to Rust & Powdery Mildew whereas, moderately resistant to alternaria blight, wilt &budfly in breeding trials under natural field conditions.

Due to all the above mentioned points and presence of superior yield and quality traits than the national and zonal checks, RLC 171 has been recently released as a promising variety for rainfed situations for Himanchal Pradesh, Jammu &Kashmir , Punjab , Jharkhand, Uttar Pradesh, Assam, Bihar and Nagaland from AICRP on Linseed, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

Correlation analysis of seed yield and its component traits in Sesame (*Sesamum indicum* L.)

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ABSTRACT

Oilseed crops are high-value agricultural commodity for use in edible oil products. Sesame is an In the present study, fifty genotypes were evaluated to assessthe association among seed yield and its component traits in Sesame, during *kharif* 2022, in randomized block design with three replications. Significant differences were observed for all the characters. Seed yield per plant showed a significant and positive correlationwith plant height, number of capsules per plant and 1000-seeds weight at both genotypic and phenotypiclevel indicated that these were main contributors to the seed yield.

Keywords: Correlation analysis, Sesame

Sesame is often referred to as the “queen of oilseeds” (Bedigian and Harlan, 1986) which covers 1.62 million hectares area In India with the productivity of 405 kilograms per hectare. Despite its high economic and nutritional value, this crop has received very little attention. From breeding perspective,information related to phenotypic and genotypic correlations among quantitative traits is prerequisite in every crop improvement programme. Thus, we aimed to investigate the association among seed yield and its component traits in fifty genotypes of sesame.

MATERIALS AND METHODS

The present investigation was carried out at the Oilseeds Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. The experimental material consists of fifty genotypes of sesame and evaluated in randomized block design with three replications. Each genotype was sown in paired row of 3-meter length with spacing of 30 x 15 cm. Correlation coefficients were calculated by the formula given by Burton (1952), and Dewey and Lu (1959).

RESULT

Analysis of variance showed significant differences for all the characters in the studied material. Genotypic and phenotypic correlation coefficient of seed yield and its contributing traits of sesame are shown in table 1. The result revealed highly significant ($P< 0.01$) positive correlation of seed yield per plant with plant height, number of capsules per plant, capsule width and 1000-seed weight, but seed yield per plant had highly significant negative correlation with days to flowering. Interestingly, oil content showed positive correlation with days to flowering, capsule width and 1000-seed weight. 1000-Seed weight showed negative correlation with days to flowering but positive with number of capsules per plant.

DISCUSSION

Genotypic correlation was found slightly higher than phenotypic correlation for all the characters. Studied. Similar findings were made by Abate *et al*. (2015), and Saxena and Bisen (2017). The high magnitudes of genotypic correlation than corresponding phenotypic correlation coefficients indicating the presence of genetic association among various characters under study. A significant and positive correlation of seed yield with one or more component traits were also reported by Fazal *et al*. (2015), Mahmoud *et al*. (2015), Saxena and Bisen (2016). Finally, information obtained from this study may enables breeders to better understand the association among the component factors for utilization in improvement of sesame.

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Table 1: Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficientsamong quatitative characters in sesame

Characters	DF	PH	NCP	CW	1000-SW	SYP	OC
DF		-0.341**	-0.164*	-0.001	-0.164*	-0.315**	0.190*
PH	-0.342**		0.292**	0.142	0.127	0.173*	-0.021
NCP	-0.230**	0.482**		0.083	0.248**	0.273**	-0.024
CW	0.012	0.206**	0.119		0.085	0.222**	0.150*
1000-SW	-0.494**	0.433**	0.423**	0.248**		0.275**	0.177*
SYP	-0.472**	0.241**	0.295**	0.366**	0.455**		-0.002
OC	0.225**	0.081	-0.047	0.165*	0.214**	0.013	

*and**Significant at $P \leq 0.05$ and $P \leq 0.01$, *respectively*. DM-Days to flowering; PH-Plant height (cm); NCP-Number ofcapsule per plant; CW-Capsule width; TSW-1000-seed weight (g); SYP-Seed yield/plant (g); OC-Oil content (%).

Doubling of farmers income through front line demonstrations of castor in Ananthapuramu district

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ABSTRACT

The cluster frontline and frontline demonstrations were implemented in castor crop during *kharif* 2021-22 by AICRP on Castor, Agricultural Research Station, Ananthapuramu district of Andhra Pradesh to evaluate the performance of ICH-66 and package of practices on production and productivity of castor. Total of 100 demonstrations were executed during *kharif*, 2021 under rainfed conditions in Ananthapuramu district covering 26 villages and 14 mandals on Castor with different crop management modules of castor. In the Ananthapuramu district all most all mandals received the excess rainfall during the season. The results indicated that with improved practice there is a significant improvement in the seed yield, gross, net returns and B:C ratio compared with farmer's practice.

Castor (Ricinus communis L.) is one of the important non-edible oilseeds having immense industrial and commercial value, and India is the major producer of castor in the world. India accounts for 59% of the global castor area and 81% of world castor production and ranks first in area and production in the world (Damodaram and Hegde, 2010). Indian castor is produced both under irrigated intensive with high productivity in Gujarat and Rajasthan and rainfed culture coupled with poor management with low productivity in Andhra Pradesh, Karnataka, and Tamilnadu. However, in the recent past farmers are moving to castor crop from other rainfed crops viz., groundnut, pigeonpea, and millets due to high remunerative prices to castor prevailing in the market for the last 3 years. Though there were lacunae in the production and adoption of technologies. Hence there was an attempt was made to improve the productivity of castor through front line demonstrations.

MATERIAL AND METHODS

The cluster frontline and frontline demonstrations were implemented during *kharif* 2021-22 by AICRP on Castor, Agricultural Research Station, Ananthapuramu district of Andhra Pradesh to evaluate the performance of ICH-66 and package of practices on production and productivity of castor. In Anathapuramu district a total of 100 demonstrations covering 26 villages and 14 mandals were conducted in castor with different crop management modules, in 40 hectare area. Random crop cutting was used to obtain yield data from the demonstration and farmer's practice, which was then examined using simple statistical tools. Gross returns (kg/ha), cost of cultivation (kg/ha), and net returns (kg/ha) were computed. Seed yield was multiplied by the prevailing market price for the commodity each year to calculate gross returns. The cost of cultivation includes the cost of agricultural activities from seed to seed and labour wages at the current wage rate. Gross profits minus cultivation costs equal net returns.

Benefit Cost Ratio= Gross returns (Rs/ha)/Cost of cultivation (Rs/ha)

The technology gap, extension gap and technology index of the study were calculated

Technology gap = Potential yield – Demonstration yield
Extension gap = Demonstration yield – Farmers practice yield

Technology index= (Potential yield-demonstration yield) *100/Potential yield

RESULT

In the Ananthapuramu district all most all mandals received the excess rainfall during the season. The crop was sown initially with sufficient sowing rain. Later on, crop was grown perfectly till the primary spike initiation. At primary spike initiation stage to development stage crop faced slight moisture stress and incidence of sucking pest. Later on, due to continuous rains the crop was infested with botrytis and grey mould incidence. Due to complete saturation of the soil moisture profile the crop able to cope up and yielded more in tertiary and quaternary spikes.

The results indicated that the in improved practice seed yield ranged from 675-1538 kg/ha with an increase in seed yield ranged from 7.9 to 19.33 percent. The B:C ratio in the improved practice/technology ranged from 1.24 to 2.25. The average net returns were recorded with 10,483 Rs/ha. The results indicated that the technology gap was 390 kg/ha. Extension gap was 167 kg/ha in the different clusters of the Ananthapuramun district. The mean additional returns were 10,483 rupees with different castor-based interventions in the Ananthapuramu district.

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Table: 1. Cluster wise Yield, economics of cluster front line demonstrations of castor during *kharif*, 2020-21 at Ananthapuramu district

Name of themandal	Seed yield (kg/ha)		Cost of Cultivation1 (Rs/ha)		Gross Returns (kg/ha)		Net returns (kg/ha)		B:C ratio		% Increase over FP	Technology Gap (kg/ha)	Extension Gap (kg/ha)	Technology Index	Additional Returns (Rs/ha)
	IT	FP	IT	FP	IT	FP	IT	FP	IT	FP					
Atmakur	1342	1115	32328	34164	67109	55750	34781	21586	2.09	1.64	16.76	218	227	13.97	13195
Bathalapalli	1060	901	30749	33861	53011	45045	22262	11185	1.75	1.33	14.68	500	159	32.05	11077
Bukkarayasamudram	1312	1093	34633	36465	65576	54653	30944	18188	1.9	1.51	16.12	248	219	15.90	12756
Garladinne	1183	1069	34205	35899	59125	53425	24920	17527	1.75	1.50	9.66	377	114	24.17	7393
Gooty	945	863	30900	34233	47250	43167	16350	8933	1.55	1.27	8.83	615	82	39.42	7417
Kalyandurg	1041	936	30839	33441	52054	46800	21215	13359	1.68	1.39	10.66	519	105	33.27	7856
Kanaganapalli	1106	1013	30050	32388	55275	50630	25225	18242	1.85	1.56	7.90	454	93	29.10	6983
Kuderu	1041	919	32819	34936	52047	45931	19228	10995	1.59	1.32	12.09	519	122	33.27	8233
Ananthapuramu	1305	1120	30500	31250	65250	56000	34750	24750	2.14	1.79	14.18	255	185	16.35	10000
C.K.Palli	1283	1035	38520	39542	64125	51750	25605	12208	1.66	1.31	19.3	277	248	17.76	13397
Beluguppa	1538	1320	36200	37000	76875	66000	40675	29000	2.12	1.78	14.15	22	218	1.41	11675
Dharmavaram	1405	1204	31200	34200	70250	60200	39050	26000	2.25	1.76	14.31	155	201	9.94	13050
Singanamala	645	450	26000	29500	32250	22500	6250	-7000	1.24	0.76	17.43	915	195	58.65	13250
Average	1170	1003	32226	34375	58477	50142	26250	15767	1.81	1.45	13.54	390	167	25.00	10483
Max	1538	1320	38520	39542	76875	66000	40675	29000	2.25	1.79	19.33	22	218	1.41	11675
Min	645	450	26000	29500	32250	22500	6250	7000	1.24	0.76	7.90	915	195	58.65	-750

Regulating flowering pattern to improve assimilate translocation efficiency and pod yield of groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Groundnut is an indeterminate crop wherein vegetative and reproductive phases overlap, resulting in immature pods and poor pod yield. Field experiment was conducted to reduce later formed flowers and pod yield. The results of experiment revealed that foliar spray of late formed flower arresting formulation significantly reduced late formed flowers and recorded higher groundnut pod yield.

Keywords: Groundnut, Flowering pattern

Groundnut (*Arachis hypogaea* L.) is a leguminous oilseed crop widely cultivated in the tropical and sub tropical countries. India ranks the first in groundnut acreage and is the second largest producer of groundnut in the world with 101 lakh tonnes and productivity of 1816 kg/ha during 2021-21 (agricoop.nic.in). In groundnut, the twin objective of higher productivity and better use efficiency can be increased by scientific intervention (Harisudan and Subrahmaniyan, 2020) by addressing the physiological issues. The early formed flowers form into pods and flowers that appear 70 days after flowering do not mature which result in low yield of groundnut. Efficient translocation of photo-assimilates to growing pods improved the groundnut production (Subrahmaniyan *et al*., 2018). By arresting the late formed flowers, the sound matured kernel may be increased and eventually the pod yield. Keeping these views, the present field experiment was conducted.

METHODOLOGY

Field experiment study on the effect of arresting late formed flowers on the yield of groundnut was conducted during *Kharif* 2021 and *Kharif* 2022 season at Regional Research Station, Vridhachalam. The experiment involves treatments *viz*., T_1 - Control, T_2 - Flower arresting formulation (FAF) 1 @ 5 ml/10 lit at 60 DAS, T_3 - FAF 1 @ 5 ml/10 lit at 70 DAS, T_4 - FAF 1 @ 6 ml/10 lit at 60 DAS, T_5 - FAF 1 @ 6 ml/10 lit at 70 DAS, T_6 - FAF 2 @ 5 ml/10 lit at 60 DAS, T_7 - FAF 2 @ 5 ml/10 lit at 70 DAS, T_8 - FAF 2@ 6 ml/10 lit at 60 DAS, T_9 - FAF 2 @ 6 ml/10 lit at 70 DAS. The experiment was laid out in randomized complete block design which is replicated thrice. Flower count before and after spray, number of pods/plant and pod yield were recorded and analyzed statistically.

RESULTS AND DISCUSSION

Flower arresting formulations spray showed significant results on yield parameters of groundnut. With regard to the flower count after the spray of flower arresting formulation, the number of flowers produced/plant between 60-75 and 70-85 days after spraying varied significantly. Foliar spray of formulation 2 @ 6 ml/10 litre at 70 DAS (T_6) recorded lesser number of flowers/plant whereas higher flower production (22.0) was noticed in control (T_1). Likewise, higher number of pods/plant (40.0) was recorded in control (T_1) and less number of pods (20.6) was recorded in flower arresting formulation 2 @ 6 ml/10 lit at 60 DAS (T8). However with regard to pod yield, foliar application of flower arresting formulation 2 @ 5 ml/10 lit at 60 DAS recorded higher pod yield (2745 kg/ha). Arresting of late formed flowers could have led to high sink potential and led to acceleration of assimilate translocation from source to sink thereby enhancing seed filling period (25 to 55 days of flowers) (Vinothini *et al*., 2018).

CONCLUSION

Foliar spray of formulation 2 @ 5 ml/10 lit at 60 DAS significantly reduced unproductive flowers and registered higher number of double seeded mature pods and groundnut pod yield.

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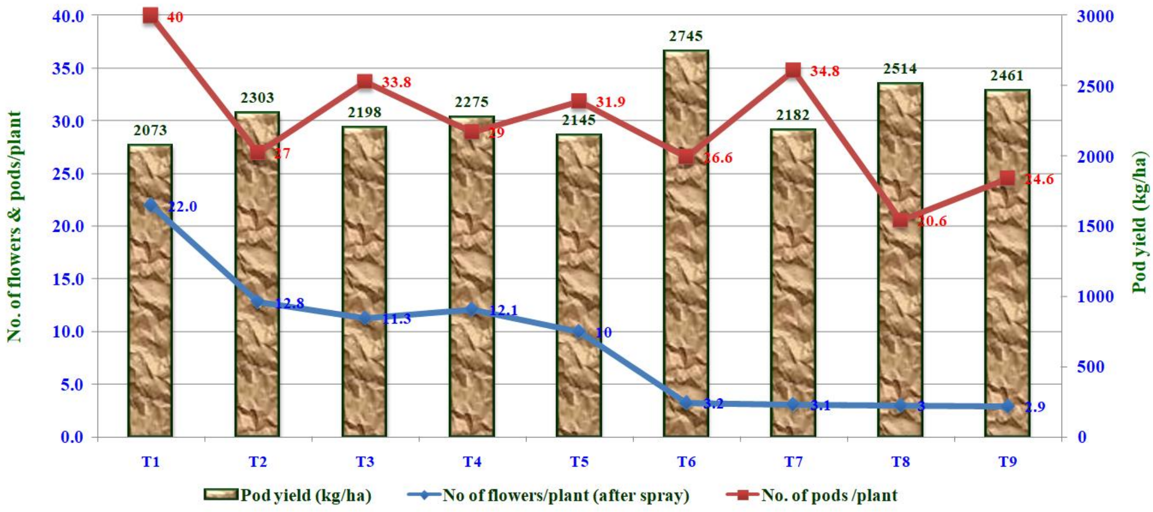

Fig.1. Effect of flower arresting formulations on yield parameters of groundnut

Inheritance of aluminium tolerance in sunflower (*Helianthus annuus* L.)

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ABSTRACT

In acidic soil, aluminium (Al) toxicity is one of the foremost restraining factors which inhibit crop performance. Breeding for Al tolerance seems to be a vital approach for enhancing productivity of field crops including sunflower in acidic soil regions. In order to understand the inheritance pattern, tolerant genotypes NDLR-06 and EC-601861 were crossed with susceptible genotypes MR-06 and RHA-298. P_1 , P_2, F_1, F_2 and backcross populations were raised in nutrient solution and classified as tolerant/susceptible by observing root re-growth after staining with eriochrome cyanine R. Dominance nature of Al tolerance over susceptible was confirmed by the responses of F_1's which were similar to the tolerant parents. The segregation ratio for Al tolerance *vs.* susceptible in the F_2 and backcross generations were 3:1 and 1:1, respectively. These outcomes indicated that inheritance of Al tolerance is governed by single dominant gene which can be transferred easily to desirable genotypes via backcross breeding method. This is the first report on inheritance of Al tolerance in sunflower.

Keywords: Aluminium tolerance; Inheritance study, Sunflower

Among the several factors, mineral toxicities and soil acidity associated with infertility are major limiting constraints to the agricultural production across the world. Sunflower is grown in diverse agro-climatic conditions in India and faces different types of abiotic stresses during its life cycle. In general, sunflower can't tolerate Al level greater than 5% hence considered as sensitive to Al toxicity (Castro and Oliveira 2005). At seedlings stage, Al ions rapidly inhibit root elongation resulting inflated root apex and poor development of the root system at micro-molar levels. Significant reduction in production as well as crop quality has been observed due to Al toxicity. Being an economic and nutritionally important crop it is essential for the breeders to cope with the Al toxicity. Remediation of soil acidity and alkalinity can be achieved by the application of lime and gypsum respectively, but it is a costly affair. Therefore, natural source of Al tolerance and genes conferring Al-tolerance in crop plants need to be exploited. Keeping above points into consideration, the main objective of present endeavor was to study the inheritance of Al tolerance in sunflower.

MATERIALS AND METHODS

The present experiment was carried out at Oilseeds Section, Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar, with four genotypes; EC-601861 and NDLR-06 were identified as tolerant while MR-06 and RHA-298 were considered as susceptible genotypes based on our previous findings (Singh *et al.*, 2022). Crosses were attempted to get F_1 progenies among selected genotypes (T

× S, T × T & S × S). F_1 progenies were selfed and backcrossed with their respective parents to get F_2 and backcross generation. The seedlings of parents, F_1, F_2 and backcross generations were subjected to Al tolerance assay in nutrient solution under controlled condition. Observations were recorded on RRG and TRL in the similar fashion as stated in previous study. Goodness of fit was tested with expected segregation ratio, inheritance of Al tolerance was calculated by Chi-square (χ^2) test of observed segregation ratio of tolerance and susceptible plants in F_2 and backcross populations.

RESULTS

The segregating pattern of plants for tolerance and susceptibility in different generations (Parents, F_1, F_2, BC_1P_1 and BC_1P_2) has been presented in table 1. None of susceptible plants observed in the F_1 population of cross NDLR-06 x RHA-298 (T x S) and EC-601861 x MR-06 (T x S) suggesting dominant behavior of Al tolerance over Al susceptible. The ratio of tolerant: susceptible was observed as 3:1 in F_2 populations of both the crosses which was further affirmed by an expected segregation ratio of 1:1 (tolerant: susceptible) in BC_2 populations confirming our hypothesis that a single dominant gene is accountable for Al tolerance in NDLR-06 and EC-601861, which was in agreement with the outcomes of Silva *et al.*, (2014) and Singh *et al.*, (2015) who like wise reported similar fact. Expectedly, the F_1 progeny of the cross EC-601861 × NDLR-06 (T × T) and MR-06 × RHA-298 (S × S) were observed tolerant and susceptible to Al toxicity, which affirmed the tolerant and susceptible nature of the parents employed in crossing programs, respectively. None of them segregated in F_2 generation, it means parents do not differ for any number of genes for the trait indicating presence of similar genetic factors associated with Al toxicity in both parents.

CONCLUSION

The results obtained in the present study showed that inheritance of Al tolerance is governed by a single dominant gene which can be transferred easily to desired lines/cultivars via backcross breeding program.

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Table 1: Segregation analysis in crosses involving Al tolerant and susceptible parents of sunflower

Cross	Generation	Total no. of plants	Tolerant	Susceptible	Genetic ratio (T : S)	χ^2	*P*
I. NDLR-06 x RHA-298 (T x S)	P_1	10	10	0	-	-	-
	P_2	10	0	10	-	-	-
	F_1	30	27	3	-	-	-
	F_2	150	112	38	3:1	0.01	0.920
	BC_1P_1	30	28	2	1:0	∞	-
	BC_2P_2	30	16	14	1:1	0.13	0.718
II. EC-601861 x MR-06 (T x S)	P_1	10	10	0	-	-	-
	P_2	10	0	10	-	-	-
	F_1	30	28	2	-	-	-
	F_2	150	109	41	3:1	0.44	0.507
	BC_1P_1	30	29	1	1:0	∞	-
	BC_2P_2	30	16	14	1:1	0.13	0.718
III. EC-601861 x NDLR-06 (T x T)	P_1	10	10	0	-	-	-
	P_2	10	10	0	-	-	-
	F_1	30	29	1	-	-	-
	F_2	150	149	1	-	-	-
	BC_1P_1	30	30	0	1:0	∞	-
	BC_2P_2	30	29	1	1:0	∞	-
IV. MR-06 x RHA-298 (S x S)	P_1	10	0	10	-	-	-
	P_2	10	0	10	-	-	-
	F_1	30	2	28	-	-	-
	F_2	150	7	143	-	-	-
	BC_1P_1	30	2	28	-	-	-
	BC_2P_2	30	3	27	-	-	-

Identification and validation of novel QTL associated with powdery mildew (*Golovinomyces cichoracearum* (DC.) V.P. Heluta.) resistance in sunflower (*Helianthus annuus* L.)

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Theme: Frontier Science for Improving Crop Productivity Resistance against biotic and abiotic stresses

ABSTRACT

Sunflower (*Helianthus annuus* L.; 2n=2x=34) is an important annual oilseed crop cultivated worldwide. In the recent past, powdery mildew disease has evolved as a significant constraint for yield and quality production in sunflower crop. Hence, a F_2 mapping population was developed from a cross COSF 15B x IR6 to identify quantitative trait loci (QTL) associated with powdery mildew resistance in sunflower. $F_{2:4}$ recombinant lines of this population were screened along with parents and scored for powdery mildew resistance during Dec-Feb 2021-22. Per cent disease index (PDI) was calculated from the data taken 75 days after sowing (DAS) using a 0-9 score scale. Genetic linkage map was constructed with 92 SSR markers which covered 1053.3 cM. The QTL analysis resulted in the detection of one QTL in LG10 for PDI. It has 2.54 LOD and accounted for 12.25 per cent phenotypic variation. The flanking markers *viz.,* ORS684 and ORS1110 have a flanking distance of 1.7 cM and validated with a set of population revealed that 24% and 28% PVE respectively. Hence, it may be concluded that markers ORS684 and ORS1110 can be effectively utilized for marker assisted breeding programme to develop the sunflower lines resistant to powdery mildew.

Keywords: Marker-assisted selection, Powdery Mildew, QTL, SSR, Sunflower

Sunflower is an economically important edible oilseed crop cultivated worldwide for its oil quality. Both biotic and abiotic stresses cause yield loss in sunflower. Major sunflower diseases are *Alternaria* leaf spot, root rot, downy mildew, rust and sunflower necrosis (virus). Recently, powdery mildew (*G. cichoracearum*) disease also gained more attention by causing a significant yield (30-74%) and quality loss (Dinesh *et al.* 2010; Sujatha *et al*. 2015).

The powdery mildew causal organism is season bound and also is an obligate parasite. Hence, screening for this disease is a major problem for sunflower breeders. Screening under poor epiphytotic conditions may lead to unreliable screening techniques. Hence, the identification of molecular markers and incorporation into marker-assisted breeding is an advisable step in the powdery mildew resistance breeding programme of sunflower.

Available information about the QTL for powdery mildew resistance in sunflower was very much limited. Identification of QTL responsible for powdery mildew resistance in sunflower, leads to progress in resistance breeding through marker-assisted breeding techniques. In this study, attempts were made to identify a QTL for powdery mildew resistance in a $F_{2:4}$ mapping population in sunflower.

MATERIAL AND METHODS

Plant material for mapping population: A field experiment was carried out at the Department of Oilseeds, TNAU, Coimbatore, with a maintainer inbred line COSF 15B (susceptible to powdery mildew) as female parent and restorer inbred line IR 6 (resistant to powdery mildew) as male parent. These parents were crossed and the resultant F_1 was selfed. The F_2 plants were selfed and forwarded to F_3 and F_4 as a single seed descent method. During Dec - Feb 2021-22, 150 $F_{2:4}$ population were screened along with parents and scored for powdery mildew resistance under artificially created epiphytotic conditions.

Phenotypic data

Evaluation for powdery mildew disease severity (PDI): In sunflower, powdery mildew disease intensity (severity) was calculated as per the standard disease rating scale of 0 to 9 (Mayee and Datar, 1986). In each entry, each leaf of every single plant was chosen and scored at 75 DAS through visual observation. Per cent Disease Index of each entry was worked out by using the following formula suggested by McKinney (1923):

$$\text{Per cent disease index} = \frac{\text{summation of all numerical rating}}{\text{total no. of leaves observed x maximum rating scale}} \times 100$$

Genotypic data: DNA from both the parents and 94 F_2 progenies were extracted by following CTAB method (Doyle and Doyle, 1987). Publicly available 442 ORS markers previously mapped by Tang et al. (2002) were used for polymorphism study. A total of 92 SSR primers showed polymorphism between parents and used to obtain genotypic data from F_2 progenies. A set of 16 genotypes consisting of 6 susceptible (>25 PDI), 4 moderate resistant (11-25 PDI) and 6 resistant lines (0-10 PDI) were taken for validation.

Linkage map and QTL detection: Genotyping data of F_2 plants and phenotyping data of $F_{2:4}$ lines were analyzed for mapping QTLs. The marker's position in the map of Tang *et al.* (2002) was used for QTL analysis. Single marker analysis was carried out by Microsoft Excel as per the standard procedure. The QTL were analyzed using the Inclusive composite interval mapping method (Zeng1994) with the software of QTL ICIM (version 4.2.53) (Wang et al., 2016).

RESULTS AND DISCUSSION

The QTL analysis by ICIM resulted one major QTL *qPDI10.1* for powdery mildew disease severity at 75 DAS and located on LG10. Markers ORS684 and ORS1110 flanked the *qPDI10.1* and explained 12.25 % of phenotypic variation for PDI at 75 DAS. The flanking markers *viz.*, ORS684 and ORS1110 had a flanking distance of 1.7 cM (Table 1 and Fig. 1). Similarly, Kallamadi and Mulpuri (2020) reported three QTLs for powdery mildew resistance with the flanking marker distance of 22, 58.18 and 60.59 cM. The flanking distance of less than 5 cM is most desirable as the recombination between markers may not happen in this region. Hence, the results of the present study are most valuable as the flanking distance is 1.7 cM.

The utilization of QTL in marker-assisted breeding depends upon the validation in other mapping populations or a set of genotypes. It revealed that ORS684 and ORS1110 were significantly associated with PDI and these markers explained 24% and 28% phenotypic variation, respectively. Hence, the identified QTL is a potential one and can be effectively used in marker-assisted breeding programmes.

CONCLUSION

In the present study, a major QTL *i.e., qPDI10.1* was identified in LG10 with the PVE of 12.25%, which is significantly associated with powdery mildew resistance in sunflower. The flanking distance between markers was 1.7 cM. Hence this QTL can be effectively utilized for powdery mildew disease resistance breeding programme in sunflower.

The flanking markers (ORS684 and ORS1110) of the *qPDI10.1* explained 24% and 28% phenotypic variation during validation. Hence it may conclude that markers ORS684 and ORS1110 can be effectively utilized for marker assisted breeding programme to develop the sunflower lines resistant to powdery mildew.

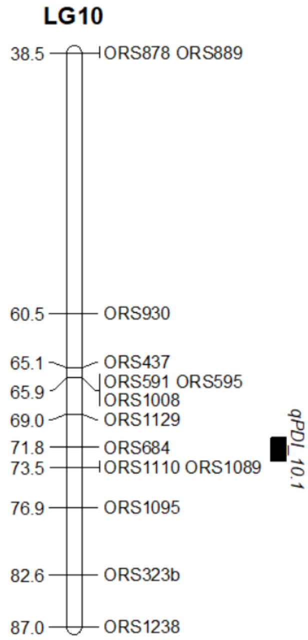

Fig. 1. Linkage group (LG10) and the QTL

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Table 1. QTL regions associated with powdery mildew disease resistance trait at 75 DAS in mapping population of COSF 15B x IR6

Trait	QTL	LG	QTL region (cM)	Left Marker	Right Marker	LOD	PVE (%)	Additive effect
PDI	*qPDI10.1*	10	71.0-73.0	ORS684 (71.8 cM)	ORS1110 (73.5 cM)	2.54	12.25	(4.79) IR6

LG-Linkage group; LOD- logarithm of the odds ratio; PVE-Phenotypic variation explained

Evaluation of certain botanicals for eco-friendly management of red flour beetle, *Tribolium castaneum* (Hbst.) infesting stored sesame

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ABSTRACT

The experiment was conducted to assess the effectiveness of different botanicals for the eco-friendly management of red flour beetle (*Tribolium castaneum*) infesting stored sesame. The effectiveness of the botanicals was assessed based on the parameters *viz.,* per cent seed damage, per cent weight loss, number of adults emerged and germination percentage at 6 months after storage. From this study, it was observed that the treatment sweet flag rhizome powder @ 10 g/kg sesame seeds recorded the lowest number of adult emerging (2.3 adults), the lowest percentage of seed damage (11.7%), percentage of seed weight loss (2.9%) and highest percentage germination (74.7%) after six months of storage. Therefore, it can be concluded that sweet flag rhizome powder @ 10 g/kg was the most effective eco-friendly method to manage red flour beetle beetle on stored sesame.

Keywords: Botanicals, Ecofriendly management, Sesame, Sweet flag, Storage pests

In India, sesame (*Sesamum indicum* L.) is the oldest indigenous oilseed crop, with longest history of cultivation. The seed oil content of sesame (~60%) and dietary energy (6355 k cal/kg) are the highest when compared with other oilseed crops such as, sunflower (~45%), rapeseed (~40%), and soybean (~20%). Among different storage pests of sesame, red flour beetle, *Tribolium castaneum* (Hbst.) is the most dominant (Sundar *et al.,* 2021). The beetle is a serious pest that feeds on broken grains, germ portion and milled products due to heavy infestation cause a stinking odour in flour and adversely affect dough quality. Management of agricultural pests has been largely dependent on the use of synthetic chemicals. The present study was conducted to find out the eco-friendly management of red flour beetle on stored sesame.

MATERIALS AND METHODS

The experiment was laid out in completely randomized design using ten treatments with three replications. The treatments were sweet flag rhizome powder, nirgundi leaf powder, datura leaf powder, lantana leaf powder, turmeric leaf powder, castor leaf powder, eucalyptus leaf powder, neem leaf powder, neem seed kernel extract and untreated control. Each treatment of 10 g was treated to one kg of seed of sesame (cv. swetha) and 50 adult beetles of *Tribolium* were release in to the cloth bag. The effectiveness of the botanicals was assessed based on the parameters *viz.,* per cent seed damage, per cent weight loss, number of adults emerged and germination percentage (Kumar *et al*., 2012). The data were collected and recorded at 2 months intervals and continued up to 6 months after storage.

RESULTS AND DISCUSSION

Among different botanicals evaluated, sweet flag rhizome powder (11.7%) recorded the lowest seed damage followed by nirgundi leaf powder (12.7%), and eucalyptus leaf powder (13.2%) at 6 months of treatment (Fig. 1). After 6 months of treatment, significant minimum weight loss was observed in the sweet flag rhizome powder (2.9%) followed by nirgundi leaf powder (3.9%), and eucalyptus leaf powder (4.7%). After 6 months of treatment, sweet flag rhizome powder was recorded least number of adult emergence (2.3 adults), and nirgundi leaf powder (9.51 adults) were the rest of the significant treatments. While the untreated control (59.3 adults) recorded maximum number of adult emergence). Maximum seed germination was observed in the sweet flag rhizome powder (74.4%) followed by nirgundi leaf powder (71.5%), and eucalyptus leaf powder (66.4%), while minimum viability was recorded in the untreated control (52.3%). Hence, sweet flag rhizome powder @ 10 g/kg can be used as an effective eco-friendly method against red flour beetle beetle infesting stored sesame.

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Damage in Sweet flag

Damage in Control

Germination in Sweet Flag

Germination in Control

Fig. 1 Efficacy of botanicals against *T. castaneum* in sesame during storage

Deciphering the SNP variations linked to female sterility in Dura fruit form of oil palm

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ABSTRACT

Among the vegetable oils, palm oil which is obtained from African oil palm (*Elaeisguineensis* Jacq.) contributes a major share at the global oil trading centres. Taxonomically, oil palm belongs to the family Aricaceae (formerly known as Palmaceae), sub-family Arecoideae and the genus Elaeis. One breeding cycle of oil palm takes 15-18 years with lot of techniques involved in achieving good yield and oil quality of oil palm in a sustainable manner. Oil palm is a highly heterozygous and heterogeneous crop with high diversity in the germplasm (Babu et al. 2020). Oil palm can be divided into mainly three forms based on the shell thickness of the fruits i.e., dura, pisifera, and tenera, whereas another type of fruit form called macrocarya also exists but not common. Based on fruit color, oil palm is classified into two types i.e., Virescence and Nigrescence type. Nigrescence is the commonly found fruit color among the commercially grown oil palm farms. In terms of quality, palm oil has approximately equal distribution of saturated to unsaturated fatty acids (UFAs). Most of the oil palm breeding programmes in generating high yielding varieties were restricted to dura variety which is having thick shelled fruit form till the 1950s. Later, research efforts at some countries like Africa, Malaysia and Indonesia resulted in generation of various breeding populations originated from the four Bogorpalms and their progenies.

Keywords: Deciphering, Dura fruit, Oil palm

The oil palm genotypes are divided into dura, pisifera and tenera forms based on the shell thickness, which is a monogenic and co-dominantly inherited trait. With the discovery of SHELL thickness gene (Sh gene) by the oil palm researchers in the Congo during 1940s led to more focus on increasing the oil palm production (Beirnaert and Vanderweyen, 1941). The dura (D) genotypes consist of thick shell (Sh/Sh, dominant homozygote), whereas pisifera (P) genotype has shell less with recessive homozygous sh/sh allele (Corley and Tinker, 2003). The tenera (T) genotype has thin shell which has 30% more mesocarp and oil production than dura and pisifera, which is generally produced as hybrid from cross between D and P. The tenera hybrid yields more oil and also is the basis for commercial palm oil production in all the oil palm growing parts of the world. Dura and tenera are generally fertile. That is, they produce mature ripe bunches regularly under natural conditions with very rare exceptions. Pisifera is often unpro- ductive, and is said to be partially female sterile, the female inflorescences tending o abort soon after anthesis. Hese are called fertilepisifera palms to distinguish them from the more common partially female sterilepisifera palms which produce a few or no bunches at all in several years. Piszjka, which is generally partially female sterile, is used only as the pollen parent for the production of the tenera commercial seed.

Gradually there is an increase in demand for vegetable oils throughout the world. To meet this demand, increasing the area under cultivation is not a suitable choice these days due to scarcity of land resources. However, at the same time, increasing the productivity will be the best option on the existing area which meets the demand world vegetable oils. Traditional tools like conventional breeding in these circumstances may play less role in comparison to the combination of molecular genomic tools with conventional breeding methods. These molecular breeding methods may play a significant role in oil palm improvement with respect to yield and oil quality parameters.

In general, pisifera is partially female sterile which produce a few or no bunches at all for several years. However, *dura* produces mature ripe bunches regularly under natural conditions with rare exceptions. In our experimental field, we observed this rare phenomenon in some of the dura palms, where there are no mature ripened fruits for several years. Hence we attempted methodology to identify the cause of sterile nature of dura palms using next generation sequencing technologies. For this, genotyping by sequencing was performed for fertile and sterile dura palms using Illumina Novaseq 6000. A total of 4.1 million reads on an average were obtained through pair end sequencing. The sequencing resulted in identification of three SNP variations between sterile and fertile dura germplasm (Fig 1.). The SNP1 (G/T) linked to EgGDSL esterase gene, SNP2 (G/A) linked to TTG1 of oil palm, whereas SNP3 (A/T) linked to EgMYB4 gene. SNP based molecular markers were designed and identified the restriction enzymes which are able to differentiate the fertile and sterile dura. These markers also validated for their amplification in the germplasm and found amplification and need to test for restriction enzyme digestion.

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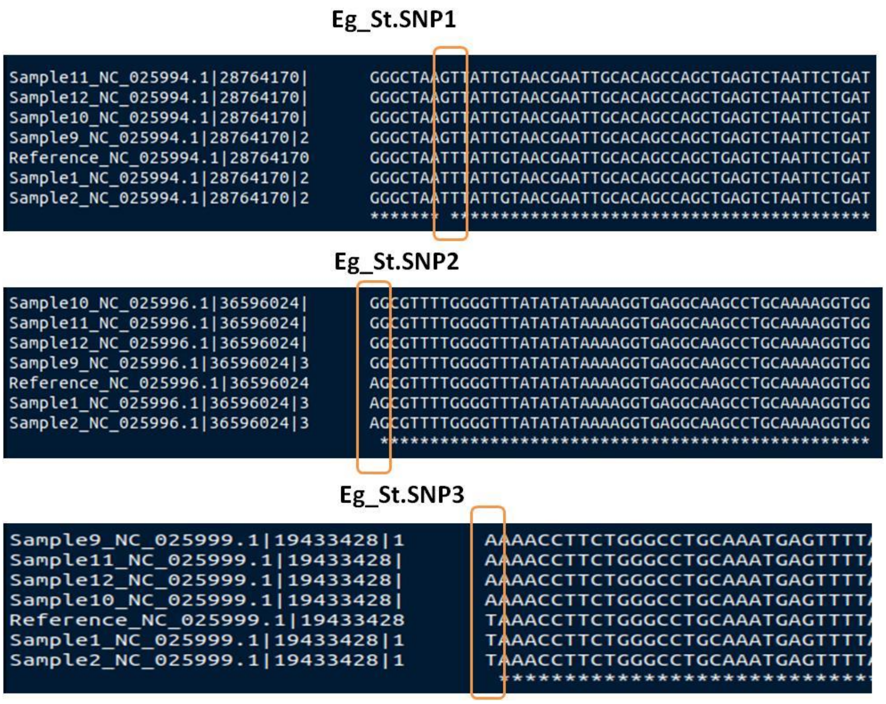

Fig 1. SNP allelic variations observed between fertile and sterile dura germplasm using GBS method

Adaptation and tolerance mechanism of sesame to drought stress

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ABSTRACT

Drought, seasonal temperature variations affects yield of sesame (*Sesamum indicum* L.) Under rainfed conditions. Sesame germplasm were assessed for drought tolerance across season in field conditions. Seed yield was significantly and positively associated with functional root traits, leaf potassium, leaf tissue moisture and CT across seasons. The identified trait, and specific germplasm will be used further in crop improvement programme.

Keywords: Association, Drought, Sesame, Traits, Yield

Sesame cultivation is reported in tropical as well as subtropical regions of the world. The arid and semi-arid regions where sesame is grown are known to experience high temperatures, high values of solar radiation, high evaporation demand and occurrence of unpredictable drought. Although India is one of the top sesame producers of the world, severe drought threatens its production under rainfed cultivation. It is of great importance to explore the traits functional root traits (Ratnakumar et al 2021), diversity of the traits and canopy temperature (Pandey et al 2021), leaf potassium content (Pandey et al 2022), SPAD (Anusha et al 2023), indices (Gopika et al 2022) and traits association (Sravanthi et al 2022) that contribute sesame tolerance to drought. Therefore the effects of drought on yield of sesame across seasons have an important challenge in sesame research.

MATERIALS AND METHODS

Improvement of drought tolerance genotypes of sesame is one of the major objectives of sesame breeding programs for recommendation to marginal and arid regions of its cultivation. With this backdrop, Indian core set of sesame were used for their drought tolerance. The core set consists of indigenous landraces from different agro-ecological zones of India. Drought was imposed by reducing 4 to 4.5 bars of soil metric potential using soil moisture sensors (Gopika et al 2022). Different traits including: the number of primary branches per plant, plant height, number of capsule per plant, number of seeds per capsule, seed weight and harvest index were recorded under both conditions under stressed and irrigated conditions in Kharif and Rabi seasons of 2017. Seed and biological yield were determined by harvesting plants of each plot.

RESULTS AND DISCUSSION

The leaf weight, total biomass, number of capsules per plant, capsule weight, seed weight per capsule and seed weight were found to reduce under drought conditions as compared to irrigated condition. The average seed yield reduced up to 20%, indicating that the reproductive process has vulnerability to intermittent drought reflecting on seed yield. Total oil content varied from 46 to 49% among core set analyzed. The genotypes IC 205471, IC 204622, IC 132 171, JCSDT 26, JCSDT 119, JCSDT 112, JCS2454 were selected based on cluster analysis and their seed yield responses under drought across seasons. The identified of source material with traits associated for drought tolerance will be used in sesame breeding programme.

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Combining ability and gene action studies in castor (*Ricinus communis* L.)

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ABSTRACT

The present study of combining ability and gene action studies will be helpful in identifying better combiners to yield superior hybrids along with selection protocol for the trait of interest. Analysis of variance studies revealed that significant variation exists in the material understudy. Higher estimates of SCA variance were observed than the GCA variance except for seed yield indicating preponderance of non-additive gene action in governing the traits. Significant *gca* effects were observed in SKP-84 and ICS-142 for seed yield and PPL-1001, SKI-215, DCS-86, PCS-327 and Kiran for oil content. Significant sca effect was observed for the crosses *viz*., M-574 x Kiran, PPL-1001 x SKI-215 and SKP-84 x JI-244 for total yield.

Key words: Castor, Combining ability, Gene action, GCA, SCA

Castor (*Ricinus communis* L.) is an industrially important crop because of its high seed oil content. Castor seed contains nearly 48% oil and ricinoleic acid is the major fatty acid component present in the oil. Castor oil is used as an efficient lubricant for high-speed engines and as an ingredient in soaps, shampoo, shoe polish, candles and ointments (Sadaiah *et al*., 2021).

To meet the growing requirement of the industries, it is imperative to breed high yielding cultivars in castor. Knowledge of gene action of economically important traits and identification of suitable breeding methods are essential for castor improvement (Panera *et al*., 2018).

MATERIAL AND METHODS

The present study consisting of 48 entries *viz*., three pistillate lines (M-574, PPL-1001 and SKP 84 used as testers/females) and eleven inbred lines (SKI-215, Kranthi, JI-244, JI-227, ICS-142, ICS-148, ICS-136, DCS-86, DCS-89, PCS-327 and Kiran used as lines/males) and their 33 hybrid combinations developed through line x tester mating design (Kempthorne, 1957) along with standard check hybrid ICH-66 were evaluated in a randomized block design with three replications during *kharif*, 2020 at the experimental plots of Regional Agricultural Research Station, PJTSAU, Palem. General and specific combining ability (GCA and SCA) analysis was done using line × tester method (Kempthorne, 1957). The analysis was done using statistical software INDOSTAT software.

RESULTS AND DISCUSSION

Analysis of variance revealed that mean square values of genotypes for all the traits were highly significant indicating presence of genetic variability in the material understudy. Mean square values for line effects were significant for seed yield and oil content. *GCA* variance was found significant for seed yield, hundred seed weight and oil content indicating significant impact of parental lines on the traits. Instead, *sca* variance was found highly significant for all the traits understudy. This signifies predominance of non-additive gene action in governing these traits. The ratio of *GCA* to *sca* variance was less than unity for all the traits except for seed yield thus indicating non-additve effect in governing the traits understudy (Delvadiya *et al*., 2018). However higher significant *gca* variance for seed yield suggests that selection of superior parental lines give rise to high yielding hybrid combinations (Solanki *et al*., 2003).

Estimation of *GCA* effects for parental lines revealed that, females and males showed significant effect for all the traits. However for seed yield, SKP-84 and ICS-142 were found good general combiners compared to other parents. *Sca* effects for seed yield were positively significant for M-574 x Kiran, PPL-1001 x SKI-215, SKP-84 x JI-244 thus considered as good specific combiners for the trait.

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Estimation of ricin in castor varieties and hybrids by Lowry method

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ABSTRACT

Development of castor cultivars with reduced levels of ricin would improve the economics of castor oil production, reduce the potential for accidental poisoning and eliminate the potential of ricin. The presence of ricin in the high protein meal of castor remaining after oil extraction has historically reduced its value as an animal feed.Castor meal when applied as an amendment to greenhouse potting media suppress root-knot nematode. Ricin has historically been degraded by exposure to high temperature for two or more hours.

Keywords: Castor, Hybrids, Lowry method, Ricin estimation, Varieties

Castor (*Ricinus communis* L.) has the potential to become the premier vegetable oil crop for industrial oil production across the globe. Castor is an ideal candidate for production of high value, industrial oil feed stocks because of the very high oil content (48–60 %) of the seed, the extremely high levels of potential oil production (500–1,000 l of oil/acre), and this plants unique ability to produce oils with extremely high levels (80–90%) of ricinoleic acid . Additionally, the high potential yield and unique fatty acid composition of castor allows this oil to provide economically competitive feedstocks needed for the production of premium quality biodiesel, short chain aviation fuels, fuel lubrication additives, and very high value biopolymers. The seeds contain 50per cent of oil which predominantly contains Ricinoleic acid, an unusual fatty acid with hydroxylation. But the seed deoiled meal cannot be used as animal feed due to the presence of a highly toxic protein ricin and an agglutinin called RCA (*Ricinus communis* agglutinin). The Lowry protein assay is a biochemical assay for determining the total level of protein in a solution. The total protein concentration is exhibited by a colour change of the sample solution in proportion to protein concentration, which can then be measured using colorimetric techniques.

MATERIALS AND METHODS

Protein estimation by Lowry Method: Seed sample of 250 mg was added and ground with 10 ml of phosphate buffer and centrifuged at 10000 rpm for 10 min. From this, 0.1 ml of supernatant was taken and made upto 1 ml with distilled water and the protein estimation was carried out.

RESULTS

Estimation of ricin in castor varieties and Hybrids

Samples	OD @ 750	µg/g (calculated from OD value
Blank	0	
Standard 1	0.11	
Standard 2	0.26	
Standard 3	0.39	
Standard 4	0.46	
Standard 5	0.54	
Sample: YRCH 1	0.44	292
Sample: YRCH 2	0.52	360
Sample: YRCS 1205	0.61	424

Mean of three replications

REFERENCE

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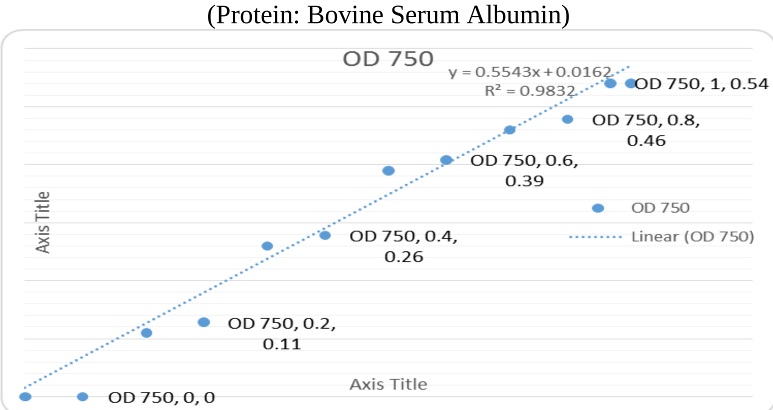
Standard Best fit curve for Ricin Estimation
(Protein: Bovine Serum Albumin)



The Protein estimation by Lowry Method of ricin in castor varieties and Hybrids provided the imformation that YRCS 1205 (YTP 1) had the highest ricin content with 1 g of sample containing = 424 µg of protein followed by YRCH 2 having 360 µg of protein and YRCH 1 recording the lowest ricin content of 292 µg of protein. It will be interesting to know the basis of this difference.

Determination of optimal lethal dose for ethyl methane sulphonate (EMS) induced mutagenesis in castor (*Ricinus communis* L)

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ABSTRACT

Castor, an indeterminate and perennial non-edible oilseed crop is unsuitable for mechanization over a large scale. Chemical mutagenesis using ethyl methane sulphonate (EMS) is resorted to exploit point mutations and induce monospike or synchronous maturity. In the present study, EMS mutagenesis dosage was standardized using combinations of concentration (0.5 %, 1 % and 1.5%) and duration (4, 8, 12 hours) of EMS treatment along with duration of pre-soaking with water (12 and 24 hours). Data on speed and percent germination of the seed along with root and shoot length at 7 days and 14 days after treatment indicated that 12 hours presoaking followed by 8 hours or 12 hours of treatment with 1.0% EMS treatment is the optimum lethal dose for EMS mutagenesis.

Keywords: Castor, Chemical mutagenesis, Ethyl Methane Sulphonate

Castor (*Ricinus communis* L.), a perennial, cross pollinated, non-edible oilseed crop is cultivated in an area of 0.8 m.ha with a productivity of 2.2 t/ha in 2021-22. India contributes more than 80% of world requirement of castor oil and its derivatives based on the presence of 80-85% ricinoleic acid. Due to non-availability or scarcity of labour, cultivation of an indeterminate crop like castor is no longer lucrative while its prolonged duration exposes it to several biotic and abiotic stresses. Castor is a monotypic genus with limited scope for intergeneric or wide hybridization. Mutation breeding is the best available option to induce desired traits like determinate or monospike plant type, top branching with synchronous maturity suitable for machine harvesting. The present experiment is an attempt to standardize optimum lethal dose for EMS mutagenesis involving optimum concentration and duration of EMS treatment along with duration of presoaking in water.

MATERIALS AND METHODS

DPC-15, a castor pistillate line with early maturity (90 days to first picking), short (<50 cm) with spreading or divergent type of branching was selected for EMS treatment. The standard protocol of IAEA, Vienna for EMS treatment using four basic steps of pre-treatment, EMS treatment, post-treatment wash and planting / test for germination was followed (IAEA, 2018). A set of nine treatments (T-1 to T-9) viz., including two durations of pre-soaking (12 and 24 hours) and different concentrations (0.5, 1.0 and 1.5 %) and duration (4, 8, 12 hours) of EMS treatment along with three controls *viz*., C-1: no presoaking and no treatment, C-2. no presoaking and C-3. no treatment were set up for determining the effective duration of soaking and desired concentration of EMS solution. The experiment was set up in three replications of 20 seeds/replication. Observations were recorded on germination percent on 3rd, 5th, 7th and 14th day while root and shoot length were recorded on 7th and 14th day.

RESULTS AND DISCUSSION

Preliminary experiments on pre-soaking and seed puncturing using 0.5% EMS indicated that presoaking is conducive for mutagenesis while seed puncturing is detrimental, even though castor seeds are bold and bigger in size compared to other crops. Final germination percent recorded on 14th day varied from 75 to 98 in 0.5% EMS, 37 to 87 % in 1 % EMS and 3 to 73% in 1.5% EMS among the nine treatments (Table 1). EMS treatment @ 0.5% either with or without pre-soaking was on par with the control while EMS @ 1.5% proved lethal starting from eight hours of mutagen treatment. Seed pre-soaked in water for 12 hours, followed by treating 1.0% EMS for 8 hours or 12 hours with 52% germination is the optimum lethal dose for induction of mutations in castor.

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Table.1. Seed germination percentage for different doses of EMS treatment*

Treatment(T) /Control (C)	EMS Treatment		Germination (%)		
	Pre-soaking (hours)	Soaking in EMS (hours)	0.5% EMS	1 % EMS	1.5% EMS
C-1	0	0	78 (62)	92 (25)	85 (24)
C-2	12	0	93 (75)	95 (26)	92 (25)
C-3	24	0	90 (75)	93 (26)	92 (25)
T-1	0	4	98 (86)	87 (25)	73 (22)
T-2	0	8	93 (78)	73 (22)	42 (17)
T-3	0	12	92 (73)	75 (23)	52 (19)
T-4	12	4	87 (69)	77 (23)	48 (18)
T-5	12	8	80 (64)	52 (18)	22 (12)
T-6	12	12	75 (60)	52 (19)	22 (12)
T-7	24	4	92 (74)	63 (21)	35 (15)
T-8	24	8	75 (61)	57 (20)	3 (4)
T-9	24	12	75 (61)	37 (16)	20 (11)
		C.D.	14.425	3.381	3.351
		C.V.	12.117	9.064	11.501

C.D. = Critical Difference; C.V. = Coefficient of Variation; *figures in parenthesis indicate arc transformed values

Exploitation of the phenotypic diversity of safflower (*Carthamus tinctorius* L.) for deficit soil moisture stress tolerance

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ABSTRACT

Safflower is an annual oilseed crop grown throughout the semi-arid regions under residual soil moisture. Under the present climatic scenarios, scarcity of water is frequent which is limiting crop yields. A series of field experiments were carried out during post rainy season of 2020-21 and 2021-22 to evaluate the genotype responses to terminal deficit soil moisture stress (DS). The phenotypic data generated in both the seasons revealed that, the huge genotypic difference among the genotypes were conferring tolerance to DS. The PCA analysis revealed that certain morpho-physiological traits *viz.,* plant height, SPAD chlorophyll meter reading, relative water content, and days to 50% flowering accounted for maximum variation under deficit and residual soil moisture conditions.

Keywords: Deficit soil moisture, Physiological traits, Safflower, Yield and soil type

In India, oilseeds account for nearly 22.01per cent of gross cropped area. Often oil seeds are cultivated in soils deprived of inputs, resulting in poor realization of genetic potential of a species. Almost 70% oilseeds production is dependent on rain-based cultivation system and their production was erratic due to climatic aberrations. Safflower is one such ancient crop known to mankind, whose cultivation dates back to 4000 years for its oil, rich in poly and mono unsaturated fatty acids, and its flowers for their role in pharmaceutical sector (Singh and Nakar, 2014). Though safflower is a crop with xeric adaptations to water stress, a delay in sowing or a decline in soil water availability often leads to drought stress (Yau, 2007). The severity of water stress is expected to increase in the near future, given the conditions of climate change, mainly characterized by long periods of null precipitation rate or shorter windows of intense precipitation. There is a dire need to develop high yielding varieties capable of withstanding the stress situations to bridge the yield gaps. For a successful breeding program, the exploration of diversity among the genotypes is a pre-requisite. With this background knowledge, the present study was formulated to explore the phenotypic diversity among the safflower genotypes under water stress situations using multi variate analysis.

MATERIALS AND METHODS

The field experiments were conducted at two locations for two seasons, at ICAR-Indian Institute of Oilseeds and Research farms available at Narkhoda and at ICRISAT, Patancheruvu following a α-lattice design. A set of 123 genotypes encompassing 100 germplasm lines and 23 released varieties were used to explore phenotypic diversity in conferring tolerance to water stress. Three treatments *viz.*, well-watered (alfisols), moistured stress (alfisols) and residual moisture stress (Vertisols) were specified to evaluate genotypes. Under Alfiosl conditions, two water regimes i.e., well-watered Alfisols (WW) where adequate soil moisture levels were maintained. In these plots the soil moisture levels were maintained at 80per cent field capacity throughout the crop period. The second treatment, water-stressed Alfisols (WS) where the last irrigation was given on 30 DAS thereafter withholding the irrigation to crop, which implies the onset of stress by 45 DAS. In this treatment, though the moisture levels were maintained at 80per cent field capacity till 45 DAS, then after it started declining and reached to 40per cent field capacity by the time of flower initiation, which is a sensitive stage for water deficit in oil seed crops till physiological maturity. In Vertisol, during both the years only one irrigation was given at the time of sowing and there after soil moisture started declining towards crop growth and reached to 50per cent field capacity by the time of flowering. The optimal moisture levels under WW conditions or steady decrease in WS or RSM conditions were frequently monitored on hourly basis with the help of soil moisture sensors (Proximal SoilSens; IIT Mumbai). These sensors were installed in all three different treatment plots at different depths of 15, 45 and 60 cm.

RESULTS AND DISCUSSION

Various morpho-physiological, yield contributing, and yield traits were measured at respective crop growth stages i.e., vegetative, flowering, physiological maturity, and harvest. The/*se* performance revealed that the germplasm lines were highly diverse for the observed morpho-physiological, yield contributing, and yield traits. The principal component analysis suggested that under WS conditions, traits such as main capitulum weight (0.359), oil content (0.307), days to 50% flowering (0.300), plant height (0.288) and SPAD chlorophyll meter reading (0.156) contributed maximum towards variability among the genotypes, whereas under RSM conditions, SPAD chlorophyll meter reading (0.33), days to 50% flowering (0.193), relative water content (0.177), plant height (0.171) attributed to the maximum diversity. Hussain et al., 2017 from their experiments assessed sunflower traits, and emphasized the importance of yield attributing components *viz.,* plant height, seed yield, 1000 grain weight as selection criterion, whereas Mohammadi et al., 2016 reported physiological traits such as RWC attributing the maximum diversity. Alongside, correlation analysis revealed a significant association of traits such as plant height, relative water content, leaf dry weight, total dry matter (flowering and harvesting stage), yield contributing traits, and test weight with seed yield ($p < 0.01$ and 0.05). Experiments also identified genotypes GMU 1059, GMU 1078, GMU 2347, GMU 4696, GMU 3047, GMU 2985 and GMU 878 and varieties TSF-1, A1, GIRNA as superior performers in terms of mean performance for most of the measured traits including seed yield/plant across the years tested.

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Improving phosphorus use efficiency in groundnut with microbial cultures

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ABSTRACT

Field experiments were carried out during 2018 to 2021 at Oilseeds Research Station, Tindivanam, to study the improved phosphorus use efficiency in groundnut with microbial culture. The results revealed that higher mean pod yield (2581 kg/ha) was recorded in the treatment that involved application of 40 kg/ha of P + DGRC culture which was on par with the treatment $T_{4,}$ that involved application of 60 kg/ha of Phosphorus. Control recorded the lowest yield.

Keywords: Groundnut, Microbial cultures, Phosphorus use efficiency

Phosphorus is an important mineral nutrient that promotes the growth of leguminous crops to produce their own N sources (Adjei-Nsiah *et al*., 2018). In addition to phosphorus and application of rhizobium inoculants, the yield of groundnut increased through the cultivation of improved groundnut varieties as well as improved P efficiency . According to Zhou *et al*. (2016) identification and use of P-efficient legume genotypes is a sustainable P management strategy for enhancing yield and P use efficiency has the potential to improve the productivity of groundnut.

MATERIALAND METHODS

Field experiment was conducted at Oilseeds Research Station, Tindivanm to study the improved phosphorus use efficiency in groundnut with microbial culture. The treatments consisted of T_1 - Control, T_2 - Application of 20 kg/ha of P, T_3 -Application of 40 kg/ha of P, T4 -Application of 60 kg/ha of P, T_5 - Application of 20 kg/ha of P + DGRC culture, T_6 - Application of 40 kg/ha of P + DGRC culture, T_7 -Application of 60 kg/ha of P + DGRC culture, T_8 - Application of FYM @ 2.5 t/ha, T_9-Application of FYM @ 2.5 t/ha+ DGRC culture, T_{10} - Application of DGRC culture enriched FYM@100 kg/ha. The size of the experiment was 5 m × 5.4 m (27 m^2) and spacing adopted was 30 x 10 cm.The design of the experiment was Randomized Block Design.

RESULT AND DISCUSSION

Results revealed that the treatment T_6 with Application of 40 kg/ha of P + DGRC culture recorded the highest pod yield (2581 kg/ha) which was on par with T_4 (Application of 60 kg/ha of Phosphorus) ((2455 kg/ha). Control recorded the lowest yield.

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Effect of Phosphorus Use Efficiency in Groundnut with Microbial Culture on Yield of Groundnut

Treatment details	Pod yield (kg/ha)				
	2018	2019	2020	2021	Mean
T_1Control	1926	1506	1679	1710	1705
T_2Application of 20 kg/ha of P	1941	2074	2031	1897	1985
T_3Application of 40 kg/ha of P	2014	2444	2303	2218	2244
T_4Application of 60 kg/ha of P	2308	2605	2438	2469	2455
T_5Application of 20 kg/ha of P + DGRC culture	2026	2160	2122	2180	2122
T_6Application of 40 kg/ha of P + DGRC culture	2200	2802	2604	2720	2581
T_7Application of 60 kg/ha of P + DGRC culture	1990	2593	2394	2450	2356
T_8Application of FYM @ 2.5 t/ha	2041	1852	1910	1981	1946
T_9 Application of FYM @ 2.5 t/ha+ DGRC culture	2045	1926	1957	1999	1981
T_{10} Application of DGRC culture enriched FYM@100 kg/ha.	1941	1802	1871	1862	1869
SEd	45.91	74.35	125.96	126.4	-
CD (p=0.05)	96.46	156.2	374.18	375.5	-

Liquid formulation *of Ampelomyces quisqualis* AQ003 suppresses powdery mildew of sunflower incited by *Golovinomyces cichoracearum*

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ABSTRACT

Sunflower (*Helianthus annuus* L.) is an important oilseed crop grown in India cultivated mainly for its edible oil which is used for culinary purposes. The productivity of sunflower is declined due to biotic stresses, among which powdery mildew caused by *Golovinomyces cichoracearum* cause huge loss to the farming community. In the present study, an attempt was made to exploit *Ampelomyces quisqualis*, a pycnidial hyperparasitic fungus for the management of powdery mildew in sunflower. The results revealed that, application of liquid formulation of *Ampelomyces quisqualis* (0.3 %) was effective in reducing the incidence of powdery mildew of sunflower (9.73 PDI) when compared to control (58.53 PDI) besides increasing the yield. The hyperparasite reduces the incidence of powdery mildew by disrupting the conidiophore and in-turn the mycelial growth. Thus it is concluded that, *Ampelomyces quisqualis* can be effectively used for the management of powdery mildew of sunflower.

Keywords: *Ampelomyces* spp., Biological control, Powdery mildew, Sunflower

Sunflower (*Helianthus annuus* L.) is an important crop grown widely for its oil, which is used for culinary purposes. In India, the crop is cultivated over an area of 0.23 M ha area with a production of 2.840 lakh tonnes and productivity of 709 kg/ha. Sunflower cultivation is hindered by various biotic and abiotic stresses, among which powdery mildew incited by *Golovinomyces cichoracearum* cause huge economical loss to the farmers. The symptoms include the presence of white powdery growth on the surface of the leaf, which later curl, become chlorotic and die. Chemicals are widely used for the management of powdery mildew which is hazardous, pollute the environment and cost-expensive. In this context, exploring bioagents is a promising alternate strategy to manage the disease. *Ampelomyces quisqualis* is an ascomycete's pycnidial producing fungi belonging to the class: Dothideomycetes, Order: Pleosporales, Fa: Phaeosphaeriaceae. It is a hyperparasite on powdery mildew which targets the coniodiophore and reduces the growth and may eventually kill the mildew (Kiss et al, 2004). In the present study, an attempt was made to isolate *Ampelomyces* spp. from the hyperparasitized conidiophore. The isolate *Ampelomyces quisqualis* AQ003was found to be effective under *in vitro* condition. Based on this, a liquid formulation has been prepared and tested for its efficacy against powdery mildew of sunflower under field conditions.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* 2022 at the Department of Oilseeds, Tamil Nadu Agricultural University, Tamil Nadu, India (11°N latitude and 77°E longitude) in Sunflower hybrid CO 2 to find out the efficacy of *Ampelomyces* spp against powdery mildew. The experiment was laid out in a completely randomized design with five treatments and four replications. A liquid formulation of *Ampelomyces quisqualis* was preparedand tested at different concentration (0.1 %, 0.2 % and 0.3 %) against powdery mildew of Sunflower. A chemical check viz., Wettable sulphur @ 0.2 % was also used. The data on disease incidence (PDI) and yield were taken and statistically analyzed using SPSS software.

RESULTS AND DISCUSSION

The results of the experiment revealed that, application of liquid formulation of *Ampelomyces quisqualis* (0.3 %) was effective in the management of powdery mildew of sunflower. Application of *Ampelomyces quisqualis* @ 0.3 % showedreduced incidence of *Golovinomyces cichoracearum* (9.73 PDI) when compared to control (58.53 PDI). The yield was also significantly increased in the treated plot. The efficacy of *A. quisqualis* against powdery mildew of phytopathogens has been reported by several scientists. *Ampelomyces* mycoparasites collected from powdery mildew can produce intracellular pycnidia in mycelia of other species of the Erysiphaceae (Sztejnberg et al., 1989). Dominic and Marthamakobe et al., (2016) observed twining of *A. quisqualis* around the mycelium of *Oidium anacardii* whichpenetrated the host and caused lysis. Nemeth *et al*., (2021) reported that the spores of the *Ampelomyces* penetrated the hyphae of *Pseudoidium* neolycopersici, continued their growth internally, and produced new intracellular pycnidia in *Ps. neolycopersici* conidiophores *ca*. @ 8–10 dpi and caused complete lysis. In our experiment also, substantial disease reduction in the liquid formulation applied plants which might be due to the invasion of the pycnidia of *A. qusiqualis* AQ003 into the conidiophores of *Golovinomyces cichoracearum.*

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Table 1. Efficacy of liquid formulation *of Ampelomycesquisqualis* against powdery mildew of sunflower

Treatments	Percent disease severity	Percent disease index	Percent reduction over control	Yield (kg/ha)
T1	Foliar application of *Ampelomyces*@ 1ml/lit during the onset of disease initiation	16.90[c]	72.76	1570[b]
T2	Foliar application of *Ampelomyces*@ 2ml/lit during the onset of disease initiation	13.17[bc]	78.45	1673[b]
T3	Foliar application of *Ampelomyces*@ 3ml/lit during the onset of disease initiation	9.73[b]	84.48	1837[a]
T4	Standard fungicide check –Wettable sulphur @ 2g/lit	6.13[a]	91.38	1928[a]
T5	Control	58.53[d]	-	1220[c]
SEd		1.59		64.55
CD (p=0.05)		3.67		148.85

Exploitation of biotic inducers for the management of important foliar diseases of sunflower (*Helianthus annuus* L.)

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ABSTRACT

Sunflower (*Helianthus annuus* L.) is a unique crop grown for human consumption as edible oil and also for ornamental use. It has become a popular cut flower, easy to grow under varied climatic conditions requires 672.4 mm water requirement during growing season. Sunflower crop is native to North America and as of now we have the varieties, hybrids developed from the huge germplasm collections maintained at ICAR-Indian Institute of Oilseeds Research and also at co-ordinating centres under AICRP on sunflower situated at different agro-climatic regions of India. During the crop growing period, many fungal and viral diseases start affecting the crop from early stage up to flowering and milky stage leads to drastic losses in seed yield. In particular, necrosis, leaf spot and powdery mildew diseases are causing drastic yield losses in the cultivation. In this study, we have attempted the biotic inducers as seed treatment and foliar spray against this disease as an alternative to fungicide.

Keywords: Biotic inducers and management, Fungal diseases, Leaf spot, Necrosis, Powdery mildew, Sunflower

Sunflower (*Helianthus annuus* L.) is a native plant of North America (Heiser, 2008) and has been widely used for oil production. It is the third largest oilseed crop in the world after soybean and rapeseed. Major growing countries are Russia, Ukraine, Argentina, China, France, USA, Spain and India. In India, the crop is cultivated over an area of 4.006 lakh ha with a production of 2.840 lakh tonnes and productivity of 709 kg/ha (Average of 2014-15 to 2018-19). The major growing states in India are Karnataka, Andhra Pradesh, Maharashtra, Odisha, Bihar and West Bengal. Both biotic and abiotic stresses cause yield loss in sunflower. Particularly, the crop is infected by many fungal (leaf spot, root rot, stem rot, downy mildew, powdery mildew and rust), and viral (necrosis and leaf curl) diseases, so far more than thirty diseases have been reported from seedling stage to crop maturity stage worldwide but the relative importance of specific diseases varies with geographic region. During the vegetative stage, necrosis and leaf spot are infecting the crop whereas in flowering stage, powdery mildew will take high infection. Given beneficial effects of SA on both plant and human health, SA and salicylates can be used as an efficient plant protector with very minor side effect on environments and humans. Hence this has been tested in the study against foliar diseases of sunflower.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* 2019, 2020 and 2021 at Department of Oilseeds, TNAU, Coimbatore (11°N latitude and 77°E longitude) by using Sunflower hybrid CO 2 to find out the efficacy of plant defense inducer namely salicylic acid (SA) as seed treatment, foliar application and mono potassium phosphate (1%) and sodium propionate (1%) as foliar application for the management of necrosis, leaf spot and powdery mildew diseases and also for seed yield.

RESULTS AND DISCUSSION

The result of the three years pooled analysis showed that seed treatment with salicylic acid (SA) @ 50 or 100 ppm enhanced higher seed germination (95 to 98%) compared to control (79%). Similarly, exogenous SA application also showed different effects on plant development, including seed germination, budding, flowering, and fruit setting and ripening. In Finger Millet plants, SA stimulated flowering (Appu and Muthukrishnan, 2014). Further, Ali et al., (2018) reported that exogenous SA treatment induces the expression of a set of pathogenesis-related (*PR*) genes, including *PR1*, *PR2* and *PR5*. The seed treatment followed by two sprays of SA 50 or 100 ppm recorded lower disease incidence of necrosis, leaf spot and powdery mildew under field conditions compared to two foliar sprays of mono potassium phosphate or sodium propionate (1%). Among the different treatments tested, T_4 (T_2 + foliar spray of salicylic acid (SA) @ 100 ppm two sprays) at 30 and 45 days after sowing showed less disease severity (0.7 % necrosis, 29.74 PDI leaf spot and 13.56 PDI powdery mildew) with highest yield of 2193 kg/ha compared to other treatments and control which recorded necrosis (5.86%), leaf spot (63.2 PDI), powdery mildew (37.7 PDI) with the seed yield of 1101 kg/ha. Further studies on practical use of SA in different crop plants will contribute to developing the cost-effective and environmental friendly crop management system.

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Table 1. Evaluation of plant defense inducers for the management of sunflower diseases (pooled analysis of data from 3 years)

Treatments	Germination %		Necrosis (%)		ALS (PDI)		PM (PDI)		Yield (kg/ha)	
T_1 : Seed treatment with salicylic acid (SA) @ 50 ppm	95.7		2.15		41.3		19.1		1532	
T_2 : Seed treatment with salicylic acid (SA) @ 100 ppm	96.6		1.67		39.9		18.6		1536	
T_3 : T_1 + foliar spray of salicylic acid (SA) @ 50 ppm at 30 and 45 days after sowing	96.3		2.39		35.2		18.1		1875	
T_4 : T_2 + foliar spray of salicylic acid (SA) @ 100 ppm at 30 and 45 days after sowing	97.8		0.75		29.7		13.5		2193	
T_5 : T_1 + foliar spray of mono potassium phosphate (1%) at 30 and 45 days after sowing	96.3		2.10		47.6		23.6		1616	
T_6: T_2 + foliar spray of mono potassium phosphate (1%) at 30 and 45 days after sowing	96.7		1.18		48.6		24.3		1415	
T_7 : T_1+ foliar spray of sodium propionate (1%) at 30 and 45 days after sowing	97.3		1.97		51.7		24.6		1455	
T_8 : T_2 + foliar spray of sodium propionate (1%) at 30 and 45 days after sowing	96.4		1.47		52.4		24.7		1396	
T_9 : Control	79.8		5.86		63.2		37.7		1101	
	S.E	CD @ 0.05	S.E	CD @ 0.05	S.E	CD @ 0.05	S.E	CD @ 0.05	S.E	CD @ 0.05
Treatment	0.66	1.87	0.44	1.25	1.01	2.87	0.73	2.09	44.8	127.5
Seasons	0.38	1.08	0.25	0.72	0.58	1.65	0.42	1.20	25.9	73.65
Seasons x Treatment	1.14	3.24	0.76	2.18	1.75	4.97	1.27	3.62	77.7	220.9
CV %	2.08		61.07		6.65		9.71		8.57	

Screening of castor (*Ricinus communis* L.) germplasm accessions against leafhopper (*Empoasca flavescens*)

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ABSTRACT

A field experiment was conducted at RARS, Palem during *kharif*, 2019 to screen the castor germplasm accessions (100 no.) against leafhopper along with susceptible (DPC-9) and resistant checks (M-574). Out of which, 20 entries did not exhibit hopper burn (hopper burn grade 0 on 0-4 scale) and found highly resistant to leafhopper. Leafhopper population among the accessions ranged from 8.8 to 27.2 leafhoppers/3 leaves/plant, whereas the susceptible check, DPC-9 recorded 67.8 leafhoppers/3 leaves/plant with hopper burn grade of 4 on 0-4 scale. Fourteen entries recorded low leafhopper population (17.6 to 38.8 leafhoppers/3 leaves/plant) with hopper burn grade 1 (upto 10% hopper burn). Leafhopper population was highest in RG-111 (70.6 leafhoppers/3 leaves/plant) with hopper burn grade of 4 (76 to 100% hopper burn). The germplasm accessions that were found resistant to leaf-hopper can be utilized in breeding programmes to develop resistant cultivars.

Keywords: Castor, Germplasm, Leafhopper, Screening, Sources of resistance.

Castor (*Ricinus communis* L.) is an important oilseed crop of dry land area with huge industrial importance.Various biotic stresses are becoming major bottleneck in yield improvement of castor. Among the insect pests, leafhoppers (*Empoasca flavescens* F.) result in significant yield loss (Patel *et al.*, 2015; Lakshminarayana and Duraimurugan, 2014). Nymphs and adults of leafhopper suck the sap from the under surface of the leaves causing leaf margins to become yellow, curling and under severe infestation, hopper burn symptoms are also noticed. The use of tolerant/resistant cultivars in the integrated pest management programmes is the most economic approach that minimizes the number of insecticidal application and conserves the natural enemies besides preserving the environmental safety. Hence, the present study was conducted to identify resistant genotypes against leafhoppers.

MATERIALS AND METHODS

The field experiment was conducted at Regional Agricultural Research Station, Palem. A total of 100 castor germplasm accessions were screened against leafhopper which were collected from ICAR-IIOR, Rajendranagar, Hyderabad. Each accession was sown in a single row of 6 m length with the spacing of 90 cm x 60 cm in augmented block design. Susceptible check DPC-9 was used as an infester row and sown after every five rows of germplasm accessions. Leafhopper counts (nymph) were recorded on three leaves in each plant selecting one leaf from top (excluding 2 topmost leaves), middle (medium maturity) and bottom (leaving one or two bottom most leaves) on the main shoot. Population recorded as number of leafhoppers/3 leaves/plant and percent leaf area burnt/plant (average of 5 plants). Hopper burn injury was recorded as/the scale suggested byAnjani *et al*. (2018).

RESULTS AND DISSCUSSION

Out of 100 castor germplasm accessions screened 20 entries *viz.,* RG-18, RG-311, RG-1607, RG-1624, RG-1922, RG-2746, RG-2781, RG-116, RG-2816, RG-2822, RG-1621, RG-3080, RG-2094, RG-3445, RG-3741, RG-3795, RG-63, RG-1389-1, RG-2296 and RG-2210 did not exhibit any hopper burn (hopper burn grade 0 on 0-4 scale) and found highly resistant to leafhopper. The leafhopper population in the entries ranged from 8.8 to 27.2 leafhoppers/3 leaves/plant; whereas the susceptible check DPC-9 recorded 67.8 leafhoppers/3 leaves/plant with hopper burn grade of 4 on 0-4 scale. Thirteen entries *viz.,* RG-19, RG-45, RG-155, RG-1647, RG-2758, RG-2800, RG-3425, RG-211, RG-2139, RG-3477, RG-29, RG-1594, RG-1663 have recorded hopper burn grade of 1 (10% hopper burn) with low leafhopper population ranging from 17.6 to 38.8 leafhoppers/3 leaves/plant as compared to the susceptible check, DCS-9 which recorded a hopper burn grade of 3 (51 to 75% hopper burn) with the population of 58.6/3 leaves/plant. The incidence of leafhopper population was high in sixteen entries *viz.,* RG-392, RG-47, RG-386, RG-2241, RG-2430, RG-104, RG-109, RG-111, RG-3548, RG-72, RG-1437, RG-2149, RG-66, RG-380, RG-3233 and RG-1298) with leafhopper population ranging from 40.2 to 70.6 leafhoppers/3leaves/plant with hopper burn grade of 4 (76 to 100% hopper burn).

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MAUS 725: A early maturity, high seed yielding and biotic stress tolerant variety release for the Marathwada region of Maharashtra

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ABSTRACT

Soybean variety MAUS 725 developed by cross between widely adopted soybean varieties *viz.,* JS 93-05 and MAUS 71. The soybean variety MAUS 725 recorded average seed yield 2207 kg/ha in state multilocation trial of Maharashtra during 2017-18 to 2020-21 (36 trials) and showed superiority of 7.65%, 10.57 % and 11.11% over national checks JS 335, JS 93-05 and JS 97-52, and 5.49 % over local check MAUS 71, respectively. In regional multilocation trial (Marathwada) conducted during 2017-18 to 2020-21 (14 trials), it recorded average seed yield 2398 kg/ha and showed the superiority of 25.54 %, 25.15 % and 33.66 % over national checks JS 335, JS 93-05 and JS 97-52 and 15.06 % over local check MAUS 71, respectively. In AICRP trial conducted during 2017-18 across seven locations in southern zone it recorded average seed yield 2161 kg/ha and showed superiority 10.48 % over national check JS 93-05. Soybean variety MAUS 725 recorded early maturity (93-98 days) and showed the numerical higher test weight as compared to national and local checks. In adoptive trials of farmers field MAUS 725 has recorded average seed yield of 2106 kg/ha and 2253 kg/ha during *kharif* 2020 & 2021 and showed superiority of 13.65, 17.85 and 12.70, 17.34per cent over local check MAUS 71 and national check JS 335, respectively. The soybean variety MAUS 725 showed moderate to highly resistant against stem tunnelling due to stem fly, moderate resistant against girdle beetle, moderate resistant to resistant against defoliators, moderate to highly resistant against aphids and white fly across zone in AICRP IVT trial conducted during 2017-18. Newly developed variety MAUS 725 was observed to be Moderately resistant/Resistant/Highly resistant/Absolute resistant to several diseases like Bacterial pustule, Pod blight, Soybean yellow mosaic virus, Brown spot, Bacterial blight, Soybean crinkle virus, Indian bud blight, Soybean mosaic virus, Alternaria leaf spot, Charcoal rot and Purple seed stain in AICRP CIVT infection index of various diseases conducted during *kharif* 2017-18 across all zones of India.

Keywords: MAUS 725, Pest and disease, Seed yield, Soybean, Tolerance

Soybean (*Glycine max* L.) is world's most important seed legume, which contributes to 25% of the global edible oil, about two-thirds of the world's protein concentrate for livestock feeding. Soybean meal is a valuable ingredient in formulated feeds for poultry and fish (Agrawal *et al*., 2013). It is therefore no surprise that global soybean demand is increasing rapidly. Improved varieties, in any crops, are essential for achieving higher productivity. Lack in diversification of varieties is a major constraint of low productivity. About more than 165 soybean varieties have been released in India but most of the varieties have narrow genetic base and hence restricted to grow on small area. The only exception is JS 335, however, the monoculture expansion of this variety in the country leads to rapid outbreak of pests and diseases, more frequently in one or other parts of the country. Hence, breeding efforts were undertaken at AICRP on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra to develop early maturing, high seed yield, pests and disease tolerant variety MAUS 725.

Soybean variety MAUS 725 developed through hybridization between JS 93-05 × MAUS 71 followed by pedigree selection in segregating generation and stable line selected in F_7 generation. New developed strain MAUS 725 evaluated in station trial conducted during 2014-15 to 2016-17 along with the three local checks and three national checks. The same strain was tested in regional multilocation trial at 3-4 location during 2017-18 to 2020-21 along with the four checks. The same strain was evaluated in state multi-location trial at 8-10 location during 2017-18 to 2020-21. The new strain MAUS 725 was evaluated in AICRP trial (Southern Zone) during 2017-18 across 7 locations. At each location the trial was sown in Randomized Block Design with three replication. The sowing was done during last week of June to first week of July at all location. All recommended cultural practices followed at each location. Spacing of 45 × 5 cm was adopted having the plot size of $1.8 \times 3\ m^2$ (4 rows of 3 m length). The data was pooled over all location and analysed using standard analysis of variance and the treatment mean square is compared at 5% significant level, using least significant values.

The results were statistically significant for seed yield at all the locations. Soybean variety MAUS 725 has recorded average seed yield of 2477 kg/ha in station trial during 2014-15 to 2016-17 and has showed superiority of 16.22 %, 15.97 %, 24.02 % over local checks MAUS 71, MAUS 158, MAUS 162 and 28.46 %, 70.10 % & 25.60 % over national checks JS 335, JS 97-52, JS 93-05, respectively. In Regional Multilocation Trial, the soybean variety MAUS 725 has recorded average seed yield of 2398 kg/ha during four years (2017-18 to 2020-21) and has shown superiority of 15.06 % over local check MAUS 71 and 25.54 %, 33.66 %, 25.15 % over national checks JS 335, JS 97-52, JS 93-05, respectively. In State Multilocation Varietal Trial, the soybean variety MAUS 725 has showed average seed yield of 2207 kg/ha during four years (2017-18 to 2020-21) and has showed superiority of 5.49 % over local check MAUS 71 and 7.65 %, 11.11%, 10.57 % over national checks JS 335, JS 97-52, JS 93-05, respectively. Soybean variety MAUS 725 has recorded average yield of 2161 kg/ha at AICRP trial (Southern Zone) during 2017-18. It has showed superiority of 10.48 %, over check JS 93-05. Soybean variety MAUS 725 has recorded early maturity (93-98 days) and showed numerically higher test weight as compared to national and local checks. The variety MAUS 725 showed moderate to highly resistance against stem tunnelling due to stemfly, moderate resistance against girdle beetle, moderate resistance to resistance against defoliators, moderate to highly resistance against aphids and whitefly across zones in AICRP IVT trial conducted during 2017-18. In state multilocation varietal trials conducted at Parbhani & Amravati location during *kharif* 2017-18 to 2019-20, MAUS 725 found moderate resistance to resistance against girdle beetle, Stemfly and Semiloopers. The variety MAUS 725 has observed to be moderately resistance/Resistance/Highly resistance/Absolute resistance to several diseases likeBacterial pustule, Pod blight, Soybean yellow mosaic virus, Brown spot, Bacterial blight, Soybean crinkle virus, Indian bud blight, Soybean mosaic virus, Alternaria leaf spot, Charcoal rot and Purple seed stain in AICRP CIVT infection index of various diseases conducted during *kharif* 2017-18 across all zones of India. The variety MAUS 725 has showed to be highly resistance to absolute resistance against YMV and root rot disease in state multilocation varietal trials conducted at Amravati location during *kharif* 2017-18 to 2019-20. Soybean variety MAUS 725 has recorded average seed yield of 2106 kg/ha and 2253 kg/ha in farmers adaptive trial during *Kharif* 2020 and *Kharif* 2021 and showed superiority of 13.65 %, 17.85% and 12.70%, 17.34% over MAUS 71 and JS 335 respectively. Hence, Soybean variety MAUS 725 having early maturity, high seed yielding and tolerance to pests and diseases was released in soybean growing districts of Marathwada region during 2021-22.

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A novel feature extraction technique for the clustering of SNP data

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ABSTRACT

In this work, we proposed a novel feature extraction technique for the Single NucleotidePolymorphism (SNP) data, which converts an SNP sequence into the numerical form. Later, we performed the clustering analysis on the feature vectors to group similar SNP sequences in one group.

Keywords: Clustering, Feature extraction, SNP sequences, Soybean

Bioinformatics has risen to the forefront of research, attracting the attention of biologists and computer scientists alike. Primary objective of bioinformatics is collecting, organizing, and managing biological data and creating data mining methods that can better understand and analyze biological data. Applying data mining tasks such as classification or clustering to biological data requires a feature extraction technique that converts biological data into numerical form. So, in the paper, we proposed a novel feature extraction technique that transforms the SNP sequence into the numerical feature vector. An SNP is a type of mutation/alteration in DNA that can occur when a single nucleotide is added to or removed from the DNA. The SNP is a handy genetic marker for studying genomes and human genetics. Some SNPs are the direct cause of hereditary illnesses, which can be detected using SNP analysis.

MATERIALSANDMETHODS

In the proposed novel feature extraction approach, we extracted the four types of numerical features from the SNP sequences in four steps as follows:-

1 2 3 4 5 6 7 8 9
Example of SNP sequence: G A A T G C T G G

Step 1: Count the length of each sequence (L_{seq}). The length of the SNP sequence given in the example is 9.

Step1:-Count the number of each nucleotide (C_n) present in the SNP sequence. In the example given, A,T, G, and C count is 2,2, 4, and 1. So the value of C_A, C_T, C_G, and C_C will be 2,2, 4, and1.

Step 2: Calculate the sum of distances of each nucleotide from the first nucleotide (SUM_n). In the example, the nucleotide A appears at positions 2 and 3. So it sum of distances from the first nucleotide (SUM_A) will be 2+3=5. Similarly, the value of SUM $_T$, SUM $_G$, and SUM C will be11, 23, and 6.

Step3: Calculate the distribution of each nucleotide (DIS_n). The distribution of a nucleotide is calculated in two steps. In the first step, the average of the nucleotide is computed by dividing the sum of distances from the nucleotide length.

Then in the second step, the distribution is computed. The computation of the distribution of G is asfollows:-

Average of nucleotideG=SUM_G/C_G= 23/4 = 5.75

The distribution of G (DIS_G)= [(1-5.75)2 + (5-5.75)2 + (8-5.75)2 + (9-5.75)2]/4 = 9.67 Similarly, we can also compute the value of DIS_A, DIS_T, DIS_C. So, after combing the above four types of features, the 1,3-dimensional feature vector for the SNP sequence given in the example is like this.

$<L_{seq},C_A,SUM_A,DIS_A,C_G,SUM_G,DIS_G,C_T,SUM_T,DIS_T,C_C,SUM_C,DIS_C>$
<9, 2, 5, 0.25,4,23, 9.67,2, 11, 2.25,1, 6, 0>

RESULTS AND DISCUSSION

To compute the similarity among SNP sequences, we applied k-means clustering to the extracted feature vectors, which cluster the similar feature vectors in one cluster. The performance of k-means clustering is evaluated using the silhouette index (SI), an often-used performance index to evaluate clustering. To decide the optimal number of clusters initially, we performed the k-means clustering by taking different k-values. We collected the three SNP datasets of rice crops named 248 Entries, SNP-seek rice, and MAGIC-rice to perform the experiments. The results obtained on these datasets are presented in Table 1.

Thus we have presented here a novel feature extraction approach for the SNP data, which is very useful for clustering similar SNP sequences in one group.The advantage of the proposed approach is that it is an alignment-free method to perform the matching among sequences. The proposed approach is a general-purpose algorithm that can be used to analyze other oilseed crops like soybean, mustard etc.

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Table 1: ResultsontheSNPdatasetsofricecrop

DatasetName	Count ofsequences	Numberofclusters(k)	Silhouetteindex(SI)
248Entries	248	2	0.8395
SNP-seekrice	252	12	0.5534
MAGIC-rice	16932	12	0.4613

Assessment of spatial nutrient variability at farm level for castor crop (*Ricinus communis* l.) in semiarid region of Telangana state in India

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ABSTRACT

Site Specific Nutrient Management is a system for maximum yields in field crops. Nutrient Management Zones were developed for castor crop (*Ricinus communis* L.) in Inceptisols. Grids of 15 x 15 m were made in one hectare and soil samples were collected from each grid and were analyzed for soil characteristics and all available nutrients. Based on analytical data the geo-statistical analysis, varoni maps and different models were developed. The castor yield data was compared in nutrient management zones with farmers practice (FP) and recommended dose of fertilizers (RDF). The variable rates of fertilizers used in SSNM was 92, 53, 15, 40 & 25 kg of N, P, K, S and Zn/ ha and 100, 40, 30 and 80, 40, 30 kg of N, P, K in farmers practice and RDF plots and the yields realized were 28 q/ha and 15 and 13 q/ha in SSNM, RDF and farmer's practice treatments respectively.

Keywords: Castor, farmers, nutrient, soil

The knowledge of spatial variability of soil properties is the critical importance for land productivity. In site-specific nutrient management, careful considera0tions of nutrient status are employed for different management zones through geostatistical tools helped in delineation of uniform and congruous management zones from limited number of samples collected from the study area (Ferguson *et al*., 2002) and also it has emerged as popular approach for variable rate of fertilizer application. Management zones delineated using variations in soil properties have not only provided useful information for precise fertilization but also helped in identifying the areas of low, medium and high productivity potential and developed management zones based on spatial variability in soil properties in aiding site-specific management of fertilizers.

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop and known to man for ages. It is cultivated around the world primarily because of the commercial importance of its oil. India is the world's largest producer of castor seed and known to be drought resistant and meets most of the global demand for castor oil, contributing over 60% of the entire global production (www.castoroilworld.com/castor). Site-specific Nutrient Management (SSNM) is an important tool to derive maximum benefit of fertilizer usage for maximum yields dully addressing the variations in fertility of the soil at farm holding level and cost reduction. The reliability of spatial variability maps is dependent on sampling protocol and accuracy of the spatial interpolation. Optimizing grid distance is the main bottleneck in the assessment of spatial variability for site specific nutrient management. To achieve the objectives like: to develop the Site-specific nutrient management for optimization of fertilizer for castor crop and to compare such developed SSNM approach with farmers practice and general recommended dose of fertilizers of castor crop for yield maximization.

MATERIALS AND METHODS

The study was conducted in Jangamreddypalli village in Amrabad mandal of Nagarkurnool district in Telangana state of India in farmer's fields. The soil of study area was Inceptisol with semi-arid climate and covered by igneous (pink and gray granites and basalt) and metamorphic (granite gneiss) depositions (Satyavathi and Reddy, 2004). The experimental site lies between 16°24'19.33"N to 16°24'23.38"N latitudes and 78° 49' 37. 28" E to 78°49'39.83"E longitudes.

Grids formation and size: In one hectare of farmer's field, the field was divided into grids. Grid sizes of 15 x 15 m were made and geo-referenced soil samples were collected from each grid. Total of 44 grids were formed. Out of which 32 were with perfect grids and grids with irregular size at one end are 10 and 2 most irregular grids were left. The geographical coordinates, latitude and longitudes were recorded by hand held Global Positioning System (Pro Gin T-368).

Crop, variety and Season: To test the site-specific nutrient management along with farmers' practice and recommended dose of fertilizers, castor crop, hybrid PCH-111 was selected. During *rabi* season and the experiment was taken up under irrigated situation.

Geostatistical analysis: The spatial array of each soil property was done to find out the best suitable semi variogram using Arc-GIS software 10.2. Selection of most suitable semi variogram model was done on the basis of cross-validation technique for different soil properties after normalizing the data distribution using Shapiro-Wilk test at 5% (Shapiro and Wilk, 1965). The semi variograms were used to measure the spatial distribution of soil properties (Tesfahunegn et al., 2011) and the accuracy of semi variogram model was based on mean square error (MSE) and RMSE (root mean square error).

RESULTS

Soils were slightly alkaline (pH 7.4) to moderately alkaline (pH 8.5) in reaction and non-saline (EC 0.04 to 0.26 dS/m). The available N, P and K ranged from 100 to 263, 5.6 to 122 and 227 to 1047 kg/ha, available Zn (0.13 to 2.31), Fe (0.2 to 17.4), Cu (0.19 to 1.18), and Mn (2.16 to 10.73) mg/kg concentrations too varied widely. Available boron (1.0 to 2.81) and Sulphur (2.5 to 24.3) mean concentrations values were 1.71 ± 0.41 and 7.79 ± 4.55 mg/kg. Distribution of variations in soil properties over space was highly skewed for all the properties except pH, K and Mn. Kurtosis in soil properties was also found to behave similarly. The variability was interpreted using the coefficient of variation (CV). The criteria proposed by Wilding (1985) was used to classify the parameters into most (CV > 35%), moderate (CV 15–35%) and least (CV < 15%) variable classes. pH was considered to be stable soil parameter (Bouma and Pinke, 1993). However, the least variable was pH, moderate variables were E.C, N, K, B, Cu, Mn and most variables were P, S, Zn and Fe observed within the grids (in this study area of one ha field).

Spatial variability of soil fertility parameters: Based on the nutrient status of the soil samples within the grids used in the processing. The nutrient status of the experimental plot was modelled using the best semi variogram of Kriging applicable for the given data. The categories were further subdivided to introduce the spatial variability. The best fit model was selected based on lowest RMSE and MSE values. The properties of calculated semi variograms for fertility parameters indicate different degree of spatial dependence. Soil properties and available nutrients (major and micro) had different semi variogram characters. The best fit models were K-Bessel with respect to pH, N, P and K, J-Bessel with respect to EC, Circular with respect to S, Penta Spherical with respect to B, Exponential for Fe, Spherical for zinc and Rational Quadratic with respect to Cu and Mn.

Spatial distribution of soil fertility parameters and Nutrient management zones: Krigged maps of soil properties like pH and EC and available macro (N, P and K), secondary nutrient (S) and micronutrients (Zn, Cu, Fe and Mn) were developed to assess the extent and magnitude of soil fertility and their deficiency. The spatial variability maps indicate the grid wise spatial distribution of fertility parameters. The pH and EC fitted in to best models with strong spatial dependency. Available nitrogen was low in all the grids and categorized in to two nutrient management zones in spatial mapping shows that P was low to medium in many grids and only five grids showed high in P status and divided in to three management zones in spatial mapping. Likewise S with weak spatial dependency and all micronutrients with strong dependency were divided in to two categories and spatial maps were generated (fig 6 to 10) for calculation and adoption of variable rates of fertilizer / nutrient application in specific sites. These spatial maps will serve as knowledge resource for development of site- specific strategies for balanced and précised rates of nutrient application for sustained yields.

Effect of Spatial variability on variable rates of fertilizers and yield of castor crop: Variable rate of fertilizer application was made using Soil Test Crop Response equation for castor in different rates in nutrient management zones with that of farmers practice (FP) and recommended dose of fertilizers (RDF) to the castor crop. The amount of fertilizers used in nutrient management zones was (sum of 44 grids) 92, 53, 15, 40 & 25 kg of N, P, K, S and Zn/ ha and 100, 40, 30 and 80, 40, 30 kg of N, P, K in farmers practice and RDF plots. The yield data of castor in nutrient management zones developed for SSNM was compared to that of farmers practice (FP) and recommended dose of fertilizers (RDF). The yields obtained with SSNM practice was 28 q/ha. 15 and 13 q/ha yields were realized with RDF and farmer's practice treatments, respectively. SSNM is an important tool to derive maximum benefit of fertilizer usage for maximum yields dully addressing the variations in fertility of the soil at farm holding level and cost reduction through modelling. The highestper cent variation in yield of 54 and 13per cent was observed due to SSNM & RDF to that of FP, respectively. Similarly, the highest BC ratio of 3.85 was obtained in SSNM and followed by RDF (2.07) practice.

DISCUSSIONS

Assessing spatial variability and mapping of soil properties has great importance than the temporal variations; spatial variability through variograms explores and interpolates the information about un-sampled locations with the help of geostatistical tools which, helps in delineation of uniform and congruous management zones from limited number of samples collected from the study area and is a pre-requisite and first step to measures the spatial variability in site-specific nutrient management to increase the nutrient use efficiency vis-â-vis sustaining the agricultural productivity in rainfed farming system in order to optimize the cost of cultivation in terms of costly inputs through balanced nutrients. This study indicated that a grid interval of 15 x 15 m would serve the purpose of spatial variability mapping at farm level under intensively cultivated fields by achieving the high yields and BC ratio. These results can be used to make recommendations of best nutrient management practices within the locality and also to improve the livelihood of smallholder farmers.

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Semi Variogram | **Spatial Variability maps**

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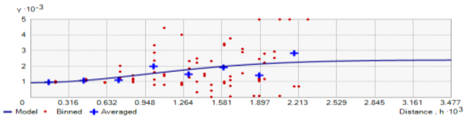
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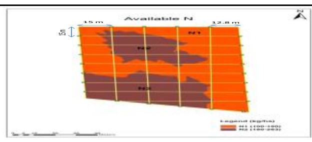

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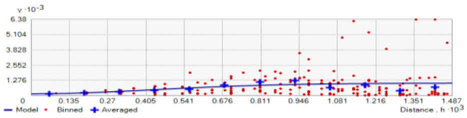
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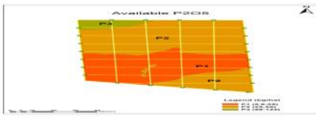

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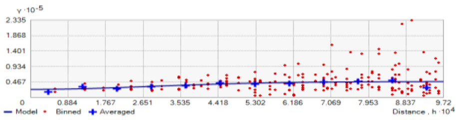
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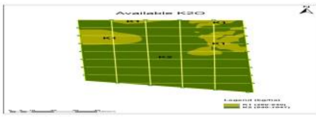

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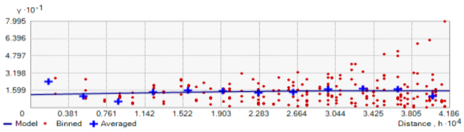
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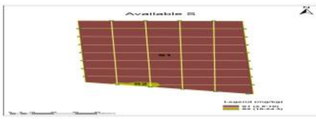

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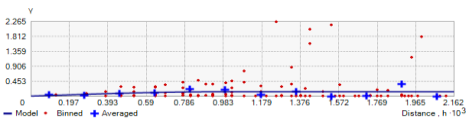
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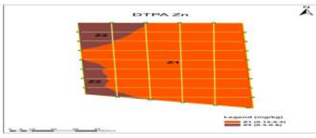

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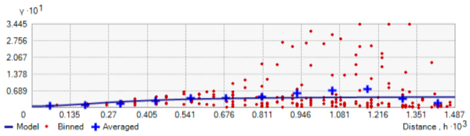
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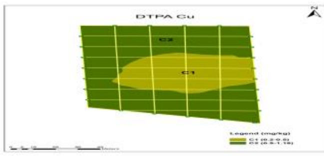

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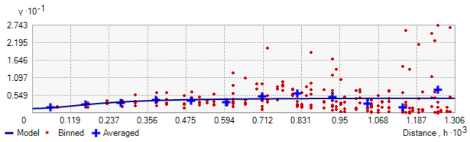

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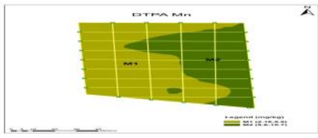

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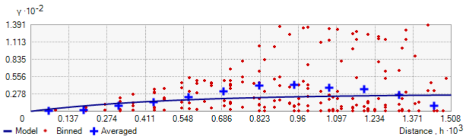

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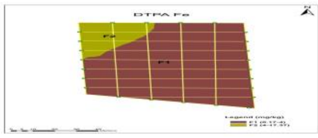

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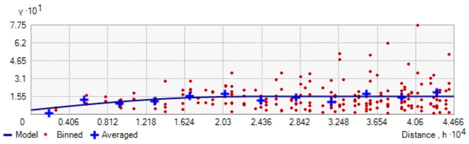

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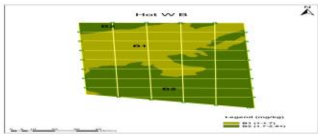

A Novel biopolymer-based *T. harzianum,* (Th4d) - a viable alternative to chemical seed treatment for management of collar rot of groundnut

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ABSTRACT

Groundnut (*Arachis hypogaea* L.) is an economically important edible oil seed crop of the world. Collar rot caused by *Aspergillus niger* is one of the most serious, destructive diseases in groundnut. A field experiment on the effect of seed treatment with biopolymer-based *T. harzianum,* Th4d blend in groundnut on disease incidence and seed yield of groundnut was taken up at IIOR, Hyderabad during 2020 and 2021. Chitosan-based *T. harzianum*, Th4d blend recorded pooled mean of significantly high germination percent (90.0%), pod yield (3047 kg/ha) and reduced collar rot incidence (67.7%) whereas chemical seed treatment with carboxin + thiram recorded germination of 78%, 45.1% reduction in disease and 2064 kg/ha pod yield.

Keywords: Biopolymer, Groundnut, Trichoderma

Collar rot caused by *Aspergillus niger* is one of the most serious, destructive diseases in groundnut. It is both seed and soil borne in nature. Seed treatment is one of the need based technique to provide protection against seed and soil born disease. Chemicals agri-inputs over a period resulted in deterioration of soil health and environmental pollution. To promote environmentally friendly farming practicesbio control agent like *Trichoderma,* has a beneficial role in agriculture. Alternative to harmful chemicals as seed dressing agents, novel biopolymer-based *T. harzianum*, Th4d (Prasad *et al.*, 2020; Chandrika *et al.*, 2019) applied as film forming seed coat on groundnut are evaluated against groundnut collar rot under field conditions at IIOR-Hyderabad.

MATERIAL AND METHODS

Two biopolymer-based *Trichoderma* formulations which are developed at IIOR (Prasad *et al.*, 2020; Chandrika *et al.*, 2019) *viz.,*Chitosan-based *T. harzianum,* Th4d blend @ 10ml/kg seed (1% w/v), Cellulose-based *T. harzianum,* Th4d films, (Per kg seed 2 films dissolved in 10ml water and coated) , Carboxin 37.5% + Thiram 37.5% DS @ 2g/kg seed (chemical), *T. harzianum,* Th4d 1.5% WP 10gm/kg seed (bioagent) and untreated control a total of five various seed treatments are selected for evaluation under field conditions. Groundnut variety Kadiri-6 is selected for the study. The field trail was performed in a Randomized block design with four replication during rabi season in the year 2020 and 2021 at ICAR-IIOR, Hyderabad.

RESULTS AND DISCUSSION

Among five seed treatments, *viz.*, Chitosan-based *T. harzianum,* Th4d blend recorded highest germination (76.7%, 90%), reduced collar rot incidence (67.4%, 76.7%) and highest pod yield (3193 kg/ha , 2900 kg/ha) during 2020 and 2021, respectively. Carboxin 37.5% + Thiram 37.5% DS recorded germination (80.0%, 78%), reduced collar rot incidence (44.4%, 45.7%) and pod yield of 2732 kg/ha, 2475 kg/ha during 2020 and 2021, respectively. From the results we can infer that Chitosan-based *T. harzianum*, Th4d blend performed better than all the other treatments in all aspects.

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Table 1: Effect of various, seed treatments on disease incidence, seed yield of groundnut under dry land conditions (IIOR-Hyderabad)

Seed treatments	Germination (%)		Root rot incidence (%) *		Reduction in disease incidence (%)		Pod yield kg/ha	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
T_1: Cellulose-based *T. harzianum*, Th4d blend (1% w/v)	75.8	84.8	6.7	4.6	50.4	73.7	2960	2887
T_2: Chitosan-based *T. harzianum*, Th4d blend (1% w/v)	76.7	90.0	4.3	5.7	68.1	67.4	3193	2900
T_3: Carboxin 37.5% + Thiram 37.5% DS	80.0	78.0	7.5	9.5	44.4	45.7	2732	2475
T_4: *T. harzianum*, Th4d WP	75.3	70.6	9.8	6.7	27.4	61.7	2795	2625
T_5: Control	66.2	61.2	13.5	17.5			2398	1622
C.V (%)	9.5	1.4	4.2	0.9				
C.D (p=0.05)	6.1	1.2	1.1	6.3				

Control Chitosan-based *T. harzianum* (Th4d) blend (1%w/v)

Fig: 1 Effect of Chitosan-based *T. harzianum* (Th4d) blend (1%w/v) as seed treatment on groundnut seed

Geographical distribution map of Alternaria blight of rapeseed-mustard in India

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ABSTRACT

Alternaria blight (AB) disease caused by *Alternaria brassicae* (Berk.) Sacc., and *A. brassicicola* (Schwein) Wiltshire is a most common destructive disease which causes upto 35% yield loss through disturbing the photosynthetic activities in plant. During 2004 to 2020, AB severity data revealed that the disease severity decreased by 7% in rapeseed-mustard growing area. Prevalence of AB severity observed in Uttarakhand (48.5%), Himachal Pradesh (47.1%), Punjab (43.7%), Bihar (38.9%), Assam (38.7%), Jharkhand (38.7%), Uttar Pradesh (38.0%), Jammu & Kashmir (31.7%), Haryana (28.5%), Madhya Pradesh (25.3%), Chhatishgarh (24.1%), and Rajasthan (15.5%). However, AB severity was negligible in Gujarat, Maharashtra and Tamil Nadu states due to unfavourable weather conditions. Although, AB severity trend was fluctuating between 18.4 to 45.2%, but severity on Rohini and Varuna at Bharatpur was observed below 15% since last 10 years which was higher upto 25% severity recorded during 2003 to 2006. AB severity was recorded maximum on *Brassica rapa* ssp. Toria (39.3%) followed by, *B. rapa* ssp. Yellow Sarson (34.9%), *B. juncea* (31.1%) and *Eruca sativa* (30.9%). Although, *B. napus* (26.0%) and *B. carinata* (22.1) were least affected crops species with AB which could be used for developing tolerance/resistance in *B. juncea* through traditional breeding methods.

Keywords: Alternaria blight, Distribution map, Oilseed Brassica, Severity

Rapeseed-mustard group of crops are attacked by a wide variety of potential plant pathogens ranging from biotrophs, hemibiotrophs to necrotrophs within their natural environment and directed cultivation. These biotic strategies cause economical losses across the cultivated areas and threaten yield and oil production of the country. The most promising way to manage the losses is to generate information on the occurrence and severity of the biotic stresses at country level influenced by changing environmental condition before devising and implementing any management approaches. Among 18 pathogens reported to infect rapeseed-mustard in the country, major pathogens/ diseases of economically important are white rust, Alternaria blight, Sclerotinia rot, and powdery mildew at different growth stages of the crop causes yield losses depending upon the prevalence of the disease severity/ incidence. In India, about 80% of total rapeseed-mustard cultivation is under *Brassica juncea* mainly in Rajasthan, MP, Gujarat, UP, Haryana, and West Bengal states of the country. Among other *Brassica* species, *B. rapa* ssp. Brown Sarson is grown under upper Himalayan temperate regions in Srinagar while, *B. napus* is under cultivation in Jammu, Himachal Pradesh, and Punjab states. Although, *B. rapa* ssp. Toria is mainly grown in foothills regions of Himalayas particularly in Uttrakhand, Eastern Uttar Pradesh, Bihar, Eastern parts of the country and Odisha. Other species including *B. rapa* ssp. Yellow Sarson is widely cultivated in West Bengal and Taramira (*Eruca sativa*) is grown in some pockets of Rajasthan and Haryana states. During 2009-10, area, production and productivity of rapeseed-mustard were 5.6 mha, 6.6 mt, and 1183 kg/ ha which have been increased by 11% to 6.86 mha, 9.12 mt with 1331 kg/ha yield respectively during 2019-20.

Alternaria blight (AB) disease caused by *Alternaria brassicae* (Berk.) Sacc. and *A. brassicicola* (Schwein) Wiltshire, is generally prevailing severely on almost all the aerial plant parts of the rapeseed-mustard and is a most common wide spread and destructive disease which causes average 35% yield losses by distressing the photosynthetic activities in plant. Among four major diseases (AB, WR, SR, PM), Alternaria blight covered 32% share with average 26.6% disease severity on different *Brassica* species over the period mainly in humid areas where rapeseed-mustard is under cultivation. Alternaria blight was considered number one threat for the crop earlier but now the data revealed decreasing trend of this disease particularly in Rajasthan, Haryana, Madhya Pradesh states of the country. Alternaria blight disease is not a problem on rapeseed-mustard crop cultivation in western Rajasthan and Gujarat states. Although, AB is a severe problem in Uttarakhand, HP, Bihar, UP, Assam and West Bengal states of the country. Weather parameters are the key factors governing fluctuation of disease severity. Usually, disease becomes visible at 40 - 45 days after sowing and most critical stages for initiation and peak of severity has been reported (Meena et al., 2004). Severity of Alternaria blight on leaves and pods were higher in later sown crops. A delayed sowing results in coincidence of the vulnerable growth stage of plants as indicated earlier with warm (maximum temperature: 18-26^{o}C; minimum temperature: 8-12^{o}C) and humid (mean RH >70%) weather (Saharan et al., 2015). The geographical distribution map of the disease on rapeseed-mustard indicates the wide spread all over the cropping areas in India.

MATERIALS AND METHODS

Seventeen year's (2004 to 2020) AB disease severity data of AICRPRM from various geographical locations on different species of *Brassica* were compiled to observe the disease prevalence trends in India (Anonymous 2001-2020). Average of different geographical locations over the years and locations was taken on same varities of particular species of Brassica. Disease severity trend was compared with prevailing geographical weather conditions over the time. Different possible reasons fluctuating disease severity were identified based on reported from particular location. Alternaria blight disease severity data presented as mean of different locations, species and years.

RESULTS AND DISCUSSION

In view of the fact that some *Alternaria brassicae* isolates sporulated at 35°C and several isolates had increased fecundity under higher RH, it seems that as/recent changes towards warmer and humid winters, existence of such isolates could pose more danger to the oilseed Brassicas due to Alternaria blight in times to come. Weather parameters are predominantly the key factors governing fluctuation of disease severity. Usually, disease becomes visible at 40 - 45 days after sowing and most critical stages for initiation and peak of severity has been reported 45 and 75 days of plant growth. Severity of Alternaria blight on leaves and pods was higher in later sown crops. A delayed sowing results in coincidence of the vulnerable growth stage of plants as indicated earlier with warm (maximum temperature: 18-26^{o}C; minimum temperature: 8-12^{o}C) and humid (mean RH >70%) weather. The pathogen survives through infected seed, crop residue, cruciferous hosts, weeds, microsclerotia and chlamydospores and all act as source of primary inoculum. Secondary infection during the crop season is through conidia produced on infected host plants (under high humidity), which spread through rain splashes and wind to complete the disease cycle. There may be role of defensive difference contributed by age of plant in cultivars and species of Oilseed Brassica, cultural practices, and use of phosphate fertilizers in exhibiting disease response.

Periodic trends of AB severity: Over the 17 year's (2004 to 2020) period, AB severity data revealed the disease severity trends at different agro-climatic conditions in the country that the disease severity decreased by 7% over the regions where rapeseed-mustard is grown with delay appearance of AB. There may be role of defensive difference contributed by age of plant in cultivars and species of Oilseed Brassica, cultural practices, and use of phosphate fertilizers in exhibiting disease response. However, AB severity trend on lower 3-4 leaves at all over the period was declined with fluctuating between minimum 18.4 (2012) to maximum 45.2% (2005). Though, the AB severity trend on cultivar Rohini and Varuna at Bharatpur was observed below 15% since last 10 years which was higher upto 25% severity recorded during 2003 to 2006.

Host response against AB: Among different species, *B. juncea* and *B. rapa* are more susceptible than *B. carinata* and *B. napus*. AB severity was recorded maximum on *B. rapa* ssp. Toria (39.3%) followed by, *B. rapa* ssp. Yellow Sarson (34.9%), *B. juncea* (31.1%) and *Eruca sativa* (30.9%). Although, *B. napus* (26.0%) and *B. carinata* (22.1) were least affected crops species with AB which are mainly used for developing tolerance/resistance in *B. juncea* through traditional breeding methods. Most useful attribute is waxy leaf surface of *B. napus, B. carinata* and *B. juncea* genotypes which does not allow dew deposition required for Alternaria conidial germination and infection establishment.

Geographical distribution of AB: In India, prevalence of AB disease devastating rapeseed-mustard severely in different states with fluctuating intensity viz., Uttarakhand (48.5%), Himachal Pradesh (47.1%), Punjab (43.7%), Bihar (38.9%), Assam (38.7%), Jharkhand (38.7%), Uttar Pradesh (38.0%), Jammu & Kashmir (31.7%), Haryana (28.5%), Madhya Pradesh (25.3%), Chhatishgarh (24.1%), and Rajasthan (15.5%) as analysed for the period of seventeen years (Fig. 2). However, the Alternaria blight severity was negligible in Gujarat, Maharashtra and Tamil Nadu states due to unfavourable weather conditions for the development of the pathogen.

AB disease severity trends in zone II [Hisar (HSR), Ludhiana (LDH), Bhatinda (BTH), Sriganganagar (SGN)] showed static trend and similar trend was also observed in zone III [Bharatpur (BHP), Kanpur (KPR), Faizabad (FZB), Morena (MOR)]. Particularly in zone V at Jagdalpur (JAG) and Berhampore (BER), AB severity decreased drastically.

Probable factors declining Alternaria blight: Some of the genotypes in these species show slow blighting or horizontal resistance through their, a) thick cuticular surface, b) less number of stomata with wider spacing, c) low sporulation of pathogen, d) longer infection/ incubation and latent periods, e) low infection rate and, f) high phenolic compounds. Other factors contributed by progressive farmers through extension advisory services are, a) awareness of growers to sow crops with high yield, clean, and quality seed, b) clean cultivation, c) timely sowing of crops, d) use of judicious irrigation and fertilizers, e) proper spacing, and f) adopting plant protection measures. Now the use of phosphatic fertilizers has provided required phosphorus to build up tolerance in the host. Environmental factors like high temperature, low humidity, CO_2 ratio, and pollution are also players of fluctuating disease severity in the Brassica crops.

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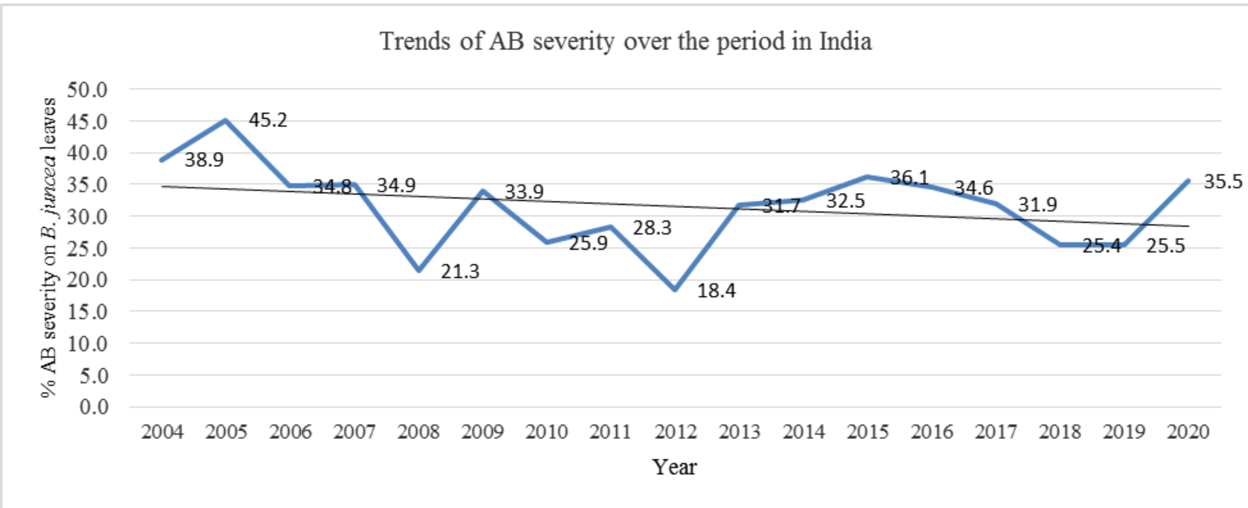

Fig. 1: Trends of Alternaria blight severity on *Brassica juncea*

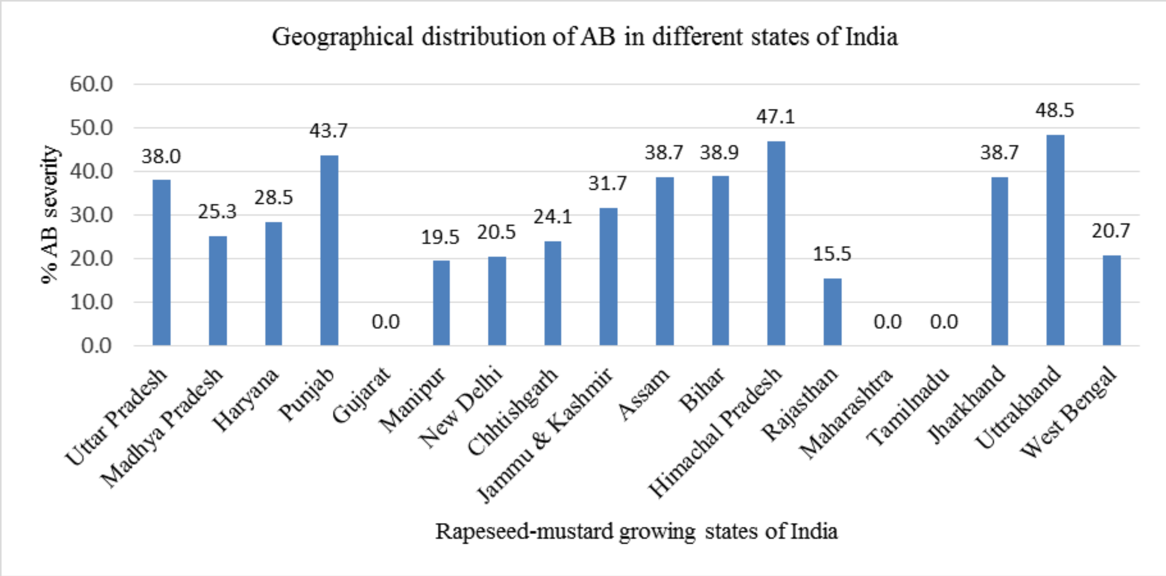

Fig. 2: Geographical distribution map of Alternaria blight on rapeseed-mustard in India

Biopolymers as a new paradigm in the plant disease management

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ABSTRACT

Changing climate makes great impact on the pest incidence which directly affects the global food production. There is a need for promising alternative for chemical pesticides. Biopolymer, chitosan is well known for its antimicrobial property and eco-friendly nature. We have synthesized speciality polymers using chitosan for seed treatment and foliar spray. Synthesized biopolymers showed antifungal activity against the phytopathogens (*Aspergillus niger* and *Amphobotrys ricini*) and 100per cent compatibility with the biocontrol agent *Trichoderma harzianum* Th4d. Results indicated the applicability of these particles as an alternative for the disease management.

Keywords: Biopolymers, Climate, Diseases

Climate change has great impact on farming sector, since it directly depends on climatic conditions which affects crop growth, productivity and pest occurrence. Phytopathogens cause an estimated crop loss of up to 20–30% annually, regarded as one of the most unnerving impediment to the global food security. Currently, crop production mainly depends on synthetic agrochemicals for the management of diseases. However, excessive and indiscriminate use of agrochemicals leads to several adverse effects and serious threat to environmental and human health.

Biopolymers are gaining attention as carrier materials due to their eco-friendly nature and ability to offer the persistent release of the associated active components. This study aims to synthesise Cu-chitosan polymer and Cu-chitosan coacervates for application in management of diseases.

MATERIAL AND METHODS

Synthesis of Cu-chitosan polymer and Cu-chitosan coacervates in different variations done by sequential addition of biopolymers and other adjuvants in water and kept for stirring on magnetic stirrer for 4-6 hrs for Cu-chitosan polymer and 15-45 min for Cu-chitosan coacervates. Later solutions were stored at room temperature and used for further studies.

Antifungal activity: Castor capsules were inoculated with *Amphobotrys ricini* and then treated with copper-chitosan coacervate and kept under incubation at 25 ± 1℃. Cu-chitosan polymer was coated on the groundnut seeds, later inoculated with *Aspergillus niger* and kept under incubation at 25 ± 1℃.

Compatibility test with *T. harzianum* Th4d: Both synthesized polymers were tested for its compatibility with *T. harzianum* Th4d using poison food technique.

RESULT AND DISCUSSION

Cu-chitosan polymer showed 42-85per cent inhibition of *A. niger* growth on groundnut seeds. Saharan *et al.* (2015) also showed antifungal property of the Cu-chitosan particles. Cu-chitosan coacervate also exhibited 25-100per cent inhibitory action against *Amphobotrys ricini*.

Both, Cu-chitosan polymer and Cu-chitosan coacervate showed 100per cent compatibility with the *T. harzianum* Th4d. Vincekovic *et al*. (2016) also showed compatibility of chitosan-copper cations with the *Trichoderma viride*.

Cu-chitosan polymer and Cu-chitosan coacervates showed antifungal activity against pathogens and compatibility with the biocontrol agent *T. harzianum* Th4d, which throws light on future applications of these two types of particles in the management of diseases and also in improving soil fertility and boosting plant growth.

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Production efficiency of linseed varieties under organic management condition in mild hills of Sikkim Himalayas

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ABSTRACT

Six linseed varieties *viz*., RLC 153, Sekhar, LSC-93, Priyam, JSL-95 and T-395 were evaluated at Research Farm of ICAR Research Complex for NEH Region Sikkim Centre, Tadong, Gangtok, Sikkim during *Rabi* season of 2021-22 in a randomized complete block design (RCBD) with four replications under organic management condition. The results indicated that significantly maximum number of bolls/plant and number of seeds/boll was observed in Priyam followed by LSC-93. Maximum 1000 seed weight was noticed under LSC-93 which was statistically a par with JSL-95 and significantly higher than other varieties. Significantly highest seed yield was recorded in Priyam followed by LSC-93, RLC-153 and may be recommended for cultivation by farmers of Sikkim Himalayas and similar agro-ecoregions under organic production system.

Keywords: Linseed, Variety, Sikkim

The agrarian economy of NER is rice based but in Sikkim maize–fallow and rice–fallow is the major dominant cropping systems.The cropping intensity of the state is very low (118%) compared to the national average (143%). Diversification of cereal based cropping system with other alternate short duration, low input requiring crop for enhancing the sustainable profitability and improve the soil health. Presently, Sikkim has become the first organic state of our country and demand of organic vegetable oil is more at national and international market. Linseed seed yield in our country is highly variable: linseed thrives best in regions with temperate climates with moderate warmth, high humidity and well-drained medium–heavy soils. Assessment of linseed varieties in different environmental conditions becomes essential before planning an appropriate cultivation strategy. The aim of this study was to evaluate the influence of linseed varieties, year of production in tight relation to weather conditions on seed yields, oil content and its quality, with a focus on human nutrition value, through a field study carried out at Research Farm of ICAR Sikkim Centre.

METHODOLOGY

A field study was carried out to evaluate the performance of six linseed varieties at Research Farm of ICAR Research Complex for NEH Region Sikkim Centre, Tadong, Gangtok, Sikkim (1300 meters AMSL with latitude 27º33' N and longitude 88º62' E) during *Rabi* season of 2021-22. The soil of the study site is sandy loam in texture and free from any hardpan and had initial pH, soil organic carbon, available N, P and K as 5.98, 12.4 g/kg, 345.3 kg/ha, 13.1 kg/haand 364 kg/ha, respectively. It was aimed at selecting high yielding varieties for cultivation in the State. The six varieties under study were RLC 153, Sekhar, LSC-93, Priyam, JSL-95 and T-395. The experiment was laid out in a randomized complete block design (RCBD) with four replications. Under organic nutrient management condition nutrients were applied on 60 kg N equivalent basis to each variety. Nutrients were supplied through organic sources i.e. FYM (containing 0.45% N and 0.23% P and 0.48% K), Vermicompost (containing 2.84 % N and 0.92 % P and 1.42 % K) and Biofertilizers. Before sowing of crop, apply dolomite @ 2 t/ha for neutralizing the soil pH. Neem cake can also be added @ 300 kg/ha to the field for effective control of soil-borne insect-pests. Crop was grown with the recommended cultivation practices. During the crop growing period data with respect to different parameters of growth, yield attributes and yield of linseed varieties were collected. The data collected were subjected to appropriate statistical analysis under Randomized Complete Block Design by following the procedure of ANOVA analysis of variance (SAS Software packages, SAS EG 4.3). Significance of difference between means was tested through 'F' test and the least significant difference (LSD) was worked out where variance ratio was found significant for treatment effect. The treatment effects were tested at 5% probability level for their significance.

RESULTS AND DISCUSSION

The data pertaining to growth parameters, yield attributes and yield of linseed varieties were influenced significantly under organic management condition except harvest index. The results clearly indicated that significant maximum plant height (76.4 cm) at harvest stage was noticed in Sekhar followed by LSC-93. Highest dry matter accumulation (16 g/plant) was noticed under LSC-93 which was statistically at par with Priyam and significantly higher than other varieties. Significantly highest total numbers of branches/plant (30.6) were recorded in Priyam as compared to other varieties. Significantly maximum number of bolls/plant (113.7) and number of seeds/boll (8.80) was observed in Priyam followed by LSC-93. Maximum 1000 seed weight (8.21 g) was noticed under LSC-93 which was statistically at par with JSL-95 and significantly higher than other varieties. Significantly highest seed yield (746 kg/ha) was recorded in Priyam followed by LSC-93, RLC-153. Maximum stover yield was recorded in Priyam (1605 kg/ha) which was statistically at par with Sekhar but significantly higher than other varieties. Significantly maximum biological yield (2351 kg/ha) was noticed in Priyam followed by LSC-93. Many similar studies have indicated that varieties have significant impact on growth and yield components (Barbara *et al*., 2020; Birhanu, 2020). Some other reasons that the application of nutrients through organic sources improve the soil organic C, microbial biomass C, dehydrogenase activity, earthworm population and water availability, consequently results in good crop growth and productivity (Badkul *et al*., 2022). The increase in growth and yield may be due to the availability of nutrients at various critical crop growth stages in optimal amount which might have increased the growth and yield attributes of crops thus resulting in the increased yield (Babu *et al*., 2020, Dabalo *et al*., 2020).

It could be inferred that short duration linseed variety Priyam followed by LSC-93, RLC-153 were found most promising in terms of productivity and profitability and may be recommended for cultivation by farmers of Sikkim Himalayas and similar agro-ecoregions under organic production system.

Table 1: Performance of linseed varieties under organic management condition

Variety	Plant height at harvest stage (cm)	Dry matter accumulation at harvest stage (g/plant)	Total number of branches/plant	Number of bolls/plant	Number of Seeds/boll	1000 seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Harvest Index
RLC 153	71.2	10.0	15.2	66.0	6.90	6.38	733	1512	2245	32.7
Sekhar	76.4	12.0	18.4	99.4	6.00	7.54	716	1569	2285	31.3
LSC-93	72.6	16.0	24.0	106.4	8.31	8.21	740	1558	2298	32.2
Priyam	62.6	15.0	30.6	113.7	8.80	6.41	746	1605	2351	31.7
JSL-95	69.4	9.40	16.4	62.0	7.90	8.03	630	1393	2023	31.1
T-395	55.4	11.0	25.2	90.8	6.80	5.56	680	1500	2180	31.2
SEm±	1.30	0.35	0.74	2.41	0.17	0.15	6.93	12.1	19.7	0.32
LSD (p=0.05)	3.98	1.10	2.25	7.31	0.52	0.44	20.8	36.7	57.9	NS

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Genetic transformation of *Trichoderma* with GUS & Hyg Genes to study root colonisation in Groundnut

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ABSTRACT

A stable β-glucoronidase, hygromycin transformed *Trichoderma harzianum* was obtained by *Agrobacterium* mediated transformation.The confirmation was made with PCR and gel electrophoresis. This transformed strain was used to study the activity of*Trichoderma* in the groundnut root with the aid of β-glucoronidase gene expression. Microscopic analysis revealed *Trichoderma* colonization and the presence of GUS-stained mycelium in the root section.

Keywords: Genetic transformation, Groundnut

The fungal antagonist *Trichoderma* received considerable attention for its role as a potential biocontrol agent against a wide range of plant pathogens. With the conventional indigenous methodologies, the survival and growth pattern of *Trichoderma* in soil and plant areunclear. Therefore, for a better understanding, the genetic transformation with marker gene was carried out, where β-glucoronidase is a promising tool for detecting and monitoring fungal biomass.

MATERIALSANDMETHODS

In this study, *Trichoderma harzianum* Th4d strain was transformed with hygromycin B (hyg) and β-glucoronidase (GUS) genes by the process of agroinfection. Initially the electro-competent cells of *Agrobacterium tumefaciens* AGL1 were electroporated with the pCAMBIA 1305.2 plasmid and the transformants were screened on kanamycin antibiotic selectionmedia plate. Subsequently, the transgenic bacterial colonies were inoculated into liquid minimalmedia containing 200 mM acetosyringone and incubated to an optical density of 0.5 absorbance units at 600nm.Then equal volumes of the incubated bacterial culture and the *Trichoderma harzianum* Th4d spore suspension were co-cultivated, 100µl was inoculated on to the nitrocellulose filter membrane placed on the minimal media plate. After 48 hours, the filter membrane was transferred to *Trichoderma* selection media plate containing 300µg/ml cefotaxime to inhibit *Agrobacterium* growth and 250µg/ml of hygromycin to select*Trichoderma* transformants. From the mitotically stable pCAMBIA 1305.2 transformed Th4d strain, the genome was isolated and components specific PCR was performed for CaMV35S, GUS and Hyg genes.

For root colonization studies, this transformed Th4d strain was seed treated to groundnut, while the native Th4d strain was used in control treatment. For histochemical analysis, the rootsamples from treated groundnut seeds were collected and each individual root was immersed in GUS solution (5-bromo-4-chloro-3-indolyl-β-D-glucuronicacid) at 37°C for 24 hours in dark.

RESULTS AND DISCUSSION

As a result of co-cultivation, five transformed colonies were observed on the hygromycin selection media plate. The DNA from all the five transformed strains and the native Th4d was isolated, quantified and PCR was performed, the bands were analysed by comparing with the100bp DNA ladder. An amplicon size of 717 bp of hyg, 599 bp of GUS and 537 bp of CaMV 35S confirmed the successful integration of T-DNA into fungal genome in all five samples. No amplification was seen in native Th4d. Similar results were quoted by Yang *et al.*, 2007.

In the histochemical GUS assay, when the root sample was immersed in GUS solution, the β-glucoronidase enzyme produced in the pCAMBIA1305.2(GUS) transformed *Trichoderma harzianum* Th4d strain react with the substrate X-gluc resulting in the formation of a reaction product which is indigo blue colour, therefore the groundnut roots and the solution were noticed to turn blue in the transformed *Trichoderma* treatment sample, whereas no colour change was observed in the control treatments.The results were in agreement with Yates *et al.,* 1999.

In the microscopic observation of root sample, typical blue colour stained mycelium andspores were detected in transformed Th4d. The GUS stained mycelium was observed to coloniseand proliferate in the root cortical cells providing qualitatively convincing evidence of colonizationby*Trichoderma*.

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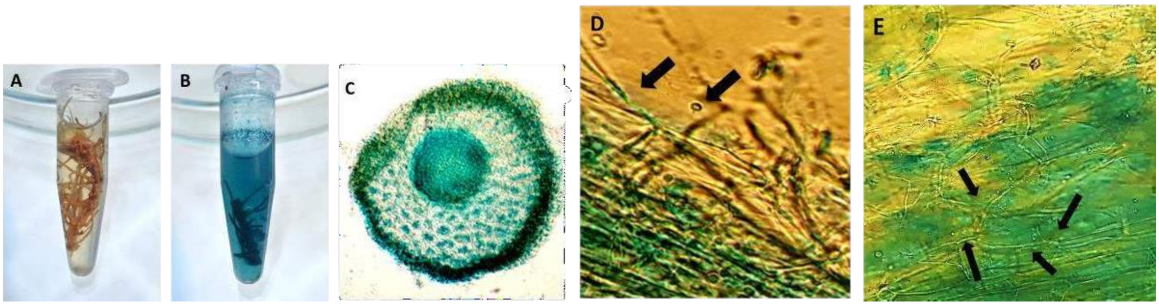

Fig. A. Control; B. GUS transformed *Trichoderma* treated root turned blue; C. Horizontal sectionof GUS stained root; D&E. Histochemical localization of GUS activity in *Trichoderma* colonized in the root

Evaluation of niger (*Guizotia abyssinica*) germplasm for seed yield and its attributes

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ABSTRACT

A total of 114 germplasm of niger along with two check varieties RCR 18 and DNS 4 were evaluated during *kharif*, 2020 at College of Agriculture, Raichur for seed yield and its attributing characters. The seed yield ranged from 0.7 to 9.0 g/line with a mean of 2.14g. Among all, five genotypes were performed better for seed yield (g) /line *viz*., IGP-GP-22 (9.0g), ICNR 04 (8.7g), IGP-GP-48 (8.5g), ICNR 05 (8.5g) and DNS 17 (8.4g). Two genotypes ICNR 04 (30 days) and DNS 17 (40 days) exhibited early days to 50% flowering compared to rest of the genotypes.

Keywords: Germplasm, *Guizotia abyssinica*, Niger, Seed yield

Niger (*Guizotia abyssinica*) is a minor oilseed crop grown in India. It is grown for seed and oil purpose. Though the improved varieties are available in niger, farmers are still cultivating local varieties. To improve the seed yield, it is necessary to collect the germplasm and evaluate them for variation in yield and its contributing characters and also to identify high yielding genotypes.

MATERIAL AND METHODS

The material included the 114 germplasm acquired from NBPGR, New Delhi, ARS, Igatpuri, UAS, Dharwad and some collections of UAS, Raichur along with two check varieties RCR 18 and DNS 4. The experiment was laid out in an augmented design with each genotype sown in single row during *kharif* 2020, at College of Agriculture, Raichur. The observations were carried out on days to 50% flowering and maturity, plant height (cm), number of primary branches and capitula and seed yield (g)/ line.

RESULTS AND DISCUSSION

The seed yield ranged from 0.7 to 9.0 g/line with a mean of 2.14g. Among all the genotypes, five genotypes were performed better for seed yield (g) /line *viz*., IGP-GP-22 (9.0g), ICNR 04 (8.7g), IGP-GP-48 (8.5g), ICNR 05 (8.5g) and DNS 17 (8.4g) (table 1). Two genotypes ICNR 04 (30 days) and DNS 17 (40 days) exhibited early days to 50% flowering compared to rest of the genotypes. The range for days to 50% flowering was 30 -70 days with a mean of 50.3 days. Days to maturity ranged from 60-113 days with a mean of 94.5 days. A range of 27.5 to 102.5 cm and a mean of 79.7 cm was observed for plant height. Number of primary branches ranged from 2.0-10.5 with a mean of 5.6. The number of capitula ranged from 4.0 to 56.0 with a mean of 17.7 capitula. The variation for the observed characters were present in the studied material. Hence, selection of genotypes can be carried out with respect to the observed characters to achieve improvement in seed yield. Similar studies and results were reported by Rani *et al*. (2010) and Suvarna *et al*., (2019).

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Table 1 Promising genotypes identified for seed yield (g)/line

Name	Days 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches	Number of capitula	Seed yield (g)/line
IGP-GP-22	47	93	91.6	6.0	22.0	9.0
ICNR 04	30	60	65.0	6.0	16.7	8.7
IGP-GP-48	48	90	86.0	6.0	20.0	8.5
ICNR 05	47	91	93.0	7.0	23.0	8.5
DNS 17	40	70	77.7	8.5	17.0	8.4
Mean	50.3	94.5	79.7	5.6	17.7	2.14
Range	30-70	60-113	27.5-102.5	2.0-10.5	4.0-56.0	0.7-9.0

Genetic diversity studies in soybean (*Glycine max* L. Merrill) germplasm

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ABSTRACT

Hundred soybean genotypes along with five checks were evaluated to study the nature and magnitude of genetic divergence using Mahalanobis's D^2 Statistics. The data was recorded on nine important quantitative traits from the genotypes grown in Augmented Block Design. The characters plant height, number of pods/plant, days to 50% flowering, days to maturity and 100 seed weight contributed maximum towards genetic diversity. The genotypes grouped into 6 clusters, cluster I was larger containing 60 genotypes whereas cluster V has smallest cluster containing only one genotype. On the basis of clusters formed genotypes were selected to be utilized as donor like NRC 105, JS 20-34 and JS 95-60 for earliness; Kalitur and AGS 25 for more number of pods and branches; Karune for bold seed and AMS 100-39 and AMS 48-7-3 for high seed yield. On the basis of average inter cluster distance the cross AMS 48-7-3 x Kalitur and AMS 100-39 x AMS 48-7-3 were suggested for getting more number of pods and branches with high yield. The cross combination Karune x Kalitur, AMS 48-7-3 x Karune and AMS 100-39 x Karune were suggested for getting extra bold seeded high yielding variety.

Keywords: Cluster, Diversity, Soybean

Soybean (*Glycine max* (L.) Merill.) Popularly known as **"**Golden Bean**"** or **"**Miracle crop**"** is a member of leguminaceae family. In any crop improvement programme, genetic diversity plays an important role. In fact, it is an essential pre-requisite while initiating hybridization programme because the choice of potential and diverse parents determines the success of such programme and will serve the purpose of combining desirable genes so as to obtain superior recombinations. Assessment of genetic divergence by the use of D^2 statistics is useful method for determining the degree of genotypic diversity (Arunachalam, 1981). Therefore, the present study aimed to quantify the genetic diversity in elite germplasm.

MATERIALS AND METHODS

The set of 100 genotypes along with 5 checks were evaluated in Augmented Block Design at Regional Research Centre (Dr. PDKV), Amravati during *kharif* 2021 with spacing 45 x 5 cm. Observations were recorded for nine quantitative characters *viz.* on plot basis days to 50% flowering, days to maturity and on plant basis plant height (cm), number of branches/plant, number of pod clusters/plant, number of pods/plant, number of seeds/pod, 100 seed weight (g) and seed yield/plant (g). The genetic divergence analysis was done as/Mahalanobis D^2 statistic (1936) and genotypes were classified into distinct clusters using Tocher's method (Rao, 1952).

RESULTS AND DISCUSSION

Plant height showed highest percent contribution towards genetic divergence (37.05%) followed by number of pods/plant (34.16%), days to 50% flowering (12.09%), days to maturity (4.84%), 100 seed weight (3.96%), number of pod clusters/plant (2.23%), seed yield/plant (2.01%), number of branches/plant (1.87%) and number of seeds/pod 1.79% (Table 1).The highest magnitude of genetic diversity for plant height in soybean had also been reported by Ramana and Satyanarayana (2006); for pods/plant by Mahesh *et al.* (2017).

The study revealed the presence of considerable genetic diversity among all characters under the study. The genotypes were grouped into 6 clusters by Tocher's method. Cluster I was the largest having 60 genotypes followed by cluster III with 22 genotypes, cluster II (12 genotypes), cluster VI (6 genotypes) and cluster IV (4 genotypes). Cluster V was the smallest cluster containing only one genotype (Table 2).

The cluster means for all the characters are presented in Table 3. The highest cluster mean was observed in cluster IV for characters days to 50% flowering, days to maturity, plant height, number of branches/plant, number of pods/cluster, pods/plant. On the basis of clusters formed the following genotypes could be selected as donors like NRC 105, JS 20-34 and JS 95-60 for earliness; Kalitur and AGS 25 for more number of pods and branches; Karune for bold seededness and AMS 100-39 and AMS 48-7-3 for high seed yield (Table 4).

The average inter cluster distance was maximum between clusters IV and VI (33.35), followed by clusters II and IV (29.72), clusters IV and V (29.24), clusters I and IV (27.46), clusters III and VI (23.97) cluster III and VI (21.19) and cluster II and III (20.82). In the present study; the cross AMS 48-7-3 x Kalitur and AMS 100-39 x AMS 48-7-3 were suggested for getting more number of pods and branches with high yield. Similarly the cross combination JS 20-34 x Kalitur/AGS 25, AMS 48-7-3 x JS 95-60, AMS 100-39 x NRC 105 and AMS 100-39 x JS 95-60 were suggested for high yield with earliness. The cross combination Karune x Kalitur, AMS 48-7-3 x Karune and AMS 100-39 x Karune were suggested for getting extra bold seeded high yielding variety (Table 5).

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Table 1: Contribution of each character towards genetic divergence

Source	Times rank first	% contribution
Days to 50% flowering	660	12.09
Days to maturity	264	4.84
Plant height (cm)	2023	37.05
No. of branches/plant	102	1.87
No. of pod cluster	122	2.23
No. of pod/plant	1865	34.16
No. of seed/pods	98	1.79
100 seed weight (g)	216	3.96
Seed yield/plant (g)	110	2.01

Table 2: Grouping of genotypes into different cluster

Cluster	No. of genotype	Genotypes
Cluster I	60	AMS 475, AMS 140, AMS 114,AMS 100, NRC 522, AMS 46-1-16, AMS 77-3-6, VLS 62, SL 790, JS 93-05, MACS-NRC 15-75, VLS 68, PS 1444, RSC 10-52, AMS 2018-1, NS 209, JS 20-29, DT 21, RVS 2001-18, AMS 243-7-1, JS 20-69, JS 335, AMS 22, AMS 5-39, AMS 2005-13, JS 21-71, MACS 1508, JS 20-53, MAUS 144, NRC 86-2, AMS 353, MAUS 49-1, DS 228, AMS 1001, NRC 86, AMS 21, NRC 138, AMS 158, NRC 21-72, Himso 1579, PK 416, AMS 2017-1, RSC 10-46, TAMS 38, AMS 99-33, AMS 60-2-34, MACS 1281, TS 86, TS 104, IC 118041, EC 519845, NRC 66, NRC 127, AMS 2014-1,AMS 0542, KDS 753, MAUS 71, KDS 7, AMS 160-2-12, MAUS 158.
Cluster II	12	Harasoya, NRC 146, JS 95-60, JS 20-34, Karune, NRC 148,RVSM 2011-35, UPSM 534, Himso 1685, PS 1450, NRC 2005-0-5-3, MAUS 162.
Cluster III	22	AMS 140, GBIC 18-75-8, AMS 596, AMS 25, AMS 31-1, TS 25, Bragg, AMS 115, AMS 100-39, NRC 142, TS 83, KDS 344, MACS 1188, MACS 1520, KDS 726, AMS-MB 5-18, NRC 37, Himso 1676, PK 1029, AMS 20-20, JS 97-52, MAUS 612.
Cluster IV	4	AGS 25, Kalitur, JS 96-31, AMS 595.
Cluster V	1	MAUS 1
Cluster VI	6	EC 519579, AMS 47, SL 744, NRC 105, AMS 48-7-3, JS 20-98.

Table 3 Cluster means for nine characters

Clusters	Days to 50% flowering	Days to maturity	Plant height	Number of bran./ plant	Number of pod cluster / plant	Number of pods /plant	Number of seeds / pod	100 seed weight (g)	Seed yield / plant (g)
Cluster I	42.57	96.81	38.52	2.47	4.97	30.14	1.95	10.73	5.51
Cluster II	40.07	95.75	43.34	2.00	4.01	20.40	1.92	13.34	4.75
Cluster III	45.87	99.93	47.58	2.44	5.67	35.07	1.86	10.38	5.99
Cluster IV	50.85	100.80	60.93	3.40	7.66	36.82	1.78	7.15	4.56
Cluster V	50.05	100.50	35.95	1.82	4.43	24.21	1.88	10.52	3.96
Cluster VI	41.72	95.43	31.57	2.53	5.36	37.00	1.90	9.62	5.92

Table 4 Genotype selected for different characters on the basis of cluster formed

Characters	Clusters	Genotypes selected from clusters formed
Early maturity (days)	I	IC 118041 (91), EC 519845 (92), NS 209 (93)
	II	JS 95-60 (87), JS 20-34 (83)
	VI	NRC 105 (92), EC 519579 (94)
Maximum plant height (cm)	IV	Kalitur (62.6), AMS 595 (61.8) AGS 25 (60.6), JS 96-31 (58.6)
	III	NRC 142 (55.4), AMS 100-39 (55.2)
Maximum number of branches	IV	Kalitur (4.4), AGS 25 (4.2)
	III	KDS 344 (4.2)
	I	NRC 127 (3.8), NRC 86-2 (3.8)
Maximum number of pod clusters/plant	VI	SL 744 (9.0)
	III	Himso 1676 (8.8)
	IV	Kalitur (8.6), AGS 25 (8.4)
	I	Himso 1579 (8.6)
Maximum number of pods/plant	VI	EC 519579 (43.8), AMS 47 (40.2)
	IV	AGS 25 (41.0), Kalitur (40.0)
	III	AMS-MB 5-18 (42.6), MACS 1188 (40.1), KDS 344 (39)
Maximum number of seeds/pod	I	AMS 2018-1 (2.85), JS 93-05 (2.68), AMS 475 (2.66), AMS 46-1-16 (2.51), AMS 140 (2.51)
	VI	AMS 48-7-3 (2.45)
Maximum 100 seed weight (g)	II	Karune (20.5), Himso 1685 (15.0), Harasoya (15.0), NRC 146 (15.0)
	III	KDS 726 (15.0)
	I	MACS-NRC 1575(14.5), NRC 21-71 (14.5)
Maximum seed yield/plant (g)	III	AMS 100-39 (8.20), MACS 1888 (7.90), AMS-MB 5-18 (7.84), KDS 726 (7.70), MACS 1520 (7.61)
	I	AMS 2014-1 (7.96)
	VI	AMS 48-7-3 (7.63)

Table 5 Maximum inter-cluster distance and cross combinations suggested

Cluster combination	Average inter cluster distance	Cross combination suggested	Characters to be improved
IV x VI	33.35	AMS 48-7-3 x Kalitur	More no. of pods and branches with high yield
II x IV	29.72	JS 20-34 x AGS 25	Earliness with more no. of pods, branches and 100 seed weight
I x IV	27.46	AMS 2014-1 x AGS 25	More no. of pods, branches with high yield
II x VI	23.97	AMS 48-7-3 x Karune	Extra bold seeded with high seed yield
		AMS 48-7-3 x JS 95-60	High yield with earliness
III x VI	21.19	AMS 100-39 x NRC 105	High yield with earliness
		AMS 100-39 x AMS 48-7-3	High yield with more no. of pods.
II x III	20.82	AMS 100-39 x JS 95-60	High yield with earliness
		AMS 100-39 x Karune	Extra bold seeded with high seed yield

Influence of harvesting stages on seed quality characteristics and seed yield in soybean (*Glycine max* (L) Merrill)

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ABSTRACT

The experiment was conducted with an objective of knowing the proper stage of harvesting in soybean. The treatments consisting five genotypes with three harvesting stages *viz*., physiological maturity (H_1), five days after physiological maturity (H_2), and field maturity (H_3). The seed moisture content, hundred seed weight, seed size, germination, root length, shoot length, vigour index, seedling weight, seedling dry weight and seed yield were maximum at physiological maturity stage. Among the genotypes, AMS 100-39 was found to be best genotype for seed/crop production. All seed and seedling vigour components attained maximum values at physiological maturity stage and decreased at subsequent stages of harvesting after physiological maturity. Hence, it is advisable to harvest the soybean crop at physiological maturity stage.

Keywords: Environment, Harvest, Soybean, Yield

Soybean (*Glycine max* (L.) Merrill) is truly a "Wonder crop" as its vast multiplicity uses as food, fodder, industrial products and residues in soil and also accounting for nearly 50 percent of total oilseed acreage as well as production. On the global scales, it ranks on the top of the list of oilseed crops and contributes over one third of the total supply of the world vegetable oil pool. The productivity of soybean in India is lower due to constraints like lack of high yielding location specific, disease/pest resistant varieties and availability of quality seed. In general, environment plays an important role in production of quality seed. Among the various factors seed size may influence on rate of germination. Environmental factors, such as temperature and humidity have great importance in production of quality soybean seed. To maintain maximum vigour and viability of seed and to avoid losses at the time of harvest, harvesting of soybean crop at proper maturity stage is important.

MATERIALS AND METHODS

Soybean genotypes JS 335, JS 93-05, NRC 37, MAUS 612, AMS 100-39 with three harvesting stages *viz*., harvesting at physiological maturity (H_1), five days after physiological maturity (H_2) and at field maturity (H_3) in FRBD was conducted during *kharif* 2021 at Regional Research Centre (Dr. PDKV), Amravati. Observations were recorded on five randomly selected plants from each replication on eleven parameters *viz*., seed moisture at harvest (%), hundred seed weight (g), seed germination (%), seedling vigour, root length (cm), shoot length (cm), seedling weight (g/five seedlings), seedling dry weight (g/five seedlings), vigour index, seed size (ml/100 seeds), seed yield/plant (g).

RESULTS AND DISCUSSION

The seed characters as influenced by genotype x stage of harvest is presented in Table 1. Substantial amount of variation was observed among treatments for all the characters studied. Significantly higher seed moisture was noted by AMS 100-39 (22.54%) followed by genotype JS 93-05 (21.48%) whereas significantly higher hundred seed weight was recorded by genotype JS 93-05 (13.37g). Results for seed size indicated that genotype JS 93-05 produced bold sized seeds whereas AMS 100-39, NRC 37 and JS 335 produced medium sized seeds.

The highest seed moistureper cent at harvest was recorded at physiological maturity (28.97%) while lower seed moisture in soybean seed (15.68%) was observed at field maturity stage. Higher seed weight was recorded at physiological maturity (12.72g), while lower seed weight (10.82g) was observed at field maturity stage. Seed size was not differing much due to harvesting of soybean at different maturity stages.

Genotype x stage of harvest interaction (Table 2) revealed, maximum seed moisture at harvest was observed in AMS 100-39 (30.86%), when harvested at physiological maturity and decreased significantly at subsequent stages of harvest. In all the genotypes the seed moisture at harvest was high at physiological maturity and decreased significantly at subsequent stages of harvest. The highest hundred seed weight (14.7g) was observed in JS 93-05, when harvested at physiological maturity and decreased significantly at five days after physiological maturity and field maturity stage of harvest (Table 2). In all the genotypes the hundred seed weight decreased significantly at subsequent stages of harvest. Data on seed size as influenced by genotype x stage of harvest was found to be non-significant.

The seedling vigour components and seed yield as influenced by genotype x stage of harvest is presented in Table 4. The maximum seed germination (84.33%) was observed in AMS 100-39 and it was significantly superior over all other genotypes. In general the performance of seed germination was better in all the genotypes. Significantly higher vigour index was registered by AMS 100-39 followed by JS 93-05, JS 335, MAUS 612 and NRC 37. Significantly highest seed yield/plant was noted by AMS 100-39 (20.23g) whereas, lowest seed yield/plant was observed in JS 335 (14.36g). Harvesting of soybean at physiological maturity significantly increased theper cent seed germination up to 85.00per cent than harvesting at field maturity stage (70.00%). Harvesting of soybean five days after physiological maturity also performed well (78.00%) in respect of germination.

Significant differences were observed for vigour index values due to harvesting of crop at different stages viz., physiological maturity (2740.8), five days after physiological maturity (2286.2), at field maturity (1914.8). Harvesting of soybean at physiological maturity significantly increases vigour index as compared to later stages of harvest. Harvesting of soybean at physiological maturity shows significantly increased seed yield/plant (18.58g) as compared to field maturity stage (15.60g).

The interaction effect (Table 5) for vigour index was significant. Significantly higher vigour index was observed in AMS 100-39 (3117) over all the remaining genotypes when harvested at physiological maturity. The higher vigour index have been observed in all the genotypes when harvested at physiological maturity and decreased significantly at subsequent stages of harvest. This may be due to germination capacity and vigour index reached its maximum values at physiological maturity stage and the cells of cotyledons were filled with starch, lipid granules and protein globules. It was further observed that the seed germination, vigour index, seedling weight, seedling dry weight and seed yield were significantly reduced with advancement of different stages of harvest after physiological maturity. This may be due to deterioration of seed because of field weathering and pod shattering after physiological maturity. Similar results were also obtained by Osei *et al.*, (2016) andHirpara *et al.*, (2020).

Results obtained from present investigation revealed that, among the genotypes, AMS 100-39 was found to be best genotype for seed/crop production, as the seeds of this genotype have good germinability, high vigour index and seed yield and should be exploited for further crop improvement programme. The seed germination, seed vigour components, and seed quality were found to be better when the soybean crop was harvested at physiological maturity than the crop harvested at five days after maturity and at field maturity. All seed and seedling vigour components has attained maximum values at physiological maturity stage and decreased at subsequent stages of harvesting after physiological maturity. Hence, it is advisable to harvest the soybean crop at physiological maturity stage.

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Table.1 Seed characters as influenced by genotype x stage of harvest

Characters	Seed moisture at harvest (%)	Hundred seed weight (g)	Seed size (ml/100 seeds)
Genotypes (G)			
JS 335	20.00 (26.15)	10.73	9.53
JS 93-05	21.48 (27.31)	13.37	12.06
NRC 37	19.79 (26.11)	11.77	9.83
MAUS 612	19.96 (26.14)	11.67	8.63
AMS 100-39	22.54 (28.01)	10.97	10.26
SE±	0.24	0.09	0.17
CD (P = 0.05)	0.70	0.27	0.51
Stages of harvest (H)			
Physiological maturity (PM)	28.97 (32.48)	12.72	10.6
5 days after PM	17.62 (24.62)	11.56	10.16
Field maturity	15.68 (23.12)	10.82	9.63
SE±	0.19	0.07	0.14
CD (P = 0.05)	0.56	0.21	0.41
Interaction (G x H)			
SE±	0.42	0.16	0.31
CD (P = 0.05)	1.14	0.42	NS

(Figures in parentheses are arc sine transformed); NS- Non-significant.

Table.2 Seed moisture at harvest (%) as influenced by genotype x stage of harvest

Genotypes		Stages of harvest		
		Physiological maturity (PM)	5 days after PM	Field maturity
JS 335		28.96(32.44)	15.59(23.04)	15.46(22.94)
JS 93-05		29.19(32.64)	19.16(25.84)	16.09(23.44)
NRC 37		26.96(31.24)	17.36(24.44)	15.06(22.64)
MAUS 612		28.86(32.44)	16.19(23.54)	14.82(22.44)
AMS 100-39		30.86(33.64)	19.80(26.24)	16.96(24.14)
SE+	0.38			
CD (P=0.05)	1.12			

(Figures in parentheses are arc sine transformed)

Table.3 Hundred seed weight (g) as influenced by genotype x stage of harvest

Genotypes	Stages of harvest		
	Physiological maturity (PM)	5 days after PM	Field maturity
JS 335	12.1	10.5	9.6
JS 93-05	14.7	13.0	12.4
NRC 37	12.6	11.8	10.9
MAUS 612	12.1	11.7	11.2
AMS 100-39	12.1	10.8	10.0
SE+	0.15		
CD (P=0.05)	0.44		

Table.4 Seed germination, seedling vigour components and seed yield as influenced by genotype x stage of harvest

Characters	Seed germination (%)	Root length (cm)	Shoot length (cm)	Vigour index	Seedling weight g/five seedlings	Seedling dry weight g/five seedlings	Seed yield/ plant (g)
Genotypes (G)							
JS 335	77.00 (8.80)	13.90	13.30	2220.00	4.24	0.42	14.36
JS 93-05	78.33 (8.86)	14.05	14.10	2383.67	4.23	0.39	17.36
NRC 37	70.33 (8.62)	14.24	13.53	2182.33	4.06	0.42	18.40
MAUS 612	78.33 (8.82)	13.10	12.63	2152.33	4.16	0.37	15.36
AMS 100-39	84.33 (9.16)	14.32	13.70	2631.33	4.66	0.41	20.23
SE±	0.07	0.12	0.14	35.06	0.08	0.01	0.44
CD(P=0.05)	0.21	0.34	0.40	105.10	0.23	0.02	1.32
Stages of harvest (H)							
Physiological maturity (PM)	85.00 (9.18)	14.93	14.27	2740.80	4.62	0.46	18.58
5 days after PM	78.00 (8.82)	13.86	13.38	2286.20	4.26	0.40	17.26
Field maturity	70.00 (8.62)	12.98	12.70	1914.80	3.94	0.35	15.60
SE±	0.06	0.09	0.10	26.33	0.07	0.01	0.36
CD(P=0.05)	0.18	0.27	0.29	78.50	0.20	0.02	1.08
Interaction (G x H)							
SE±	0.13	0.21	0.24	61.39	0.15	0.01	0.8
CD(P=0.05)	NS	NS	0.62	185.89	NS	0.03	NS

(Figures in parentheses are square root transformed), NS- Non-significant

Table.5 Vigour index as influenced by genotype x stage of harvest

Genotypes	Stages of harvest		
	Physiological maturity (PM)	5 days after PM	Field maturity
JS 335	2553	2133	1974
JS 93-05	2738	2373	2040
NRC 37	2706	2066	1775
MAUS 612	2590	2119	1748
AMS 100-39	3117	2740	2037
SE+	55.33		
CD (P=0.05)	165.66		

Effect of vam and phosphorus on yield and quality of sunflower

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ABSTRACT

The field experiment was conducted at Experimental Farm, Department of Agronomy, Annamalai University, Tamil Nadu during July – October 2015 to study the effect of mycorrhizal inoculation (VAM) and different levels of phosphorus on yield and quality of hybrid sunflower cv. Sunbred.The experiment was conducted in factorial randomized block design with two replications. The treatments consisted of 5 levels of P_2O_5 (0, 25, 50, 75 and 100kg/ha) applied in the presence or absence of VAM inoculates. The results of experiment revealed that mycorhizal inoculated plants produced maximum seed and stalk yield, oil content, oil yield and protein content than non mycorhizal inoculation. Among the various phosphorus levels tried, P_2O_5 at 100 kg/ha recorded the maximum values for yield and quality. With regard to interaction effect, mycorrhizal inoculation with P_2O_5 @ 100 kg /ha recorded maximum values for yield and quality of sunflower but it was on par with mycorrhizal inoculation with P_2O_5 @ 75 kg /ha. Lowest values of yield and quality were recorded in non- mycorrhizal inoculation with P_2O_5 @ 0 kg /ha.

Keywords: Hybrid Sunbred, Quality, Sunflower, VAM, Yield

Sunflower oil has excellent nutritional properties, and has a relatively high concentration of linoleic acid. It is also a wealthy source of vitamins A and D.Mycorrhiza has symbiotic association between the soil fungi and roots of higher plants. These fungi enhance the plant growth through making availability of mineral nutrients such as P, Zn and Cu. These glomeromycolan fungi bank on their plant host for carbon in return for which fungus improves nutrition especially phosphate nutrition (Smith *et al*., 2010). Phosphorus is an essential plant macronutrient which is required to build important molecules such as nucleic acids and phospholipids, and plays vital role during energy transfer in processes like NADPH, ATP and regulation of enzymatic and metabolic reactions. Hence, the present study was taken up to find out the effect of mycorrhizal inoculation and phosphorus on yield and quality of hybrid sunflower.

MATERIALS AND METHODS

Field experiment was conducted during July – October 2015 at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University. The experimental soil was clay loam with pH 8.1, OC 5.0g/kg, available N (235 kg /ha), P (22.1 kg /ha) and K (356 kg /ha). The experiment consisted of ten treatments and was laid out in factorial randomized block design with two replications. M_1-Non inoculated and M_2-inoculated *Glomus intraradices* were tried along with different phosphorus levels (P_0-0, P_1-25, P_2-50, P_3-75 and P_4-100 kg P_2O_5 /ha) through SSP. Recommended dose of 60:60 kg of NK/ha was applied in the form of Urea, and MOP respectively. Half the dose of N and entire dose of K were applied basally. P was applied as per the treatments. The remaining quantity of N was applied at 30 DAS. The mycorrhizal inoculum was applied near the root zone of sunflower @ 2 gm/plant by placement method. At harvest seed and stalk yield was recorded. Oil content was analysed by using commercial Nuclear Magnetic Resonance Spectrometer (NMRS) method and oil yield was calculated by multiplying seed yield with oil content. N content of seed was analysed and multiplied with 6.25 to get crude protein.

RESULTS AND DISCUSSION

Yield: Mycorrhizal inoculated plants showed significant influence on yield (Table) over nonmycorrhizae. Mycorrhizal inoculation recorded the maximum seed yield (1845 kg /ha) and stalk yield (4069 kg /ha) than non-mycorrhizal inoculation. The seed yield increase in this treatment was 28 % than non mycorhizal inoculation.

Phosphorus levels significantly influenced the yield (Table). Among the different levels, P_2O_5 at 100 kg /ha produced maximum seed yield (2048 kg /ha) and stalk yield (4379 kg /ha).

The interaction effect between the mycorrhizal inoculation and phosphorus was not significant. The treatment combination of mycorrhizal inoculation along with P_2O_5 at 100 kg /ha recorded higher values for yield but it was on par with mycorrhizal inoculation along with P_2O_5 at 75 kg /ha. This might be due to availability of phosphorus and other nutrients at both vegetative and productive stages. The lowest values for seed and stalk yield were recorded under the treatment combination of non mycorrhizal inoculation with 0 kg P_2O_5/ha. This might be due to the absence of mycorrhiza resulted in reduced growth and yield attributing characters and seed and stalk yield. Similar findings were earlier reported by Babaei *et al* (2012)

Quality characters: Mycorrhizal inoculated plants significantly influenced the quality characters*viz*, oil content, oil yield and crude protein content (Table 1). Mycorrhizal inoculation recorded the highest oil content (42.54 **%**), oil yield (790 Kg /ha) and crude protein content (17.64**%**) than non-mycorrhizal inoculation.

Among the different levels of phosphorus, application of P_2O_5 at 100 kg /ha significantly recorded highest oil content (43.49 **%**), oil yield (891 Kg /ha) and crude protein content (18.30 **%**). The interaction effect between the mycorrhizal inoculation and phosphorus was not significant. The treatment combination of mycorrhizal inoculation along with P_2O_5 at 100 kg /ha recorded maximum values for quality charactersbut it was on par with mycorrhizal inoculation along with P_2O_5 at 75 kg /ha. This might be due to mycorrhizal inoculation and phosphorus application and its effect by enhancing photosynthesis activity which, in turn, resulted in seed formation, an increase in oil content, oil yield of hybrid sunflower.

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Table. Effect of VAM and phosphorus levels on yield and quality characters of sunflower

Treatments	Yield		Quality characters		
	Seed yield (kg /ha)	Stalk yield (kg /ha)	Oil content (%)	Oil yield (Kg /ha)	Crude protein content (%)
			VAM		
M_1	1438	3570	40.29	586	15.43
M_2	1845	4069	42.54	790	17.64
SEd	28.46	20.75	0.16	12.35	0.06
CD(P=0.05)	61.05	44.51	0.34	26.49	0.13
			Phosphorus levels (kg /ha)		
P_0	973	2692	39.01	380	14.12
P_1	1197	3179	39.12	470	14.27
P_2	1477	3589	40.58	603	15.96
P_3	1843	4129	42.47	786	17.61
P_4	2048	4379	43.49	891	18.30
SEd	40.25	29.35	0.22	17.46	0.09
CD(P=0.05)	86.34	62.95	0.48	37.46	0.19

Evaluation of castor trait specific inbred lines under rainfed alfisols of Ananthapuramu

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ABSTRACT

Identification of elite genotypes necessitates plant breeders to deploy more apt suitable tools for assessing crop performance. Univariate analyses are too narrow and unreliable as they lack considerate relations between variables. Hence the current study with twenty seven trait specific inbred lines of Castor along with four checks viz., 48-1, DCS-107, PCS-124 and PCS-262 were analysed through PCA approach for yield and its attributes during *kharif*, 2021 at Agricultural Research Station, Ananthapuramu. Two inbred lines *viz.*, ICIRG17-2-7-15-6 and ICIEEGP63-15 were found promising for high seed yield at 90 DAS & 150 DAS interval. ANOVA indicate existence of significant amount of variability among the genotypes for majority of traits studied.

Keywords: Castor, Elite, Inbreds, Rainfed

Castor (*Ricinus communis* L.), a premier non-edible oilseed is mainly cultivated for its industrial value in the rainfed alfisols of Ananthapuramu district in Andhra Pradesh, India. In recent past, due to immense demand in global castor market for its lucrative oil and commercial applications, there is a huge and rapid expansion in the area and production of castor replacing the traditional crops like groundnut, pigeonpea and millets. Studies on identification of elite genotypes in castor is very much essential to strengthen sound and efficient breeding programme. Hence the present study was taken with an objective to evaluate and select trait specific inbred lines in castor in order to harness its true potential in breeding programme.

MATERIAL AND METHODS

Twenty seven inbred lines in Castor were raised in RBD replicated twice during *kharif*, 2021 at Agricultural Research Station, Ananthapuramu. Each entry was sown in two rows of 6m length with a spacing of 90 x 60 cm. Entries were studied for eight traits viz., seed yield at 90 DAS, Total seed yield (150 DAS), days to 50% flowering (DFF), days to maturity (DM), plant height upto the primary spike (PLH), Number of nodes upto the primary spike (NNP), effective spike length of primary (ESL), Number of capsules on primary spike and hundred seed weight (HSW).

RESULTS AND DISCUSSION

Analysis of variance revealed high level of significance for majority of the traits *viz.*, seed yield @ 90 DAS, total seed yield @ 150 DAS, days to 50% flowering, plant height, number of nodes to the primary and effective spike length of primary. This infers significant level of variability exists among the genotypes for the traits studied. PCA identified four principal components which together explained almost 80% variation in data with PCA 1 and PCA 2 connoting 23.7% and 22.2% variation, respectively. Loadings for PCA1 contained all the traits except days to 50% flowering and maturity. PCA biplot showed association among the traits being studied with DFF and DM having close association. Likewise, SY 90 had strong association with TSY150 and HSW. The results are in consonance with the findings of da Piedade et al. (2019). Two trait specific inbred lines *viz.*, ICIRG17-2-7-15-6 and ICIEEGP63-15 of castor were found promising for high seed yield at seed yield at 90 DAS and 150 DAS interval implying their utilization in evolving genotypes with early harvests and stable yields.

The study identified two trait specific inbred lines *viz.*, ICIRG17-2-7-15-6 and ICIEEGP63-15 of castor were found promising for high seed yield at seed yield at 90 DAS and 150 DAS interval implying their utilization in evolving genotypes with early harvests and stable yields.

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Table: Analysis of variance for yield and its attributes of castor trait specific inbred line
s

EFFECT	DF	SY90	TSY150	DFF	DM	PLH	NNP	ESL	NCP	HSW
Blocks	1	3762.73	85174.26	37.16	14.52	0.37	0.06	7.53	0.79	1.99
Genotypes	30	73661.22**	182302.36**	12.24*	8.53	110.98**	2.04**	118.83**	67.66	0.81
Residual	30	8032.33	12342.36	6.19	6.28	21.94	0.45	11.02	43.79	0.52
Total	61	40238.84	97123.21	9.68	7.52	65.37	1.22	63.98	54.83	0.69

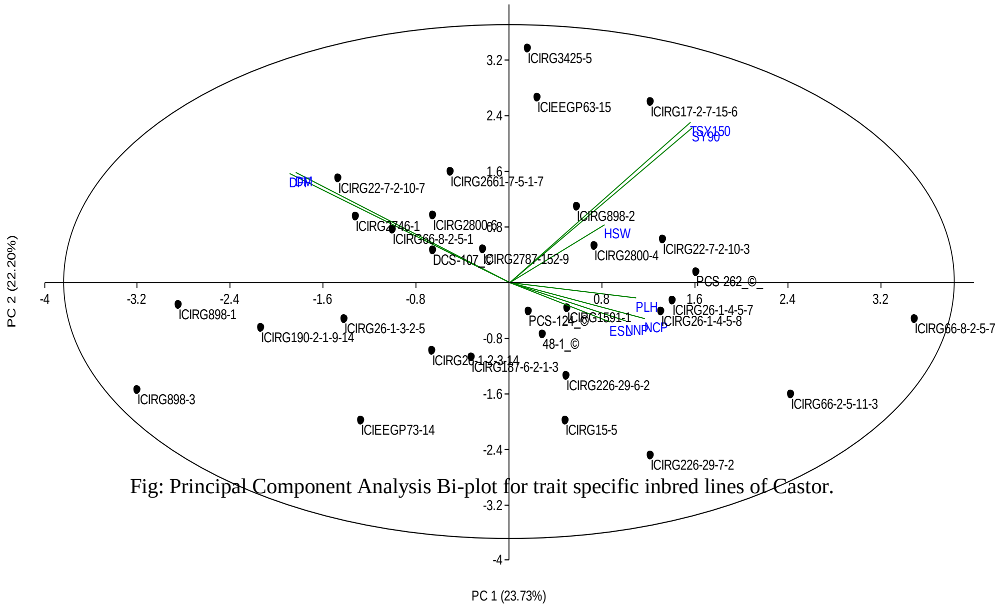

Fig: Principal Component Analysis Bi-plot for trait specific inbred lines of Castor.

Correlation analysis of Safflower genotypes for yield and yield contributing traits over the locations

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ABSTRACT

Twelve genotypes were used in the field experiments, which were carried out at the four different locations. Out of thirteen morphological characters there was positive correlation between yield and the test weight, the number of seeds/capitulum, the days to maturity, the number of seeds/capitulum and days to 50% flowering.

Keywords: Correlation, Environments, Safflower

Correlation is a metric used to assess the mutual relationship between two variables. It acts as a gauge of how linearly and closely related two variables are. Studying correlations can help plant breeders better understand how the growth of one character will influence the concurrent growth of other characters. Character association research can be used to establish selection criteria for grain yield in parental lines so that the plants with the desired combination of characters can be successfully isolated (Kante *et al*., 2022).

MATERIAL AND METHODS

The experiment was conducted at four locations *viz*, Parbhani, Latur, Somnathpur and Badnapur during the 2019 *Rabi* season. Nine safflower genotypes *viz*., PBNS–185, PBNS–200, PBNS–201, PBNS–153, PBNS–154, PBNS–197, PBNS–198, PBNS–207 and PBNS–208 and three check varieties—PBNS-86, PBNS-12, and Sharda were planted at four different locations.The experimental material was evaluated in Randomized Block Design (RBD) with three replications at Parbhani (E1), Latur (E2), Badanapur (E3), and Somanathpur (E4). Observations were recorded on thirteen yield and yield contributing characters. Analysis of variance location wise as/the method described by Panse and Sukhatme (1985). The phenotypic and genotypic correlation coefficient were elaborated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

In all environments, seed yield/plant has a significant and positive correlation with days to 50% flowering, number of seed/capitulum, days to maturity, seed yield/plot and test weight. In other correlation studies it is observed that, days to 50% flowering had positive correlation with days to maturity, seed yield/plot, rosette period and oil content in E2 and E3 environment, whereas, in E1 and E4 environment similar trend were not observed but had positive correlation with number of seed/capitulum, seed volume weight, seed yield/plot in E1 environment and days to maturity in E4 environment. Days to maturity had positive correlation with days to rosette period, seed yield/plot, capitula/plant in E2 and E3 environment, whereas, E1 environment was positively correlated with oil content, seed volume weight and seed yield/plot.

The present results of significant positive correlation between yield and yield contributing characters such as days to maturity, primary branches/plant, plant height, number of capitula/plant, number of seeds/capitulum, test weight and hull content are in agreement with the findings Purkaystha and Srivastava (2020). These characters are showing significant positive correlation with yield, it indicated that direct selection of genotypes for crop improvement on the basis of component trials.

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Stability analysis of safflower (*Carthamus tinctorius* L.) genotypes

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ABSTRACT

Among the twelve genotypes of safflower studied analysis of variance revealed significant genotypic differences among all the genotypes for thirteen morphological characters. The genotype PBNS-207 was the highest yielding, followed by PBNS-185 and PBNS-154. Environmental indices indicated that environment E4 (Somnathpur), E2 (Latur), E1 (Parbhani), and E3 were the most favourable (Badnapur). The stability parameters showed that PBNS-185 had the highest seed yield/plant stability.

Keywords: G x E interaction, Safflower, Stability.

Safflower yield is affected by a variety of factors, including location, planting date, air temperature, soil, water availability, and light intensity, particularly during the seedling and flowering stages (Hussain *et al.*, 2016). To create superior cultivars, plant breeders heavily rely on genotype-environment interactions. Interpreting G x E interactions is crucial in safflower breeding efforts for locating superior genotypes under various conditions.The

G x E analysis results also show the genotypes' phenotypic stability in each examined environment (Abdulahi *et al*., 2009).

MATERIALS AND METHODS

The experiment was conducted at four location viz, Parbhani, Latur, Somnathpur and Badnapur during the 2019 *Rabi* season. Nine safflower genotypes viz., PBNS–185, PBNS–200, PBNS–201, PBNS–153, PBNS–154, PBNS–197, PBNS–198, PBNS–207 and PBNS–208 and three check varieties—PBNS-86, PBNS-12, and Sharda were planted at four different locations.The experimental material was evaluated in Randomized Block Design (RBD) with three replications at Parbhani (E1), Latur (E2), Badanapur (E3), and Somanathpur (E4). Observations were recorded on thirteen yield and yield contributing characters. The stability analysis was estimated by using model of Eberhart & Russell (1996).

RESULTS AND DISCUSSION

The analysis of variance for all thirteen characters was significant over different environments. This indicated that material chosen for study is variable and there is scope for further study. Analysis of variances for stability by Eberhart and Russell's (1996), with four environments for various traits showed in Table 1. In terms of days to 50% flowering, plant height, number of seeds/capitulum, days to rosette period, seed yield/plant, and seed yield/plot, it was indicated that E1 (Parbhani) is a favourable environment. Plant height, primary branch count, capitula count, number of seeds/capitulum, days to rosette period, oil content, and hull content are all favourable in environment E2 (Latur). Plant height, the number of primary branches/plant, test weight, hull content, and seed volume weight were all favourable in the E3 (Badnapur) environment. All characters except plant height, the number of primary branches/plant, and seed volume weight were found to be favourable in environment E4 (Somnathpur). The different environmental indices indicate that it is necessary to identify genotype in accordance with environmental indices. The genotype PBNS-207 was the highest yielding, followed by PBNS-185 and PBNS-154. Environmental indices indicated that environment E4 (Somnathpur), E2 (Latur), E1 (Parbhani), and E3 were the most favourable (Badnapur). The stability parameters showed that PBNS-185 had the highest seed yield/plant stability.

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Table 1: Analysis of variance for stability with four environments

Character	Genotype	Environment	Gx E	Env + (G xE)	Env(L)	Gx E (L)	Pooled deviation	Pooled error
Daysto 50%flowering	3.76	202.33**	2.82	19.45**	607.01**	1.25	3.30**	0.26
Daysto maturity	3.09	955.44**	4.02	83.31**	2866.32**	4.30	3.56**	1.27
Plantheight(cm)	17.10*	203.75**	8.34	24.63**	611.27**	12.12	5.92**	1.99
No.ofprimarybranches/plant	0.41	0.59	0.46	0.47	1.77	0.35	0.48**	0.14
Numberof capitula/plant	5.04	316.52**	5.19	31.13**	949.57**	4.57	5.04**	1.51
Numberof seeds/capitulum	7.73	365.87**	5.50	35.53**	1097.63**	7.09	4.31**	1.36
Daystorosetteperiod	2.05	17.88**	1.42	2.79*	53.64**	1.85	1.11**	0.22
Testweight (g)	0.24*	0.12	0.09	0.09	0.36	0.04	0.10**	0.01
OilContent(%)	6.10***	0.52	0.21	0.24	1.56*	0.18	0.21	0.24
Hullcontent(%)	9.83***	3.86*	1.00	1.24	11.59**	0.52	1.13	1.02
Seedvolumeweight(g/lit)	258.34***	12.71	7.03	7.50	38.15*	4.71	7.50	12.79
Seedyield/Plot(g)	11923.53	141607.82**	11936.95	22742.85	424823.46**	4454.38	14371.71**	3391.57
Seedyield/plant(g)	1.58	34.97**	1.53	4.32**	104.92**	1.38	1.47**	0.48

*and**indicates significanceat5and 1percentlevelrespectively.

Genetic diversity analysis in soybean (*Glycine max* L.)

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ABSTRACT

Using Mahalanobis D^2 Statistics, genetic diversity research was carried out on 321 different genotypes of Soybean (*Glycine max* L.) at All India Coordinated Research Project on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. Total 321 genotypes were classified into ten clusters based on D^2 values. Cluster II, cluster VII, cluster VI, cluster V and cluster IX had 74, 15, 9, 3 and 2 genotypes, respectively, whereas, cluster I had the maximum genotypes of 214. One genotype was present in clusters III, IV, VIII and X. Cluster VII (1230.69) had the greatest intra-cluster distance, followed by Cluster VI (1104.13), Cluster II (604.39), Cluster I (478.57), Cluster IX (209.08) and Cluster V (96.3). D^2 Values across the clusters ranged from 128.81 to 15699.76. The maximum inter-cluster distance was noticed between cluster X and cluster III (15699.76); followed by cluster X and cluster V (15568.61); cluster X and cluster VI (12020.02) and cluster X and cluster I (11083.56). Plant height (37.1%), number of pod clusters/plant (28.83%), total number of pods/plant (21.48%) and number of nods/plant (5.95%) contributed the most to diversity. Genotypes included in Cluster X & Cluster III; Cluster X & Cluster V and Cluster X & Cluster VI were identified for diverse source in the hybridization programme for identification of desirable transgressive segregants for important Agronomic traits in soybean.

Keywords: Cluster analysis, D^2 statistics, Intra-cluster distance, Inter-cluster distance, Soybean

Soybean (*Glycine max* L.) is important and well recognized oil and protein containing crop of the world. The area under soybean cultivation is increasing as it is short duration crop and higher productivity compared to other oil seed crop. The area, production and productivity of soybean in India during 2021-22 was recorded as 121.8 lakh ha, 131.2 lakh MT and 1077 kg/ha, respectively. In Maharashtra the area, production and productivity of soybean during 2021-22 was recorded as 46.17 lakh ha, 54.21 lakh MT and 1174 kg/ha, respectively (Sopa, Indore). For creating desirable variability parents should be selected carefully and some biometrical tools can be used. For assessing genetic diversity in germplasm collection, D^2 statistics is used which measures the forces of differentiation at intra and inter cluster levels. Above all, the greatest potential of soybean lies in increasing available food supply for the rapidly increasing population. Precise information on the nature and degree of genetic divergence helps the plant breeder in choosing the diverse parents for hybridization programme. The development of new varieties is mainly governed by the magnitude of genetic variability present in these breeding lines. Therefore, in the present investigation efforts were made to understand the quantum and nature of genetic variability present in a set of 321elite soybean accessions using Mahalanobis D^2 statistics.

MATERIALS AND METHODS

The experiment was conducted using 321germplasm accessions of soybean in augmented design with two replications and single row with 1.5m row length during *kharif* 2021-22 at the experiment field of All India Coordinated Research Project on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The D^2 analysis was carried out for all the nine characters to access genetic divergence using Mahalanobis D^2 statistics (1936). The traits included under study were days to 50% flowering, days to maturity, Plant height, number of nodes/plant, number of branches/plant, number of cluster/plant, number of pod/plant, 100 seed weight and seed yield/row. The genotypes were grouped on the basis of minimum generalized distance using the Tocher's method (Rao, 1952). The 321 genotypes were grouped into clusters with the assumption that the genotypes within cluster have smaller D^2 values among themselves than those from groups belonging to different clusters**.**

RESULT AND DISCUSSION

Based on D^2 statistics and Tocher's methods, the 321 germplasm accessions were grouped into ten clusters with variable number of entries revealing the presence of variable amount of diversity in material. Cluster II, VII, VI, V and IX had 74, 15, 9, 3 and 2 genotypes, respectively. Whereas, cluster I had maximum genotypes of 214. One genotype was present in cluster III, IV, VIII and cluster X. Cluster VII (1230.69) had greatest intra cluster distance, followed by cluster VI (1104.13), cluster II (604.39), cluster I (478.57), cluster IX (209.08) and cluster V (96.3). The maximum inter cluster distance was noticed between cluster X and III (15699.76) followed by cluster X and V (15568.61). Similar results were reported by Shinde *et al*. (2013). The soybean accessions accommodated in cluster X and III, cluster V and X, cluster VI and X showed high divergence may be utilized in future hybridisation programme for development of improved cultivars in soybean.

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Drip irrigation and Fertigation improves yield and water productivity of summer sesame

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ABSTRACT

A field experiment was conducted during summer on sesame (var. *Swetha*) at College Farm, Rajendranagar, Hyderabad with two irrigation levels (0.8 and 1.0 Epan), two fertigaiton levels of 75% and 100% recommended dose Nitrogen and Potassium (RD of N & K) and two dosage schedules (Equal and differential) in Randomized Block Design. The results revealed that the 100% RD of N & K in differential dosages recorded higher yield (1011 kg /ha) at 1.0 Epan and highest water productivity (2.4 kg mm^{-1}) was observed in irrigation at 0.8 Epan with fertigation of 100% RD N&K in differential dosages.

Keywords: Differential dosages, Fertigation, Irrigation, Sesame

Sesame is an important export potential summer oil seed crop grown after turmeric *rabi* groundnut and cowpea and rice fallows. India is the world leader with the maximum (25.8%) production (340 kg /ha) from the largest (29.8%) area (1.8 M ha) and highest (40%) export of sesame in the world. Drip fertigation, an approach for water and nutrient management as the nutrients and water are applied directly into the soil, is the fastest growing segment of micro irrigation in the state of Telangana and it is used on a wide variety of crops with the increasing shortage of water.

MATERIALS AND METHODS

The field experiment was conducted in a randomized block design for two summer seasons of 2017-18 and 2018-19 at the research farm of Water Technology Centre, Professor Jayashankar Telangana State Agriculture University, Hyderabad. The sesame (variety Swetha) crop was grown at 40 cm x 10 cm spacing under in - line drip (16 mm laterals placed at 0.8 m with emitter spacing of 0.4 m, having discharge of 2 LPH). The experiment was conducted in order to know the optimum irrigation and fertigation schedules. The treatments include drip irrigation scheduled at 0.8 and 1.0 Epan and fertigation scheduled at 75 and 100% N and K with Equal and Differential dosages. The recommended dose of fertilizer was 60 and 40 kg N and K_2O /ha. The drip fertigation (Urea and SOP) were scheduled to the crop through venturi at three days interval from 10 days after sowing (DAS) to 70 DAS in 21 splits. The differential N dose was 1.5, 4.5 and 3 kg N /ha (3.26, 9.78 and 6.52 kg urea /ha) and differential K_2O dose was 0.9, 1.8 and 3.0 (1.5, 3.0 and 5.0 kg white MOP or 1.8, 3.6 and 6.0 kg sulphate of potash) was applied during 10 to 30 DAS, 30 to 50 DAS and 50 to 70 DAS. A common dose of 60 kg P_2O_5 was applied to soil as basal dose. The data was subjected to statistical analysis and critical difference (CD) values were used to compare the treatments and drawn valid conclusions.

RESULTS

Summer sesame (var. *Swetha*) grown under drip irrigation recorded significantly higher seed yield with fertigation of 100% recommended dose of (RD) of N & K either in differential dosages as/crop growth stage (1011 kg /ha) or in equal splits (962 kg /ha) with irrigation scheduled at 0.8 or 1.0 Epan over soil application of RD N & K with drip irrigation at 1.0 Epan (882 kg /ha) and furrow irrigation at 1.0 IW/CPE ratio (774 kg /ha).

Soil application of 100% RD N & K with drip irrigation at 1.0 Epan recorded significantly higher sesame seed yield than furrow irrigation at 1.0 IW/CPE. The crop used 425 mm of water under 0.8 Epan and 578 mm under 1.0 Epan. Water productivity was significantly higher with drip irrigation at 0.8 Epan (2.42 kg mm^{-1}) than 1.0 Epan and 100% RD N & K fertigation than 75% RD N & K. This treatment recorded 26.7 % higher seed yield over furrow irrigation along with soil application of fertilizers (773.5 kg /ha) and 13.5 % higher seed yield over drip irrigation with soil application of fertilizers (882 kg /ha)

(Fig. 1). Thus drip irrigation recorded 13.2 % higher yield over furrow irrigation. Mathew and Kunju (1990) reported that the both the water management practices and N levels significantly influenced the seed and stalk yields.

Increase in growth and yield attributes with higher level of nitrogen might be due to the fact that balanced nutrient supply increase the adsorptive power of soil for cation and anion, created a situation favourable for higher uptake of NPK by plant. These absorbed ions are released slowly for the entire growth period resulted in better nutrient availability at active growth of the crop and increases observed in growth parameters. The findings are in close vicinity with the results obtained by Patra (2001). Due to application of sufficient amount of water along with optimum amount of nutrients might have increased physiological processes like cell division and cell expansion which resulted favourable growth conditions (Chauhan *et al.,* 2016).

It could be concluded from these results that sesame grown in summer under 100% RD of N & K in differential dosages at 1.0 Epan recorded higher yield with 425 mm of water applied.

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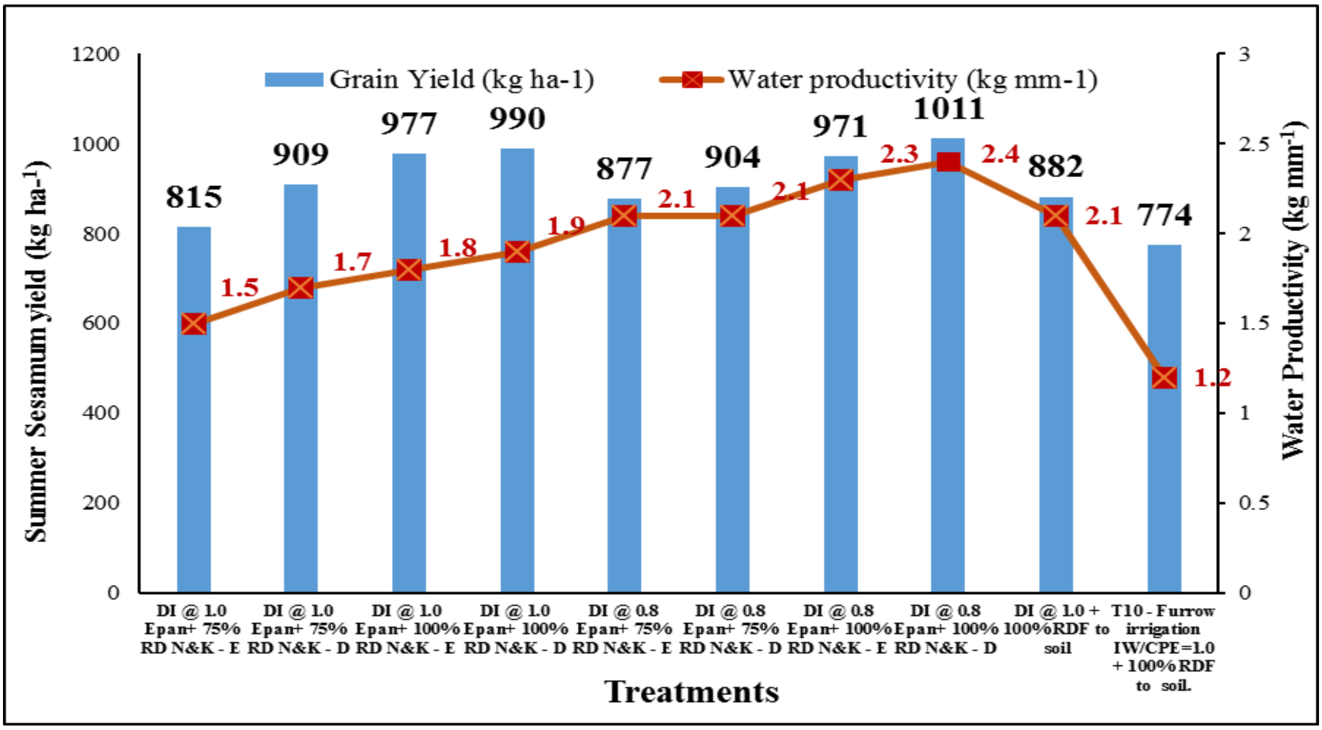

Correlation studies in safflower (*Carthamus tinctorius* L.)

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ABSTRACT

Safflower (*Carthamus tinctorius* L.) is one of the important *rabi* oilseed crops. The productivity/unit area can be achieved by exploiting heterosis or by developing varieties through systematic breeding programme suitable for rainfed as well as irrigated condition. In the present study, the genotypic correlation coefficients were slightly higher than their respective phenotypic correlation coefficient for most of the character. Correlation studies indicated that plant height, days to maturity, number of effective capitulum/plant, test weight and harvest index showed significant and positive correlation with seed yield. Hence, these traits could be considered as important for improving seed yield in safflower. Hence, importance must be given to these characters because they are directly proportional to seed yield.

Keywords: Correlation, Heterosis, Safflower

Safflower (*Carthamus tinctorius* L.) is one of the oldest oilseed crops and is widely grown under the hot and dry climate of the Middle East, the centre of its origin and diversity. Safflower, a multipurpose crop traditionally, this crop was grown for its flowers, fabric dyes, food colouring and for medicinal purposes and oil rich in polyunsaturated fatty acids (linoleic acid 78%). It is necessary to boost up the productivity/unit area by genetic manipulations. This can be achieved by exploiting heterosis or by developing varieties through systematic breeding programme suitable for rainfed as well as irrigated condition. The correlation and path analysis provides information on genetic association of yield and different yield contributing characters, which in turn are useful in developing breeding strategies.

MATERIALS AND METHODS

The present investigation was undertaken during *Rabi* 2017, at Experimental Farm of AICRP on Safflower with 32 genotypes including two checks *viz,* A-1 and PBNS-12. All other recommended packages of practices were followed. Seeds were sown row to row distance of 45cm and plant to plant distance of 20 cm. The observations were recorded on selected five plants for ten yield contributing characters.

RESULTS AND DISCUSSION

Correlation coefficient is an important statistical constant which indicate the degree of association among the various characters. In the present study, the genotypic correlation coefficients were slightly higher than their respective phenotypic correlation coefficient for most of the characters. The present studies revealed that plant height (0.3415), days to maturity (0.4937), number of effective capitulum/plant (0.4575), test weight (0.4065) and harvest index (0.3662) are the characters which showed strong positive correlation with seed yield. These results are also in conformity with those of Shivani and Ch. Sreelakshmi *(*2013). The days to maturity exhibited positive significant correlation with seed yield/plant indicating that they have inherent relationship with each other. Similar findings were quoted by Diwakar *et al.* (2006). It was important to note that the characters, days to maturity and seed yield/plant were positively and strongly associated with each other (p=0.3629, g=0.4937). Hence, these traits could be considered as important traits for improving seed yield in safflower. These results are in conformity with those of Seyed *et al.* (2012). The numbers of seeds/capitulum are positive and significant with oil content. Test weight exhibited strongly positive and significant relation with seed yield/plant.

Correlation studies indicated the importance of the character which is plant height (0.3415), days to maturity (0.4937), number of effective capitulum/plant (0.4575), test weight (0.4065) and harvest index (0.3662). These characters showed significant and positive correlation with seed yield. Hence, these traits could be considered as important for improving seed yield in safflower. Hence, importance must be given to these characters because they are directly proportional to seed yield.

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Table: Genotypic and phenotypic correlation coefficient of yield with yield contributing characters in safflower

Characters		Plant height (cm)	Days to maturity	Days to flowering	No. of effective capitulum	Test Weight (gm)	Harvest Index (%)	Seed Yield/plant (gm)
Plant height(cm)	P	1.0000	0.4158**	0.2466*	-0.1104	-0.0974	-0.1401	0.3871**
	G	1.0000	0.5792**	0.5936**	- 0.3793**	-0.2973*	-0.3460**	0.3415**
Days to maturity	P		1.0000	0.3391**	0.0236	-0.0955	-0.1337	0.3629**
	G		1.0000	0.1950	0.0208	-0.4408**	-0.7991**	0.4937**
Days to flowering	P			1.0000	0.0532	-0.1890	0.0135	0.1576
	G			1.0000	0.0863	-0.5094**	0.0283	0.1479
No. of effective	P				1.0000	0.2327	0.1375	0.3488**
capitulum	G				1.0000	0.4041**	-0.0943	0.4575**
Test Weight	P					1.0000	0.3933**	0.4441**
(gm)	G					1.0000	0.5921**	0.4065**
Harvest Index (%)	P						1.0000	0.3170*
	G						1.0000	0.3662**
Seed Yield/plant (gm)	P							1.0000
	G							1.0000

Evaluation of fungicides against stem rot of groundnut caused by *Sclerotium rolfsii* Sacc under *in vitro* condition

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ABSTRACT

The efficacy of five test fungicides *viz*., carboxin 37.5 % + thiram 37.5 %, tebuconazole 25 % EC, mancozeb 75 %WP, penflufen 13.28 % w/w + trifloxystrobin 13.28 % w/w FS and chlorothalonil 75 % WP were tested under *in vitro* by poisoned food technique against *S. rolfsii* in groundnut. Among five fungicides, penflufen + trifloxystrobin fungicide were found highly effective at all the concentrations (250, 500, 750 and 1000 ppm) tested and inhibited 100.0 % mycelial growth of *S. rolfsii* in groundnut as compared to control.

Keywords: Fungicide, Groundnut, Oilseeds, Pathogen and *S. rolfsii*

Groundnut is the second most important oilseed crop after soybean. India accounts for 27 % of global area and contributes to 19 % of world groundnut production. The crop is known to suffer from several fungal, bacterial and viral diseases. Among many soil borne fungal diseases, stem rot caused by *Sclerotium rolfsii* Sacc is an important soil borne pathogen in several groundnut growing areas and reduces yields to an extent up to 80 %. Therefore, the present study was taken up to evaluate the efficacy of fungicides against *Sclerotium rolfsii* Sacc of groundnut.

MATERIALS AND METHODS

Collection and isolation of pathogen

Diseased / infected stem of groundnut were collected from fields of ICAR-IIOR, Rajendranagar, Hyderabad during the year 2021.

Evaluation of fungicides by poison food technique under *in vitro*

Five fungicides *viz*., carboxin 37.5 % + thiram 37.5 %, tebuconazole 25 % EC, mancozeb 75 % WP, penflufen 13.28 % w/w + trifloxystrobin 13.28 % w/w FS and chlorothalonil 75 % WP at different concentrations *viz*., 250, 500,750 and 1000 ppm were tested against *S. rolfsii* of groundnut were evaluated under *in vitro* conditions by poisoned food technique (Vincent, 1947).

The double strength potato dextrose agar medium (PDA) was prepared by doubling the amount of ingredients except water. This medium (50 ml in 150 ml Erlenmeyer conical flasks) was sterilized and equal amount of water was also sterilized separately in 150 ml Erlenmeyer flasks containing 50 ml distilled water. The test fungicides were dissolved with required concentrations in sterilized water in different sets of Erlenmeyer flasks and then added independently in double strength medium in different sets of flasks, shaken well, subsequently poured separately in Petri plates and were allowed to solidify. The small bits of 5 mm of 5 to 7 days old culture of test fungus by using sterile cork borer were placed with the help of a sterile inoculation needle into the centre of each Petri plate in a laminar air flow under aseptic conditions. Petri plates without test fungicides in the medium served as control and each fungicide were replicated thrice and incubated at 25 ± 2^0C for a period of up to 15 days. The radial growth of mycelium was measured andper cent growth inhibition was calculated by using the formula given by Vincent (1947) asfollows

$$I = \frac{C - T}{C} \times 100$$

Where,
I =per cent inhibition of mycelial growth
C = Radial growth of pathogen in control (mm)
T = Radial growth of pathogen in treatment (mm)

RESULTS AND DISCUSSION

The efficacy of five fungicides were tested under *in vitro* by poisoned food technique and the results were presented in (Table 1). All the fungicides were found effective in inhibiting the mycelial growth of*S. rolfsii* to varying degrees. Significant differences were observed among the fungicides in inhibiting the mycelial growth of the test pathogen. Among five fungicides, penflufen + trifloxystrobin was found highly effective at all the concentrations tested and inhibited 100.0 % mycelial growth of *S. rolfsii* which was followed by carboxin + thiram which inhibited 100.0 % mycelial growth of the test pathogen from 500 ppm concentration onwards. Similarly, chlorothalonil also inhibited 100.0 % mycelial growth of the test pathogen at 1000 ppm concentration. Among the five fungicides tested, mancozeb and tebuconazole were found least effective with 67.6 % and87.4 % inhibition in radial mycelial growth of the test pathogen at 1000 ppm concentration.The current findings were consistent with those of Vineela *et al*. (2017) who reported the sensitivity of *S. rolfsii* to a number of fungicides and reported complete inhibition of the test pathogen (100.0 %) in carboxin + thiram, carbendazim + mancozeb at 0.2 %. Similarly, Vinod (2020) also found that carboxin + thiram inhibited 100.0 % of the mycelial growth of *S. rolfsii* followed by tebuconazole that inhibited 100.0 % at 250 ppm. Similarly, Pawer *et al*. (2021) who reported that tebuconazole and carboxin 37.5% + thiram 37.5% was highly inhibited the mycelial growth of *S. rolfsii* with 94.36 and 94.44 % @ 1000 and 2000 ppm, respectively.

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Table 1. Effect of fungicides on radial mycelial growth inhibition of *S. rolfsii* of groundnut under*in-vitro* conditions

S. No.	Treatments	Per cent mycelial inhibition				
		250 ppm	500 ppm	750 ppm	1000 ppm	Mean
1.	Chlorothalonil 75 % WP	34.3	52.6	61.9	100.0	62.2
2.	Tebuconazole 25 % EC	75.9	82.0	81.5	87.4	81.7
3.	Mancozeb 75 %WP	16.1	20.4	25.9	67.6	32.5
4.	Carboxin 37.5 % + thiram 37.5 % WS	92.6	100.0	100.0	100.0	98.1
5.	Penflufen 13.28 % w/w + Trifloxystrobin 13.28 % w/w FS	100.0	100.0	100.0	100.0	100.0
6.	Control	0.0	0.0	0.0	0.0	0.0
SE(m) ±	Factor(A)			0.599		
	Factor(B)			0.599		
	Factor (A X B)			1.339		
CD (p = 0.05)	Factor(A)			1.706		
	Factor(B)			1.706		
	Factor (A X B)			3.815		

Performance of intercrops in castor-based cropping systems under different tillage practices

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ABSTRACT

Performance of intercrops *viz*., redgram, greengram and groundnut in castor-based cropping systems under different tillage practices were assessed. Redgram (1616 kg /ha) and greengram (595 kg /ha) recorded highest yield in conventional tillage whereas groundnut (958 kg /ha) recorded highest yield in zero tillage.

Keywords: Castor, Intercropping, Reduced and Zero tillage

Intensive tillage practices cause soil degradation, deterioration of soil health through soil erosion and losses of organic carbon. Reduced and zero tillage are some of the best alternative strategies to conserve the soil (Mandal, 2011). Inclusion of short duration legumes as intercrops in castor increases the productivity/unit land area in rainfed areas and intercropping is an alternative strategy to tackle the crop failures in rainfed conditions. (Maitra *et al*., 2019).

MATERIAL AND METHODS

The experiment was conducted in *kharif* 2021-22 at Narkhoda Research farm, ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad. The experiment was laid out in split-plot design with 3 replications on red sandy loam soil (*Alfisols*) under rainfed conditions. Main plot treatments consisted of conventional, reduced and zero tillage and subplot treatments consisted of sole castor, castor + redgram (1:1), castor + greengram (1:3) and castor + groundnut (1:3). In all four cropping systems the spacing for castor followed was 120 cm x 45 cm suited for intercropping systems.

RESULTS AND DISCUSSION

Among the intercrops redgram and greengram registered higher growth, yield attributes and seed yield (1616 and 595 kg /ha) in conventional tillage whereas groundnut recorded highest pod yield (958 kg /ha) in zero tillage. Area time equivalent ratio (ATER) was found highest in castor + redgram (1.21) followed by castor + groundnut (1.02) and lowest was recorded in castor + greengram (0.89). The castor equivalent yield was highest in castor + groundnut (2640 kg /ha) followed by castor + redgram (2389 kg /ha); the castor + greengram (2022 kg /ha) and sole castor (1907 kg /ha) treatments. Among the tillage treatments highest castor equivalent yield was recorded in conventional tillage (2452 kg /ha) and was on par with reduced tillage (2294 kg /ha) while lowest was recorded in zero tillage (1972 kg /ha).

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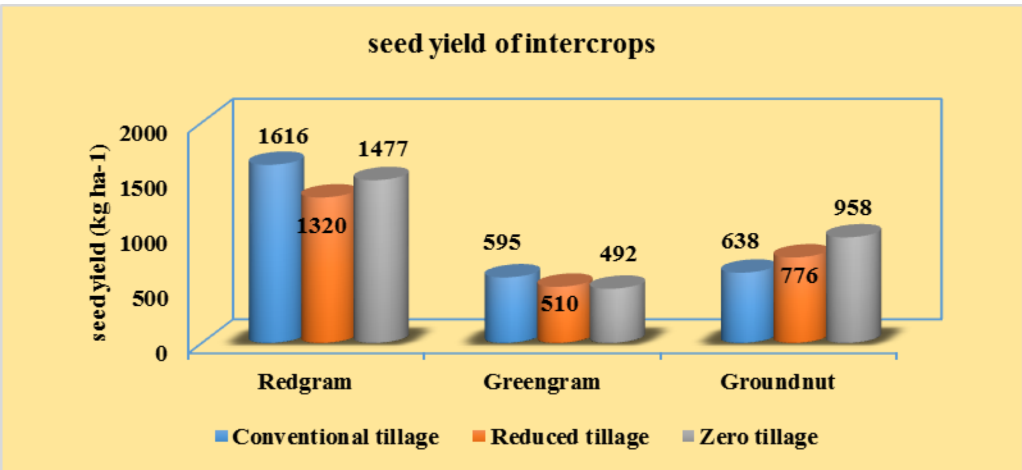
Table 1. Effect of tillage practices and intercropping systems on castor equivalent yield, net returns and B:C ratio.

Treatments	Castor equivalent yield (kg /ha)	Net returns (□ /ha)	B:C ratio
Main plots (M)- Tillage practices			
M_1-Conventional tillage	2452	126934	3.92
M_2-Reduced tillage	2294	119238	3.99
M_3-Zero tillage	1972	101374	3.79
SEm±	142	-	-
CD (P=0.05)	422	-	-
Sub-plots (S)- Intercropping systems			
S_1-Sole Castor	1907	96641	3.50
S_2-Castor + Redgram (1:1)	2389	128220	4.76
S_3-Castor + Greengram (1:3)	2022	101115	3.32
S_4-Castor + Groundnut (1:3)	2640	137419	4.03
SEm±	120	-	-
CD (P=0.05)	356	-	-
Interaction (M x S)			
SEm±	207	-	-
CD (P=0.05)	NS	-	-
Interaction (S x M)			
SEm±	264	-	-
CD (P=0.05)	NS	-	-

Figure 1. Seed yield of intercrops



Cucurbits relay cropping for resource conservation and profit maximization in castor

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ABSTRACT

A field experiment was conducted on sandy loamy soils during *kharif* seasons of 2020-21 and 2021-22 at Tapioca and Castor Research Station, Yethapur, Tamil Nadu to study the effect of Cucurbits relay cropping for resource conservation and profit maximization in castor as well as castor equivalent yield (CEY). The results of Castor-Bitter gourd recorded maximum yield of (9153 kg/ha) followed by Castor-Bottle gourd (7130 kg/ha.). Lowest cucurbits yield was recorded in Castor-Coccinia (3685 kg/ha). Relay cropping treatments significantly influenced CEY. Significantly the highest value of CEY (2472 kg ha) was recorded under Castor-Cucumber, followed by Castor-Bitter gourd recorded 2418 kg/ha.

Keywords: Cucurbits, Castor, Relay cropping

Castor is an important commercial non-edible oilseed crop, which fetches sizable amount of foreign exchange in the country through export. It is a rainfed crop, suitable for contingent crop planning in the rainfed area. However, for intensive cropping in irrigated area, this crop offers a good scope to introduce short duration and quick growing legumes before Castor to get the benefit of vacant field in Kharif season (Prosdocimi *et al.*, 2016). Relay cropping is one of most reliable and applicable practices including a complex suite of different resource-efficient technologies. Through relay cropping land and other resources can be exploited more efficiently. Therefore, it is necessary to evaluate suitability of Cucurbits for relay cropping in castor.

MATERIALS AND METHODS

A field experiment was conducted to study the effect of castor-cucurbits relay cropping on the growth, yield attributing characters and yield of cucurbits and also find out suitable cucurbit crop for higher resource use efficiency, system productivity and monitory returns, on station experimental trials on castor-cucurbits relay cropping system were carried out at Tapioca and Castor Research Station, Tamil Nadu Agricultural University, Yethapur during *Kharif* 2020-21 and 2021-22 season with a recommended spacing of 3x3 m for castor and 2.5 x 2.5 m for cucurbits. Experiments were laid out in RBD with four replications with a net plot size of 180 m^2. In order to accelerate productive branching/plant, unique agronomic practices like nipping was done at 10^{th} node (42 DAS) and subsequently pruning operations were carried out leaving 7 nodes at each primary and secondary branches, soon after harvesting of secondary, third and fourth order spikes. Consequently, cucurbits were sown during summer season in the intra row space of existing castor variety YTP 1. Cucurbits *viz.*, Bitter gourd variety CO1, Ridge gourd variety CO-1, Bottle gourd variety CO-1, Coccinia variety CO 1 and cucumber variety local were included in the relay cropping system as additive series by adopting recommended spacing for cucurbit is 2.5x2.5 m. Irrigation channels with 50 cm width were formed in between two rows of castor (3mx3 m) and seeds of cucurbits were sown on the solder of bunds which is 1.25 m apart from main trunk of castor (YTP 1), by this way cucurbits were sown at 2.5x2.5 m spacing which paved the way for easy intercultural operations for both castor and cucurbits.

RESULTS AND DISCUSSION

Regarding growth and yield attributing characters in YTP 1 castor variety showed that remarkable improvement in productive branches, spike length, capsule number was observed and no significant difference was noticed on test weight, oil content castor yield among base crop castor variety YTP 1. Averted preparatory cultivation charge of Rs. 4275/ ha. Ensure timely sowing of cucurbits and effective resource utilization (water and fertilizer). The results of cucurbits yield are presented in table 1 indicated that, Castor-Bitter gourd recorded maximum yield of (9153 kg /ha) followed by Castor-Bottle gourd (7130 kg/ha.). Lowest cucurbits yield was recorded in Castor-Coccinia (3685 kg/ha). Relay cropping treatments significantly influenced CEY. Significantly the highest value of CEY (2472 kg ha) was recorded under Castor-Cucumber, followed by Castor-Bitter gourd which recorded 2418 kg/ha. Such increase in LER was also reported by Akram *et al.*, (2004) and Dua *et al*., (2007) for different relay cropping system. The results of seed yield of castor are presented in table 1 indicated that, no significant difference was noticed on castor yield among base crop castor variety YTP 1.

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Table1. Effect of castor-cucurbits relay cropping on the growth, yield attributing characters and yield of Castor and Cucurbits Relay cropping System

Treatments	No. Productive Branches/Plant	Spike Length (cm)	No. of capsules/Spike	Shelling %	Castor Yield (Kg/ha)	Cucurbit Yield (Kg/ha)	CEY (kg/ha)
T_1-Castor sole (YTP-1)	12.4	73.2	123.1	65.8	1504	-	-
T_2-Castor sole YRCH 1	13.5	60.1	111.6	61.7	1405	-	-
T_3-Castor-Bitter gourd	14.8	79.6	130.5	68.5	1541	9153	2418
T_4-Castor-Ridge gourd	16.6	86.5	145.2	65.6	1408	5340	2015
T_5-Castor-Snake gourd	14.3	75.2	127.6	66.2	1496	6475	1466
T_6-Castor-Bottle gourd	12.9	68.3	131.3	64.3	1474	7130	1076
T_7-Castor-Coccinia	14.2	69.7	140.4	67.5	1574	3685	556
T_8-Castor-Cucumber	15.4	73.1	124.8	67.2	1519	5240	2472
S.Em.±	0.57	2.86	6.24	2.00	86	342.1	126.0
CD (P=0.05%)	1.24	6.21	13.5	NS	NS	760.5	294.3
CV (%)	13.1	13.7	12.1	11.9	14.8	8.6	10.1

Demonstration on fertigation schedule of oil palm for improved productivity and reduced cost of cultivation in Khammam district of Telangana

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ABSTRACT

The FLD on performance of fertigation schedule in oil palm conducted during the year 2021-22 in Khammam district, on 10 years old plants of selected farmer fields. The result of study revealed that average yield of 26.2 t/ha was recorded in demonstrated plot (T_2) over farmers practice (T_1)(23 t/ha) i.e 13.91 percent yield increased. Average fresh fruit bunch weight, number of bunches/plant and yield/plant in treatment was 21.64 kg, 10.80 and 234.34 kg and whereas in control it was 20.34 kg, 10.00 and 203.90 kg respectively with high B:C ratio in the treatment.

Keywords: Fertigation, Oil palm, Oil yield

Oil palm is highest vegetable oil (4-5 t/ha) producing crop than other oil seed crops. Oil palm is a gross feeder and it requires a balanced and adequate supply of macro and micro nutrients for growth and yield. Farmers facing problem of low productivity of oil palm due to lack of knowledge on nutrient deficiencies, water management etc. To overcome this, FLD on performance of fertigation schedule in oil palm was conducted by KVK, Wyra, Khammam.

MATERIALS AND METHODS

FLDs were conducted at farmers' fields during 2021-22 after studying production constraints of oil palm in Khammam District. Each demonstration was conducted in 0.4 ha area which was taken as demo while an adjacent 0.4 ha as control for comparison of farmer's practice. In demonstration plots (T_2) fertigation schedule imposed which was given by IIOPR, Pedavegi. As/the schedule, 5 kg Urea, 3 kg DAP and 5 kg Murate of potash/month/acre was applied. In case of farmer practice (T_1) application of fertilizers 3-4 splits/year without fertigation. (Caliman, 2009 and Gawankar *et al*., 2018).

RESULTS AND DISCUSSION

The results revealed that 13.91% yield increase was recorded in T_2 over T_1. The details of yield and yield attributes furnished in Table 1. Gross cost, gross income, net income and B:C ratios of demo plots were Rs.78,150, Rs.3,89,520, Rs.3,11,370 and 4.98 whereas in farmers' practice they were Rs. 83,620, Rs.3,66,120, Rs.2,82,500 and 4.38 respectively. Thus as per these results, additional income of Rs. 28,870 was obtained in demo plots.

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Table1: Effect of fertigation schedule on yield and yield attributing traits in oil palm

Parameters	2021-22	
	T_1 (FP)	**T_2 (Demo)**
Average fresh fruit bunch weight (kg)	20.34	21.64
Number of bunches/plant/year	10.00	10.80
Total yield/plant (kg)	203.90	234.34
Yield/ha (t/ha)	23.00	26.20

Blending of linseed oil with edible oil to improve nutritional quality of edible oil blends

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INTRODUCTION

Per capita consumption of edible oils has significantly increased (Yadav et al., 2022). Deficiency of essential omega-3 fatty acid, altered omega-6 to 3 ratio and its impact on human health is well established (Simopoulos, 2002). Majority of the edible oil consumed in India are rich in omega-6 fatty acid, saturated fatty acids and have limited amount of omega-3 fatty acids. In order to improve omega 6:3 ratio, omega-3 fatty acid intake needs to be raised. Blending can effectively improve the omega-3 content and thereby omega-6 to 3 ratio (Joshi et al., 2022). However, maintaining the nutritional quality, long term storage and thermal stability of these blended oils is a major challenge.

MATERIALS AND METHODS

We selected commonly used edible oils such as coconut oil and rice bran oil (base oil) and blended it with linseed oil in 80:20 proportion. Initially oxidative stability assessment and fatty acid profiles were carried out. In storage stability study of oil, effect of various antioxidants such as Ascorbyl Palmitate, Tertiary butyl hydroquinone, α-tocopherol acetate and tri-vitamin E etc. was studied by keeping these oil blend (with/without antioxidants) at room temperature and evaluated for stability over the period of 15 months and primary oxidation parameters and fatty acid profile was estimated at pre-defined time points. Further thermal stability study of blended oil was carried out by placing oil/blends into electric deep fryer and heated to 180 °C for 8 hr continuously and assessed stability of oil/blends and fatty acid degradation.

RESULTS AND DISCUSSION

Blending of linseed oil with coconut oil and rice bran oil in the ratio of 80 (edible oils):20 (linseed oil), was found to improve the ratio of omega-6 to 3 without much alteration in oxidative stability parameters. In storage stability study, the antioxidant, asorbyl palmitate was found to control lipid peroxidation in both the experimental blends effectively (12-15 months). The thermal stability study indicated, blending of linseed oil with rice bran oil was better in controlling the primary and secondary oxidation parameters with marginal alterations in the fatty acid profile as compared to coconut oil blend which showed comparatively more oxidation and significant alterations in fatty acid profile.

Based on this study, we could conclude that linseed oil can be effectively used to improve nutritional quality of edible oil using blending technology with added antioxidants and rice bran oil blend was more superior for blending with linseed oil as compared to coconut oil.

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Management of *Macrophomina* dry root rot of Safflower with different bioagents

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ABSTRACT

Safflower (*Carthamus tinctorius* Linn) is a significant oilseed crop that is grown in more than 60 nations throughout the world. *M. phaseolina* is a facultative parasite and causal agent of seedling blight, root rot and charcoal rot of Safflower. Considerning the harmful effects of chemical fungicides on environment, present investigation was carried out to test seven bioagents *in vitro* for their bio-efficacy in inhibition of the growth of *M. phaseolina*. In dual culture technique, highest per cent inhibition of *M. phaseolina* was exhibited by the bio-agent *Tricoderma harzianum* (88.15%) followed by *Tricoderma virens*and *T. asperellum* which inhibited mycelial growth to an extent of 84.07 and 78.89 per cent, respectively.

Keywords: Bio-agents, Dry root rot, *M. phaseolina*, Safflower

Safflower is a multipurpose crop used for its seeds (oil), flowers and foliage with several different uses. Root rot of safflower although considered disease of minor importance in earlier days, now a days it is causing devastation and huge losses and the causal pathogen *Macrophomina phaseolina* (Tassi) Goid has world-wide distribution. It is major soil-borne disease and appears sporadically all over the country. In some cases, this pathogen kills up to 25per cent of the plants in commercial fields of safflower (Govindappa *et al.* 2011). Considering the advantages of bio-agents, the current research was undertaken to check the bio-efficacy of different bio-agents under *in vitro* conditions against *Macrophomina phaseolina* in safflower.

MATERIAL AND METHODS

The cultures of bio agents were obtained from the Department of Plant Pathology, VNMKV, Parbhani. The antagonistic effect of different bio agents against *Macrophomina phaseolina* under *in vitro* conditions was studied on PDA medium by dual culture technique. Sterilized media was taken in Petri plates and was allowed to solidify. Aseptically under laminar air flow cabinet on those plates 5mm diameter bio agent discs and test pathogen discs were placed at equidistance from centre at opposite ends and in control, only pathogen was inoculated. Experiment was designed in CRD with three replications and eight treatment. Later the area covered by both pathogen and bio agent was measured 4 days after incubation. The per cent inhibitions were calculated by the formula:

$$I = \frac{C-T}{C} \times 100$$

Where,
I = Per cent inhibition over control
C = Radial growth of pathogen in Control (mm)
T = Radial growth of pathogen in treatment (mm)

RESULTS AND DISCUSSION

When the test pathogen was treated with different bio-agents in dual culture technique they showed different range of per cent mycelial growth inhibition and mycelial growth (in mm). The results so obtained are depicted in Table 1.

Mycelial growth: The radial mycelial growth of the pathogen in dual culture ranged from 10.67 mm (*Trichoderma harzianum*) to 44.00mm (*Paecilomyces lilacinum*). The least mycelial growth was observed in case of the dual culture with *Trichoderma harzianum* which was most effective and showed superiority, and was significantly against control and other bio-agents. It was followed by *Trichoderma virens* which allowed mycelial growth of 14.33 mm, *Trichoderma asperellum* (19.00 mm), *Metarhizium anisopliae* (21.67 mm), *Aspergillus niger* (27.33 mm), *Verticillium lecanii* (42.67 mm) and the bio-agent which allowed maximum mycelial growth of the pathogen with least inhibition was *Paecilomyces lilacinum* (44.00 mm) which was on par with *Verticillium lecanii.*

Per cent inhibition: The per cent inhibition of the mycelial growth of the pathogen *M. phaseolina* varied between 51.11 per cent (*Paecilomyces lilacinum*) to 88.15 per cent (*Trichoderma harzianum*). The highest per cent inhibition was exhibited by the bio-agent *Trichoderma harzianum* which was 88.15 per cent and it was significantly superior over control and other bio-agents. This treatment was followed by *Trichoderma virens* which inhibited the mycelial growth to an extent of 84.07 per cent, *Trichoderma asperellum* (78.89%), *Metarhizium anisopliae* (75.93%), *Aspergillus niger* (69.63%), *Verticillium lecanii* (52.59) and the bio-agent which showed least inhibition was *Paecilomyces lilacinum* (51.11%) which was on par with *Verticillium lecanii.*

The above results are similar to those reported in the past. Suryawanshi *et al* (2014) reported that *Trichoderma* *viridae* as most effective bio agent against *M. phaselina* with 77.30 per cent inhibition and it was followed by *T. harzianum* with 75.30 per cent inhibition. Sathpathi and Gohel (2018) evaluated bio agents against *M. phaselina* causing roor rot of Sesame and concluded that *T. harzianum, T. asperellum* and *T. viridae* were effective in inhibiting mycelial growth. Gholve *et al* (2020) showed *T. harzianum* and *T. viridae* as effective bio agents with mycelial inhibition of 77.07 per cent and 80.00 per cent respectively against *M. phaselina* causing root rot of safflower. Kishanawat *et al* (2021) observed maximum mycelial growth inhibition in case of *T. harzianum* (70.67%) followed by *T. viride* (63.25%) when treated against *M. phaseolina* causing root rot of safflower.

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Table 1: In vitro bio-efficacy of different bio-agents against mycelial growth and inhibition of Macrophomina phaseolina

Tr. No.	Treatments	Radial mycelial growth *(mm) at conc.	% inhibition at ppm
T_1	*Trichoderma asperellum*	19.00	78.89 (62.63)
T_2	*Trichoderma harzianum*	10.67	88.15 (69.87)
T_3	*Trichoderma virens*	14.33	84.07 (66.49)
T_4	*Metarhizium anisopliae*	21.67	75.93 (60.60)
T_5	*Aspergillus niger*	27.33	69.63 (56.54)
T_6	*Verticillium lecanii*	42.67	52.59 (46.47)
T_7	*Paecilomyces lilacinum*	44.00	51.11 (45.62)
T_8	Control	90.00	0.00 (0.00)
SE(m)±		0.76	0.84
C. D.(P=0.01)		2.28	2.54

*- Mean of three replications, the figures in parenthesis are arc sine transformed values

Valorization of castor oil-derived fatty acids for new bioactive compounds via chemo-enzymatic reactions

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ABSTRACT

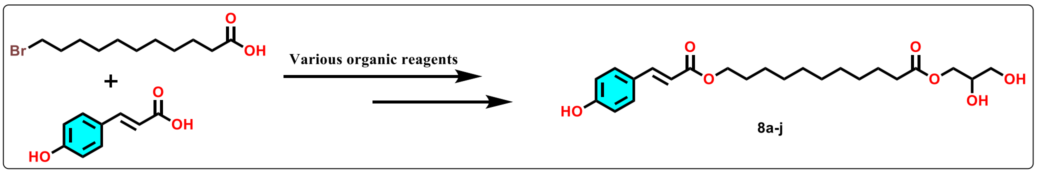
Novel lipidic compounds were prepared from 10-Undecenoic (UDA) and 11-bromoundecanoic acids (BUA) which are well known castor derived fatty acids. Ten novel structured monoacylglycerol (MAG)-based phenolic lipids were prepared from 11-bromoundecanoic acid by chemo-enzymatic approach and 20 new triazole based UDA hybrids were synthesized by Click chemical synthesis. The synthesized compounds were characterized by spectra analysis and studied for their antioxidant, antimicrobial and cytotoxic activities.

Keywords: Bioactive, Castor, Hybrids, Valorization

Oleochemicals, regarded as renewable resources with a variety of applications are the most practical alternatives to non-renewable petrochemicals. Vegetable oils are the potential source for the production of oleochemicals with castor oil being the major non-edible vegetable oil that is exploited for the generation of numerous platform chemicals. However, castor oil is still under-utilized for biological applications and provides a promising scope due to its biocompatible nature. With a view to add more value to castor based derivatives, we attempted to study new chemical entities from BUA and UDA. We aimed at the preparation of new MAGs containing phenolic acids from BUA based on a natural product [Cong Y *et al.*, 2013]. In another aspect, we employed UDA which is known for its antibiotic potential for the generation of heterocyclic-UDA hybrids [Sammaiah A *et al.*, 2015].

MATERIALS & METHODS

A 6 step synthetic route was designed employing BUA as starting material and different organic reagents to synthesize novel structured monoacylglycerol (MAG)-based phenolic lipids.



Scheme 1: Synthetic route for structured phenolic MAG with *p*-coumaric acid.

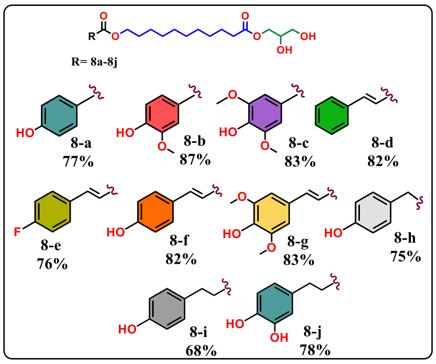
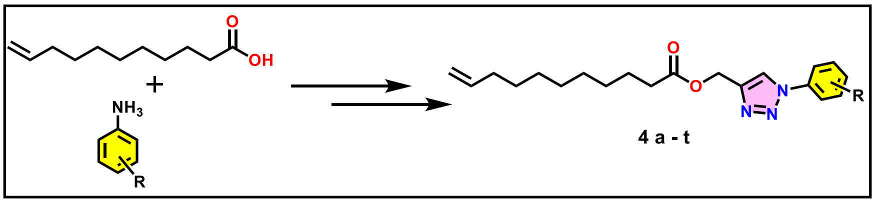


Figure 1: Structures of the synthesized structured phenolic MAG derivatives.

A 3 step synthetic route was designed employing UDA as a starting material for the synthesis of UDA based triazoles.



Scheme 2: Synthesis of UDA based triazoles.

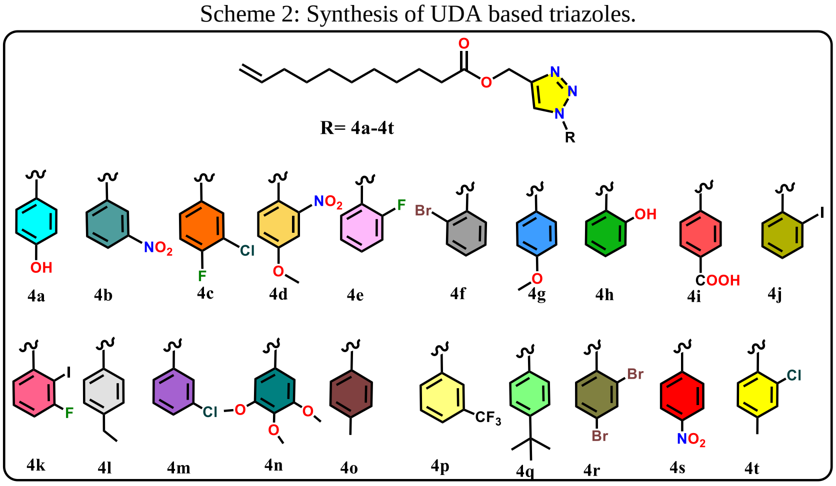


Figure 2. Structures of the UDA based triazoles.

RESULTS AND DISCUSSION

MAGs: The antioxidant activity was evaluated by DPPH and TBARS assays where it was observed that **8g** exhibited the highest radical scavenging activity in both assays followed by **8j** and **8f** derivatives. It was observed that the phenolic lipids with benzoic acid derivatives exhibited lower antioxidant activity compared to the cinnamic acid derivatives. In the antimicrobial assay, it was observed that only the **8f** derivative exhibited antimicrobial activity against all the organisms. In cytotoxicity studies, the **8g** derivative showed the highest activity followed by the **8f** derivative the on DU-145 cancer cell line.

Triazole-lipids: The antibacterial and antifungal activity of the lipidic triazoles was studied on two plant pathogens namely *Ralstonia solanacearum* and *Fusarium oxysporum*. The antibacterial investigation revealed that UDA-triazole hybrid **4j** displayed excellent activity followed by **4k, 4t** and **4a** analogs. In the antifungal study, it was found that compounds **4q** and **4e** showed the highest growth inhibition.

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Evaluation of DNA extraction methods for molecular traceability in cold pressed, solvent extracted and refined groundnut oils

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ABSTRACT

Groundnut oil (GNO)/ peanut oil is one of the agro-food products with great economic value and hence an attractive target for adulteration and mislabeling. Simple Sequence Repeats (SSR) are markers of choice for DNA fingerprinting studies as they exhibit high polymorphism due to variable number of repeats. Hence, this study was designed to evaluate and optimized a method for DNA isolation from groundnut oil and study the possibility of using the isolated DNA for molecular traceability using SSR markers. Four methods to isolate DNA from groundnut oil were evaluated. All the four methods were modified CTAB protocols, but differed in procedures forextraction, buffer compositions, amount of oil used and DNA carriers. For molecular traceability of oils, extraction and recovery of DNA from edible oil is a key step, especially in refined oils. A method that employed DNA enrichment prior to extraction with CTAB buffer yielded amplifiable DNA from cold pressed GNO, crude hexaneextracted GNO and refined GNO. The optimized method for isolation of DNA from groundnut oil is simple, efficient, less costly and reproducible when compared to chromatography and spectroscopy based techniques.

Keywords: - DNA extraction, Food adulteration, Finger printing, Groundnut oil, SSR markers

Peanut (Groundnut) oil is derived from Arachis hypogaea, a legume that is rich in proteins, vitamins, phytochemicals, antioxidants, polyphenols, mono and polyunsaturated fats (Carr´ın and Carelli, 2010; List, 2016). Peanut (Groundnut) contains approximately 50 per cent oil which is compara- bly higher than other vegetable oil sources. Among the Asian countries, India and China are the major producers, and majority of peanut produced across the globe is utilized for oil extraction (Arya et al., 2016; Devasena et al., 2017). Groundnut oil is expensive than sunflower oil, palmolein oil and rice bran oil, and is consumed largely due to its nutty flavor. Ever increasing demand for edible oils has resulted in adulteration with cheap, unhealthy, or synthetic oils (Dorni et al,. 2018; Yang et al., 2018). Food fraud and adulteration have become serious social and economic issues worldwide and it poses a serious threat to the con- sumer interests and health. The conventional methods based on physical, chemical and spectroscopy do not pro- vide reliable results for oil traceability to specific cultivar. Hence the need to develop traceability protocols that verify the authenticity of agro-food products to protect both consumer rights and avoid health threats.

DNA-based methods have been widely applied for the detection of adulteration and identification of components in food, due to their fastness, simplicity, sensibility, relia- bility and specificity (Costa et al. 2012; Gomez et al. 2008; Wu et al. 2011). DNA-based methods are not only suit- able for food analysis but can also be used for species or varietal identification as they are stable across environ- ments in food chain (Costa et al. 2012; Gime´nez et al. 2010). Costa et al (2012), Gryson et al

(2002) and Muz- zalupo et al (2015) also reported about difficulties in obtaining amplifiable DNA from vegetable oils, as they are refined to avoid high acidity levels and improve organoleptic characters prior to consumption. The process of refining involves harsh heat treatments, usage of acti- vated clays and alterations in pH which affect the integrity of DNA (Gryson et al. 2002; Nemat et al. 2017), which inturn poses a challenge to acquire intact DNA for amplification.

The availability of even traces of intact DNA from a reliable DNA extraction method is enough for identifica- tion at genome level. Previous reports by Costa et al (2012); Gomez et al (2008); Ramos-Gomez et al. (2014), have proved the feasibility of recovering DNA from oils such as olive (Olea europea), sunflower (Helianthus annuus) and palm (Elaeis guineensis) oil, soybean (Glycine max), canola (Brassica napus) and maize (Zea mays) for conducting PCR-based experiments. Among the DNA based methods for molecular traceability, PCR has been the most popular and widely used technique. However, very few studies were carried out in groundnut oil extracted by various methods for molecular traceability. DNA isolation efficiency from oils is the most critical aspect of DNA based detection method. The rapid development of oil processing and refining technology brings new challenges for adulteration detection in vegetable oils (Li et al. 2018). The selection and choice of a suitable marker system is very important for authentication and varietal traceability in edible oils. Since SSRs have a high discrimination power, they are the most employed markers (Herrero et al. 2010). In the near future, it may be mandatory to establish edible oil authenticity and detect possible adulterations through DNA-based markers; hence development of DNA extraction procedure is the first step towards the work. Under this scenario the present work aims at comparing various methods of DNA recovery from groundnut oil extracted from three methods, as a show case for the application of DNA markers in food safety and traceability.

MATERIALS AND METHODS

Three different oils were used in the study. Cold pressed oil extracted by mechanical extraction, solvent extracted crude oil and refined commercial oil were selected, to study if there is difference in the DNA obtained from groundnut oils extracted by various means. Procurement of raw materials: Groundnut variety Kadiri 6 (50 Kgs) was procured from Regional Agricultural Research Station, Palem, Professor Jayashankar Telangana State Agricultural University, Nagarkurnool District, Telangana, India and Agricultural Research Station, Kadiri, Acharya N G Ranga Agricultural University, Ananthapur District, Andhra Pradesh, India. The seed was pre-dried overnight at 40 °C. Oil was extracted by two procedures— Mechanical Extraction and conventional solvent extraction. Mechanical Extraction, was carried out using a table oil expeller (SP Engineering Corporation, Kanpur, India), where, the seeds were placed between barriers thereby forcing oil out of the seeds. The oil obtained was cold pressed oil. Solvent extraction was carried out with hexane as a solvent for oil extraction. Refined groundnut oil, which has undergone solvent extraction, neutralization, bleaching and deodorization was sourced from Telangana State Oil Packaging Station in Shivarampally, Hyderabad, India. All the three oil samples were stored in dark glass bottles at room temperature and used for the DNA extraction pro- cedure within a month. Kadiri 6 groundnut seeds were also sown in controlled conditions at MFPI—Quality Control Laboratory, and the leaf tissue was used for DNA extrac- tion which served as a positive control for PCR.

DNA Extraction from groundnut leaf Genomic DNA was isolated from groundnut leaf tissue using the modified CTAB method from Doyle and Doyle (1990).

DNA Extraction from oil Three groundnut oils (GNO)— cold pressed ground nut oil (CPGNO), hexane extracted crude groundnut oil (HCGNO) and commercially available refined groundnut oil (CRGNO) were used for DNA extraction. Four different methods were adapted with modifications (M1, M2, M3 and M4), which were per- formed on all the three oil samples.

M1 Method 1 is a modified CTAB method adopted from Ramos-Gomez et al. (2014) with modifications in the volume of oil and lysis buffer used. Lysis was carried out by addition of 12 ml pre-warmed lysis buffer [2 %(w/v) CTAB, 1.4 M NaCl, 50 mM DTT, 20 mM EDTA, 100 mM Tris–HCl, pH 8.0, 2% (v/v) Tween-20 & 20 lg Proteinase K] and 10 ml hexane to 12 ml groundnut oil. The contents were incubated at 65°C for 15 min and Chloroform: Isoamylalcohol [12 ml of (24:1)] extraction was carried out at 4°C. The upper aqueous phase was subjected to overnight precipitation with equal volume of isopropanol at - 20°C. The contents were centrifuged at 12,000 9 g for 30 min at 4°C. The DNA pellet was washed with 300 ll 70% ethanol and resuspended in 30–50 ll of TE (10 mM Tris & 1 mM EDTA), and stored at - 20ºC until further use.

M2 Modified method was adapted from Busconi et al (2003). Oil samples (50 ml) were transferred to 50 ml tube and centrifuged at 12,000 9 g for 15 min at4°C. The wet pellet was transferred to a 2 ml microcentrifuge tube and centrifuged at 12,000 9 g for 15 min at 4°C. The pellet was frozen in liquid nitrogen and thawed at 65°C. The freeze–thaw procedure was repeated twice. The pellet was re-suspended vigorously (without vortexing) in 750 ll of 10X CTAB extraction buffer (10% (w/v) CTAB, 75 mM Tris–HCl pH 8.0, 15 mM EDTA pH 8.0, 1 M NaCl, 1% (v/v) b-mercaptoethanol) and incubated at 65°C for 90 min with occasional mixing. Chloroform:octanol [750 llof 24:1] extraction was carried out twice at 21,000 9 g for 10 min at room temperature. 75 ll of 10% CTAB was added to the supernatant, mixed for 5 min followed by addition of 1.5 volumes of CTAB precipitation buffer (1% w/v CTAB, 50 mM Tris–HCl pH 8.0, 10 mM EDTA pH 8.0). The contents were mixed by inversion for 10 min and centrifugation was carried out at 12,000 9 g for 20 min at room temperature. The supernatant was discarded and DNA pellet was washed with 70% ethanol and dissolved in TE buffer, and stored at - 208C until further use.

M3 The DNA from all the three GNOs was extracted using 17 ml of chloroform/ hexane (as organic reagent) with slight modifications (He et al. 2013). 17 ml oil was transferred to a 50 ml glass bottle and 17 ml chloroform/ hexane was added. The contents were mixed thoroughly for 3 h on a magnetic stirrer. 14 ml of CTAB buffer (5% CTAB, 0.8 M NaCl, 50 mM Tris–HCl, 1 mM EDTA) was added, mixed thoroughly for another 3 h. The contents were transferred to 50 ml tube and centrifuged at 12,000 9 g for 10 min at room temperature. The aqueous phase was transferred to a new tube and centrifuged again at 12,000 9 g for 10 min. The DNA was precipitated from the aqueous phase with equal volume of isopropanol, 1/10thvolume of 3 M sodium acetate (pH 5.2) and 1/1000 volume of glycogen as carrier. The contents were incubated at - 80°C for 2 h. The sample was aliquoted into 1.5 ml tubes and centrifuged at 21,000 9 g for 30 min at 4°C. The DNA pellet was washed using 70% ethanol and dissolved in 30 ll of TE buffer, and stored at - 208C until further use.

M4 As M1, M2 and M3 methods resulted in the recovery of minute amount of DNA, a protocol based on DNA enrichment method reported by Cheng et al (2018) was used. The DNA enrichment was carried out by adding 1 ml oil to 500 ll TE buffer (10 mM Tris–HCl, (pH 8.0), 1 mM EDTA (pH 8.0) in a 2 ml tube followed by centrifugation at 21,000 9 g for 5 min. The supernatant oil was removed and 1 ml groundnut oil was again added into the same tube. The above process was repeated 35 times to enrich DNA from 35 ml groundnut oil into 500 ll TE buffer, which took 3 h for enrichment. After DNA enrichment, a modi- fied CTAB method was adapted. 500 ll CTAB extraction buffer (2% CTAB, 0.1 M Tris–HCl (pH 8.0), 20 mM EDTA (pH 8.0), 1.4 M NaCl, 0.2% b-Mercaptoethanol) was added to DNA-enriched sample. The contents were mixed and incubated in a water bath at 65°C for 60 min with gentle shaking for every 10 min. An equal volume (1000 ll) of chloroform/isoamyl alcohol (24:1) was added, and centrifuged at 21,000 9 g for 15 min. The extraction was repeated twice to eliminate impurities. The supernatant was collected and precipitated with cold isopropanol and 1/10thvolume of glycogen. The contents were incubated at -80°C for 1 h, followed by centrifugation at 21,000 9 g for 20 min. The supernatant was discarded and the DNA pellet was washed twice with 300 ll of 70% ethanol. The DNA pellet was air dried and dissolved in TE buffer.

Quantification and quality of DNA: Genomic DNA obtained from four methods was analyzed on 0.8% agarose gel and quantified using Nanodrop 1000 spectrophotometer (Thermo Fisher Scientific, Waltham, MA, USA). The purity and quality of the extracted DNA was determined by the ratio of the absorbance at 260 and 280 nm (A260/280) and 260/230 nm.

PCR amplification: The PCR was performed in 10 ll total volume including template DNA 5.0 ll Emerald Amp GT PCR (PCR buf- fer ? dNTPs ? Taq polymerase), 0.5 ll of each reverse and forward primer (2.5 pmol/ll) in automated thermo cycler (Eppendorf, Germany). The amplification program consisted of initial denaturation at 94°C for 5 min and 35 cycles of denaturation at 94°C for 1 min, annealing at 56–60°C for 40 sec, extension at 72°C for 30 sec. Final extension was carried out at 72°C for 7 min. The PCR products were detected on 1.5% agarose gel and visualized using gel documentation system. DNA extraction from GNO oil was repeated thrice. Mean and standard deviation was calculated for the data obtained from DNA concentration and purity. Values were then expressed as Mean ± SD.

RESULTS AND DISCUSSION

DNA extraction from groundnut oil: The application of biotechnological tools based on DNA analysis for food authentication gained a surging interest (Mafra et al. 2008) because of advantages such as high stability of DNA molecules compared to other compounds such as proteins/fatty acids profiling. Molecular traceability based on DNA markers for assessment of the authenticity of virgin olive oils has been emphasised earlier (Con- solandi et al. 2008; Doveri and Lee 2007; Gimenez et al. 2010; Muzzalupo et al. 2007). However no study has been carried out to identify the most suitable DNA isolation method for oil extracted by various methods.

In this study, we made an attempt to isolate genomic DNA from groundnut oil using four extraction methods that were reported earlier in various oils (Busconi et al. 2003; Cheng et al. 2018; He et al. 2013; Ramos-Gomez et al. 2014). All the extraction methods used in this study are based on CTAB lysis buffer as described by Doyle and Doyle (1990). Different GNO oils (HCGNO, CPGNO & CRGNO) were chosen based on the extraction and oil processing methods. Groundnut specific SSR markers associated with genetic mapping for foliar disease resis- tance {GM1573 (300 bp), GM1009 (400 bp), GM2301 (150 bp), PM3 (200 bp), PM137 (200 bp) and Seq5Do5 (300 bp)} Reported in earlier studies were employed for molecular traceability (Shoba et al. 2012; Sujay et al. 2012).

DNA extraction was carried out following M1 protocol advocated for olive, sunflower and palm oils (Ramos- Gomez et al. 2014). A minimum of 0.5 ml and maximum of 5 ml oil was used for DNA isolation, as described in the procedure. Genomic DNA could not be visualized on agarose gel although nanodrop reading was around 70 ng/ ll. Earlier studies emphasized the importance of increased starting material in order to obtain amplifiable DNA from plant oil samples (Costa et al. 2012). To dismiss the pos- sibility that small amount of starting sample did not result in extractable DNA, 12 ml of oil was used for extraction. DNA was visible as a smear on the agarose gel. However, the ratio of A260/280 was less than 1.8, (Table 1) indicating the presence of compounds co-extracted with the DNA. To check for minute traces of DNA and its suitability for PCR amplification, PCR reaction was carried out using groundnut SSR markers. Failure of amplification in PCR further confirmed the presence of PCR inhibitors in the DNA samples isolated from HCGNO, CPGNO and CRGNO. The M1 method standardized for olive, sunflower and palm oil, could not be validated in groundnut oils.

M2 protocol developed by Busconi et al (2003) for olive oil, was adopted for DNA extraction from GNO. 50 ml of GNO's were used as starting material for DNA extraction. Genomic DNA was visible as a smear on the agarose gel in CRGNO, while DNA isolated from CPGNO and HCGNO could not be visualized, indicating that method of oil extraction also plays an important role in DNA isolation. The absorbance ratios of A260/A280 were \ 1.8 (Table 1) indicating low purity of the extracted DNA. Amplification with SSR markers failed with the DNA extracted using M2 protocol, which may be attributed to either poor quality DNA from HCGNO and CPGNO, or due to the presence of PCR inhibitors in CRGNO. This method was used for identification of olive cultivar based on DNA isolated from oil using both RAPD and AFLP marker systems.

M3 protocol reported by He et al (2013) was adopted using two types of organic reagents (Hexane and Chloro- form) and a carrier (Glycogen). The protocol resulted in very faint bands of genomic DNA on the agarose gel in all the three types of groundnut oil, where hexane was used as an organic reagent. The DNA isolated using chloroform as organic reagent could not be detected on agarose gel. Although intact, but faint DNA was visualized on agarose gel, when hexane was used as organic reagent, PCR did not result in amplification which might be due to the presence of inhibitors in the DNA. The A260/A280 ratio (Table 1) was suboptimal (\ 1.8) for M1, M2 and M3 methods indicating poor quality of extracted DNA, which might be due to the presence of residual reagents/PCR inhibitors associated with the extraction protocol.

M4 protocol based on the principle of DNA enrichment in TE buffer resulted in faint but intact DNA along with large chunk of degraded DNA in HCGNO (Fig. 1). How- ever, DNA could not be visualized in the CRGNO. A large amount of degraded DNA was present in both CPGNO and HCGNO in the size range of 200–1000 bp. The ratio of absorbance at 260/280 was optimum in the case of CPGNO and HCGNO indicating very good quality of extracted DNA when compared with CRGNO. However, PCR amplification using SSR markers resulted in faint amplifi- cation in CRGNO compared to CPGNO and HCGNO owing to difference in the amount of extracted DNA.

Even with a lower ratio of A260/A280, amplification was possible supporting earlier reports on absence of cor- relation between purity of the DNA and its ability to amplify during PCR (Costa et al. 2010). Amplification using SSR markers was observed in all the three types of oil (Figs. 2, 3, 4), but it was faint in the case of CRGNO which may be attributed to recovery of less DNA. DNA recovery was very high in both HCGNO (579.8 ± 0.02 ng/ll) and CPGNO (491.0 ± 0.02 ng/ll), while it was very low in CRGNO (8.9 ± 0.01 ng/ll) and could not be visualized on the agarose gel. The low DNA concentration (8.9 ± 0.01 ng/ll)) and purity from CRGNO oil may be due to the refining process of the GNO. Exposure of GNO to heat and pH variations can degrade the DNA. Earlier reports laid emphasis on the fact that detection limit of DNA extracted from food matrices is generally influenced by the presence of inhibitory sub- stances, extent of DNA damage and average fragment length of nucleic acid (Gryson et al. 2002). DNA amplifi- cation was possible only for very small PCR products of approx 100 bp in refined soybean oil (Costa et al. 2010), while it was 150 bp for crude soybean oil (Nikolic et al. 2014). However results of our study indicated that PCR amplification to the extent of 400 bp has been possible in the case of genomic DNA isolated using M4 protocol.

Method 4 with DNA enrichment process was robust and suitable with CRGNO, HCGNO and CPGNO. This method of genomic DNA extraction can be validated for other vegetable oils. The extracted DNA was amplified with five SSR markers which further confirms the suitability of the extraction protocol for molecular traceability. The stan- dardized methodology was immensely reproducible as the DNA was obtained from all the three different groundnut oils tested—cold pressed oil or refined oil or crude oil, regardless of the oil extraction /processing procedure used.

Table1DNAconcentrationandpurityfromthegroundnutoilextractsobtainedwithM1,M2M3andM4

	HCGNO(ng/ll)	A260/280	CPGNO(ng/ll)	A260/280	CRGNO(ng/ll)	A260/280
Method1	72.2±0.08	1.29±0.01	88.9±0.02	1.44±0.02	57.0±0.02	1.13±0.02
Method2	239.1±0.06	1.46±0.02	123.9±0.02	1.35±0.02	10.1±0.03	0.62±0.02
Method3	34.1±0.05	1.39±0.01	27.2±0.03	1.01±0.05	17.5±0.01	0.84±0.01
Method4	579.8±0.02	1.8±0.01	491.0±0.02	1.90±0.01	8.9±0.01	1.12±0.01

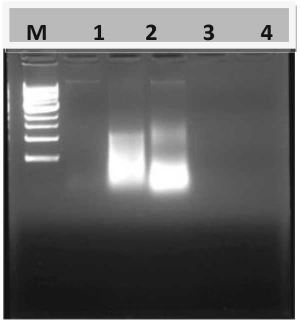

Fig. 1Agarose gel electrophoresis of genomic DNA visualized withethidiumbromide(M4).M-1 kbladder;Lane1:positivecontrol(groundnut leaf); Lane 2: CPGNO; Lane 3: HCGNO and Lanes 4–5:CRGNO

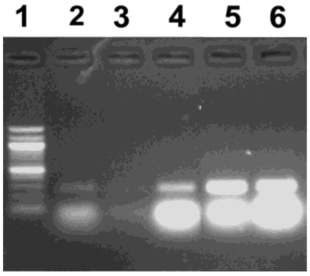

Fig.2AgarosegelelectrophoresisofPCRproductsusingDNAextracted from GNO oils using the primer GM1573. Lane 1: (100 bpladder); Lane 2:positive control(Groundnut leafDNA); Lane 3:CRGNO;Lane4:HCGNOandLanes5–6:CPGNO

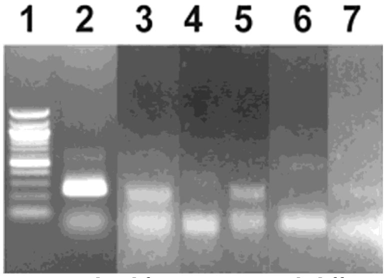

Fig. 3Agarose gel image of PCR productsobtained using DNAisolated from CRGNO with different SSR primers. Lane 1: 100 bpladder); Lane 2: positive control (groundnut leaf); Lane 3: PrimerGM1573;Lane4:GM1009;Lane5:GM2301;Lane6:PM137andLane7:Seq5Do5

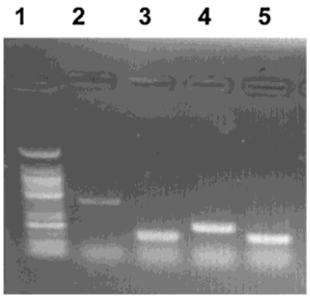

Fig. 4Agarose gel of PCR products (DNA from CPGNO) using 4SSRprimers.Lane1:(50bpladder);Lane2:GM1009;Lane3:GM2301;Lane4:PM137andLane5:PM137

CONCLUSION

The efficiency of isolating good quality DNA plays a very important role in the molecular traceability from edible oils like groundnut oil. Because of the diversity of edible oil extraction and processing procedures, two serious prob- lems like presence of trace DNA in oils and DNA degra- dation have to be dealt with careful DNA extraction methods to ensure optimum and good quality DNA. Con- sequently, the selection and optimization of DNA extrac- tion methods are crucial for the successful application of DNA-based techniques to different edible oils. DNA enrichment method was the most suitable method to extract optimum DNA from all the three groundnut oils, irre- spective of their extraction procedure or refining processes. The protocol was also effective, reliable, and reproducible, leading to optimum yield of DNA in unrefined oils, and a reasonably good amount of amplifiable DNA from refined oil. Different DNA markers/gene specific primers can be used for molecular traceability based on PCR. SSR markers employed in the study have an added advantage of varietal identification/ DNA fingerprinting.

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Effect of *in-situ* moisture conservation practices on yield and economics of sunflower and pigeonpea intercropping in *Vertisols* of Northern Karnataka

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ABSTRACT

Field experiments were conducted during *Kharif* 2020 and 2021 to study the effect of *in-situ* moisture conservation practices on yield and economics of sunflower and pigeonpea intercropping in *Vertisols* of Northern Karnataka. Treatments consisted of broad bed and furrow, ridges and furrow, tied ridging, conservation tillage, flatbed and opening furrow after every three rows at 30 DAS compared with flatbed sowing as main plots. Treatments in sub plots were sunflower + pigeonpea (1:1), sole pigeonpea and sunflower. Results showed that significantly higher yield and yield attributes of sunflower and pigeonpea were recorded in ridges and furrows followed by tied ridges and furrow. Yield of both the crops were significantly more in respective sole crops over the intercropping. Higher SEY, LER, net return and BC ratio were noticed in ridges and furrow under intercropping.

Keywords: Economics, Intercropping, Moisture, Pigeonpea, Sunflower, Vertisols

Sunflower is highly sensitive to moisture stress at any part of the growing season. Though many factors contribute for increased potential yield of sunflower and pigeonpea, soil moisture profile is vital than all other inputs. Availability of soil water in the profile was critical at bud formation and seed setting. Sunflower and pigeonpea intercropping is a prominent in the region. It was proved that the *in-situ* moisture conservation practices were effective to enhance crop productivity of many crops. Hence, effective use of rainwater through soil water conservation measures at farmer's field is becoming important due to frequent droughts and predicted moisture deficit situations in future due to changing climatic situations. Field trial was conducted to evaluate moisture conservation strategies in sunflower intercropping in *kharif* for deep black soils of Karnataka.

METHODOLOGY

Field experiments conducted during 2020 and 2021 in fixed plots at Main Agricultural Research Station, University of Agricultural Sciences, Raichur. It was laid out in split plot design replicated thrice. Main plots were broad bed and furrow (C_1), ridges and furrow (C_2), tie ridges and furrow (C_3), conservation tillage (C_4), flatbed sowing and opening furrow after every three rows at 30 DAS (C_5) and flatbed sowing (C_6). Subplots were sunflower + pigeonpea (1:1) (I_1), sole pigeonpea (I_2) and sole sunflower (I_3). Pigeonpea variety TS-3R at 120 x 20 cm and sunflower hybrid RSFH-1887 at 60 x 30 cm were selected for the study and sowing done in 10th July, 2020 and 6th July, 2021. Crops were raised under rainfed condition the total rainfall received during the crop growth period 933 mm in 40 days and 447 mm in 37 days in 2020 and 2021, respectively. Data was analyzed by adopting procedure of split plot design at probability at 0.05.

RESULTS

The data over two years showed that among the different moisture conservation practices significantly higher sunflower head diameter, seed yield/plant, pigeonpea pods/plant and yield/plant were recorded in ridge and furrow over the rest of moisture conservation practices in 2020 and 2021, respectively (Table 1). Therefore, ridge and furrow resulted significantly greater sunflower and pigeonpea yield. In case of cropping system significantly sunflower head diameter and seed yield of individual crop were noticed in sunflower + pigeonpea (1:1) intercropping over the sole sunflower. But, sole sunflower produced significantly more seed yield as compared to intercropped sunflower in pooled data over two year study. With respect of pigeonpea significantly higher number of pods/plant yield of individual plant and seed yield were recorded in sole pigeonpea over the intercropped pigeonpea.

Under different cropping system yield advantage with respective of sunflower equivalent yield (SEY) and land equivalent ratio (LER) were significantly higher in sunflower + pigeonpea (1:1) over the sole cropping system. Lower cost of cultivation was incurred in farmer practice and greater in tied ridge and furrow. A gross return was significantly higher in ridge and furrow and intercropping due to its higher yield. These treatment combinations also resulted greater gross returns. In spite of higher net returns and BC ratio were obtained in ridge and furrow and sunflower + pigeonpea (1:1). Among the treatment combinations significantly higher net returns and BC ratio was obtained from sunflower + pigeonpea intercropping under ridge and furrow practice.

Results of the study concluded that sunflower + pigeonpea (1:1) on ridges and furrow method significantly greater yield and yield attributes over respective sole crops. Intercropping of sunflower and pigeonpea had greater advantage in terms of SEY, LER and economic returns over the sole crops.

Table 1: Yield, yield components and economics of sunflower and pigeonpea as influenced by moisture conservation practices and cropping system (pooled data of 2020 and 2021)

Treatment	Sunflower		Pigeonpea		Sunflower yield (kg /ha)	Pigeonpea yield (kg /ha)	SYE (kg /ha)	LER	Net Returns (Rs. /ha)	BC ratio
	Head diameter (cm)	Seed yield (g / plant^{1})	Pods/plant	Grain yield (g /plant)						
Moisture conservation practices (C)										
Broad bed and furrow	17.1	25.8	138	28.7	1,029	2,008	1,949	1.17	70,774	3.12
Ridges and furrow	19.6	29.5	156	34.5	1,275	2,230	2,253	1.18	86,866	3.61
Tie ridges and furrow	16.8	25.2	133	27.8	1,030	1,976	1,929	1.17	68,925	3.02
Conservation tillage	16.8	24.5	121	22.2	1,015	1,563	1,659	1.15	56,238	2.74
Flatbed sowing and opening furrow after every three rows at 30 DAS	17.2	24.3	121	23.2	1,019	1,580	1,673	1.15	56,149	2.69
Flatbed sowing	14.1	17.1	99	19.9	783	1,067	1,193	1.13	31,528	1.98
C.D @ 5%	0.7	1.4	9.7	2.9	52.2	82.0	54.1	0.02	2,866	0.09

Cropping system (I)										
Sunflower + Pigeonpea (1:1)	17.7	25.4	111	22.3	817	1,569	2298	1.47	84,221	3.23
Sole pigeonpea	-	-	146	29.7	-	1,906	1798	1.00	65,133	3.14
Sole Sunflower	16.2	23.3	-	-	1,233	-	1233	1.00	35,886	2.22
C.D. @ 5%	0.4	0.7	6.7	1.9	42.8	34.9	39.8	0.03	2,114	0.07
Interaction (C x I)										
C.D @ 5%	NS	NS	NS	NS	NS	NS	96.2	0.06	5,105	0.17

Pathogenicity studies on pod rot associated pathogens of groundnut

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ABSTRACT

Pathogenicity study was carried out on groundnut plants by artificial inoculation of one month old giant culture of three pod rot pathogens (*Sclerotium rolfsii, Rhizoctonia bataticola and Fusarium oxysporum*) which exhibited interaction effect as individual and in combination. In pathogen alone treatments, the results showed the highest/per cent incidence was recorded with *S. rolfsii* (28.04 %) and *R. bataticola* (28.03 %) followed by *F. oxysporum* (16.25 %). In pathogens combination, maximum pod rot incidence (47.49%) was recorded in *S. rolfsii* + *R. bataticola* + *F. oxysporum* followed by *S. rolfsii* + *R. bataticola* (24.46 %) and *S. rolfsii* + *F. oxysporum* (23.31 %). The minimum pod rot incidence (19.48%) was recorded in *R. bataticola* + *F. oxysporum*.

Keywords: *Fusarium oxysporum*, Groundnut, Pod rot, Pathogenicity, *Rhizoctonia bataticola* and *Sclerotium rolfsii*.

Groundnut/Peanut (*Arachis hypogaea* L.) an annual herbaceous plant of family Fabaceae is considered to be one of the most important oilseed crops in the world. In India, groundnut occupied total area of 26.4 m ha with 37.1 m ton and 1,550 kg /ha is the average productivity. In world, Among the Indian states, Karnataka is in fourth rank in terms of acreage with 0.378 m ha area with 0.502 m ton and productivity of 627 kg /ha (Anon., 2019). Low production of groundnut is attributed to major devasting disease *viz.*, pod rot, it become major constraint in groundnut producing areas in northern parts of Karnataka. Pod rot is with complex etiology caused by *Sclerotium rolfsii* (Sacc.), *Rhizoctonia bataticola* (Taub.) and *Fusarium oxysporum* (Mart.) Butler. Thus pathogenicity study was carried out using GPBD-4 as susceptible variety of groundnut for pod rot, by artificial inoculation with one month old giant culture of pod rot associated pathogens under glass house condition.

MATERIALS AND METHODS

Sterilized soil was taken in earthen pots of 30 × 26 cm^2 size. Giant culture of pod rot associated pathogens (*Sclerotium rolfsii,Rhizoctonia bataticola* and *Fusariumoxysporum*) were prepared one month before and were mixed thoroughly with the soil at the rate of fourper cent to get sick soil when groundnut plants were one month old. Seeds were sown in pots at four seeds/pot and pots without inoculum served as control. The eight treatments with three replications were maintained. Then fourper cent of one month old mass cultured pathogen was added to one month old groundnut plants grown in pot containing sterilized soil and observations on symptoms development was taken at different growth stages of plants. After the harvesting of plants from the pots, incidence of pod rot from each pod rot pathogens and their combinations in each treatment were recorded. Observations were taken at regular interval for symptoms development and observations were taken at different growth stages of plants. After the harvesting of plants from the pots, incidence of pod rot from each pod rot pathogens and their combinations in each treatment were recorded.Per cent incidence of pod rot in single and their combination of pathogens was calculated using the formula (Dwarakanath, 1994).

$$\text{Per cent incidence of pod rot (\%)} = \frac{\text{Number of pods affected}}{\text{Total number of pods observed}} \times 100$$

RESULTS AND DISCUSSION

Isolation and identification of pathogens: The repeated isolation of pod rot associated pathogens was done from infected groundnut pods yielded three major species of *Sclerotium rolfsii* (Sacc.), *Rhizoctonia bataticola* (Taub.) and *Fusariumoxysporum* (Mart.). These fungi were identified by their morphological characters under microscope that agreed with characterestics of *Sclerotium rolfsii* (Sacc.), *Rhizoctonia bataticola* (Taub.) by Butler and Bisby (1931) and *Fusariumoxysporum* (Mart.) by Booth (1971).

Pathogenicity studies : The studies on pathogenicity was carried out on GPBD - 4 variety of groundnut and continued the pathogenicity of all the associated pathogens of pod rot to ascertain thecent of association of all three fungi in pod rot disease.

Per cent pod rot incidence of groungnut in pot under glass house: The studies on pathogenicity were carried out under glass house conditions in pot containing sick soil using variety GPBD - 4. The data related to percentage of pod rot pathogens is listed in Table 1. The one month old mass cultured inoculum of three pathognes were added alone and in combinations. In pathogen alone treatments, the results showed that highestper cent incidence was recorded in of *S. rolfsii* (28.04 %), *R. bataticola* (28.03 %) followed by *F. oxysporum* (16.25 %). In pathogen combination treatments, maximum (47.49 %) pod rot incidence was recorded in *S. rolfsii* + *R. bataticola* + *F. oxysporum* followed by *S. rolfsii* + *R. bataticola* (24.46 %) and *S. rolfsii* + *F. oxysporum* (23.31 %). The minimum pod rot incidence was recorded in *R. bataticola* + *F. oxysporum* (19.48 %) when compared to control (without pathogen) (0.00 %).

Pathogenicity study was conducted in controlled condition in glass house using pots with sterilized soil. The infected plants showed the poor growth, wilted symptoms and rotting on pods and roots. The symptoms caused by *S. rolfsii* were in agreement with the description of Ramprasad (2005) who reported that wilting of plants, rotting on pods and roots of groundnut and Prabhu (2003) who reported that symptoms of wilting and root rotting in soybean under pot study.

In the present investigation, three pathogens exhibited inhibition interaction effect in their pathogenicity on groundnut plants in mixed inoculation. After harvesting of groundnut plants from the pots, highest per cent incidence was observed in inoculation of *S. rolfsii* + *R. bataticola* + *F. oxysporum* (47.49 %) followed by *S. rolfsii* + *R. bataticola* (24.46 %), *S. rolfsii* + *F. oxysporum* (23.21 %) and *R. bataticola* + *F. oxysporum* (19.48 %). The maximum incidence was recorded in single inoculation of *S. rolfsii* (28.04 %) followed by *R. bataticola* (28.03 %). Least incidence was recorded in *Fusariumoxysporum* (16.25 %). The pathogenicity was proved by the infection of pod rot pathogens in groundnut by producing similar symptoms as reported by Ramakrishna and Kolte (1988). From this discussion it is evident that, visual symptoms observations may not help to identify the pathogens owing to the complixicity produced by several pathogens.

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Table 1: Interaction effect of different pathogens of pod rot of groundnut under glass house condition

Treatments	Per cent disease incidence
S. rolfsii	28.04 (31.97) *
R. bataticola	28.03 (31.97)
F. oxysporum	16.25 (23.77)
S. rolfsii + R. bataticola	24.46 (29.64)
S. rolfsii + F. oxysporum	23.21 (28.80)
R. bataticola + F. oxysporum	19.48 (26.19)
S. rolfsii + R. bataticola + F. oxysporum	47.49 (43.56)
Control (without pathogens)	0.00 (0.00)
S.Em. ±	0.59
C.D. @ 1%	2.36

* Arc-sine values.

Hermetic storage for eco-friendly management of insect pests infesting stored sesame (*Sesamum indicum* L.)

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ABSTRACT

Sesame provides excellent food, nutrition, health care, edible oil, and biomedicine. Insect pest infestations in stored sesame have been a problem of major concern in recent years. Two hermetic storage bags, *viz*., high density polyethylene (HDPE) bag and double layered polythene (DLP) bag, were evaluated alone and in combination with botanical treatment (sweet flag rhizome powder @ 10 g/kg seed) against rice moth and red flour beetle under storage condition in comparison with conventional farmers' storage bags (jute gunny bag and cloth bag). Among the treatments, sesame seeds stored in HDPE bag with sweet flag rhizome powder and HDPE bag recorded significantly low seed damage due to the pests as compared to sesame seed stored in cloth and jute gunny bags at 6 months after treatment. The study revealed that HDPE bag alone or in combination with sweet flag rhizome powder could be employed as an eco-friendly method for preventing storage insect pests infesting sesame under storage conditions.

Keywords: Eco-friendly management, Hermetic storage, Sesame, Storage loss, Sweet flag rhizome powder

Insect pests infesting stored grains/seeds can result in significant losses, deterioration, and price reductions, as well as export rejections. Insect pests *viz*., rice moth (*Corcyra cephalonica*), red flour beetle (*Tribolium castaneum*), khapra beetle (*Trogoderma granarium*), rice weevil (*Sitophilus oryzae*), dried fruit beetle (*Carpophilus obsoletus*) and almond moth (*Ephestia cautella*) are reported to attack sesame seed and cake under storage conditions (Varaprasad and Duraimurugan, 2016). Among them, the red flour beetle and rice moth are predominant and cause significant damage to stored sesame (Sundar*et al*., 2021). The management of storage pests has been largely dependent on the use of synthetic chemicals. Increasing health concerns and the requirement of pesticide residue-free produce for export have necessitated search for alternate techniques that are eco-friendly and economically viable for management of storage insect pests. Hence, the present study was conducted to find out the eco-friendly management of sesame storage pests using hermetic storage techniques alone and in combination with botanicals.

MATERIALS AND METHODS

The experiment was laid out in completely randomized design using eight treatments with three replications.Four storage bags *viz*., double layered polythene (DLP) bag, high density polyethylene (HDPE) bag, jute gunny bag and cloth bag were evaluated alone and in combination with botanical treatment (sweet flag rhizome powder @10 g/kg seed) against the rice moth and red flour beetleunder storage conditions. Each treatment was treated with one kg of sesame seed (cv. swetha). In each bag, 50 eggs of rice moth and 50 adults of red flour beetle were released separately. The effectiveness was assessed based on the parameters,*viz.*,per cent seed damage,per cent weight loss, number of adults emerged and germination percentage.The data were collected and recorded at 2 months intervals and continued up to 6 months after storage.

RESULTS AND DISCUSSION

Among the treatments evaluated against rice moth, sesame seeds stored in HDPE bag+sweet flag rhizome powder and HDPE bag recorded significantly low seed damage (4.2-4.8%) as compared to the damage (48.1-50.4%) in sesame stored in cloth and jute gunny bags at 6 months after treatment (Fig. 1a). HDPE bag + sweet flag rhizome powder and HDPE bag were also found effective against red flour beetle and recorded significantly low seed damage (4.1-4.8%) at 6 months after treatment as compared to the damage (14.4-16.4%) in cloth and jute gunny bags (Fig. 1b). The study revealed that high density polyethylene (HDPE) alone or in combination with sweet flag rhizome powder could be employed as an eco-friendly method against insect pests infesting stored sesame.

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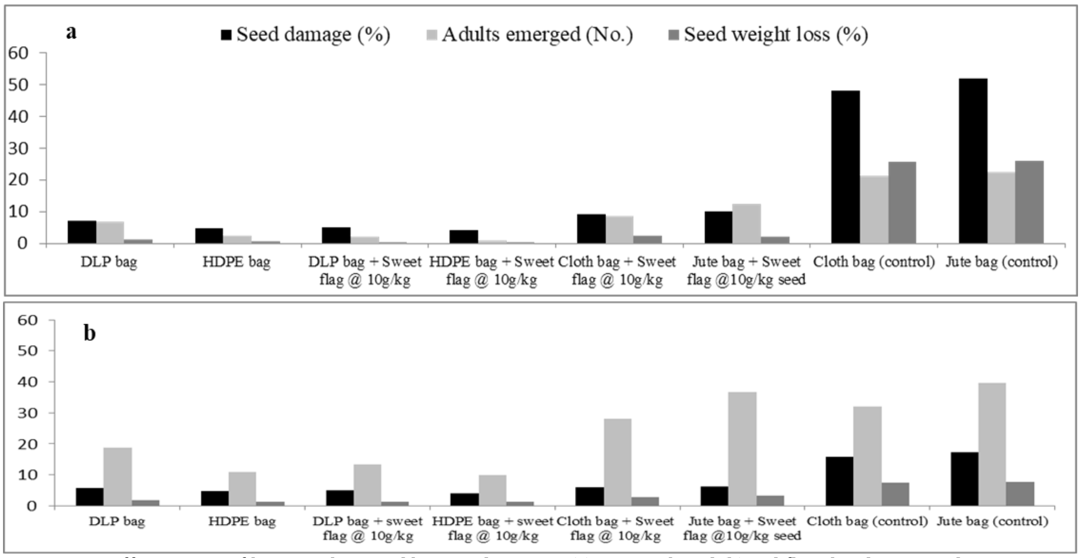

Fig.1. Effectiveness of hermetic bags and botanicals against (a) rice moth and (b) red flour beetle in stored sesame

Correlation coefficient and path coefficient analysis studies in *Brassica* spp. for yield and quality traits

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ABSTRACT

An experiment was conducted with 40 genotypes of *Brassica* species (*Brassica juncea*-15, *Brasica rapa* var. yellow *sarson*-10, *Brassica rapa* var. *toria*-5, *Brassica tournefortii*-5, *Brassica nigra*-2 and *Brassica carinata*-3) in *Rabi season* 2021-22 College of Agriculture, Jodhpur (Rajasthan). The experiment was put out in randomized block design (RBD) with 3 replications. Correlation coefficient analysis indicated that seed yield/plant had positive significant correlation with days to 50% flowering, days to maturity, plant height and siliqua density of main shoot. The direct effect on seed yield/plant were observed for plant height, number of primary branches/plant, first branch initiation height, number of seeds/siliqua, 1000 seed weight and glucosinolates. The genotypes MYS-172 and MN-2 showed high and low oil content, respectively, whereas, genotype TM309-1 and MBT-4 showed the highest and the lowest glucosinolates, respectively.

Keywords:*Brassica* spp, Correlation, Glucosinolates, Path Analysis

India is one of the major oilseeds producing country in the world and having third position in production after Canada and China, and accounts for 12% of total global production. India has diverse agro-ecological conditions, which are favourable mainly for growing nine oilseeds crops, in which, seven are edible and two are non-edible cultivated across the country in both irrigated and rainfed area. The family Brassicaceae contains over 338 genera and 3709 species (Al-Shehbaz, Beilstein and Kellogg, 2006; Warwick, Francis and Al-Shehbaz, 2006). Species grown as oilseeds include *B. juncea*, *B. rapa* and *B. carinata*. The vegetable Brassicaceae includes *B. napus*, *B. rapa* and *B. oleracea*. The condiment crops include *B.juncea* (brown and oriental mustard), *Sinapis alba* (yellow mustard), *B. nigra* (black mustard, but now little used).

Brassica spp. contains 35–45 percent oil, 17–25 percent protein, 8–10 percent fibre and 6–10 percent moisture (Cartea, 2019).The anti-nutritional elements in the oil are erucic acid and glucosinolate. Myocardial fibrosis in adults and lipidosis in children are two diseases that are more prone to develop with a high erucic acid diet. *Brassica juncea* contains nearly 50 % erucic acids although it varies from 35.7% to 51.4% (Chauhan *et al.*, 2007 and Rai *et al.*, 2018) among different varieties of *Brassica juncea*. It is also reported that *Brassica napus* and *Brassica campestris* have lower levels of erucic acids then other species of genus *Brassica*. Glucosinolates varies from species to species, genotypes to genotypes and among varieties in genus *Brassica*, as low as 13 µmol/gm (PDZ) to 132 µmol/gm (Pusa Tarak) in *Brassica juncea* (Mawlong *et al.*, 2017, Saikaia *et al.*, 2018). *Brassica* spp.

is the second most important oilseeds crop in India after groundnut.

There are six *Brassica* spp. mainly grown in India, out of which, three are diploids *viz.Brassica rapa* (AA, n=10), *Brassica oleracia* (CC, n=9) and *Brassica nigra* (BB, n=8) and three are amphidiploids *viz.Brassicajuncea* (AABB, n=18), *Brasscia carinata* (BBCC, n=17) and *Brassicanapus* (AACC, n=19). *Brassica* spp. have wider adaptability for various environmental conditions. Genetic variability is the key component for any breeding program.

MATERIAL AND METHODS

The experiment was conducted at instructional farm, College of Agriculture,Agriculture University, Jodhpur, during *Rabi* 2021-2022.The experimental material used for study consisted of forty *Brassica* accessions. The investigation was carried out in randomized complete block design using three replications. The experiment was laid out single row of four meter with 30 cm x 10 cm spacing. All the recommended agronomic and plant protection measures were followed to raise the normal crop. The data were collected by taking mean values of ten randomly selected plants from each accession for the characters *viz*., days to 50% flowering, days to maturity, plant height, first branch initiation height, number of primary branches/plant, siliqua density of main shoot, number of siliquae/plant, siliqua length, number of seeds/siliqua, 1000 seed weight, seed yield/plant, oil content and glucosinolates, The data recorded for all the characters were subjected to analysis of variance with the formula suggested by Panse and Sukhatme (1978). Analysis of variance permits the estimation of phenotypic, genotypic and environmental variance for various traits calculated as/Johnson *et al*. (1955) while, the genotypic (GCV) and phenotypic coefficients of variation (PCV) were calculated as/Burton (1952) and categorized as low, moderate and high by Shivasubramanian and Menon (1973). Broad senseheritability (h_b^2) and Genetic advance (GA) were calculated by using the formula proposed by Allard (1960) and categorized as demonstrated by Robinson(1966). The phenotypic and genotypic correlations were also estimated from which genotypic correlations were subjected to path coefficient analysis.

RESULTS AND DISCUSSION

Correlation Coefficient and Path Coefficient analysis: Correlation coefficient provides the information about the economic characters like yield and yield contributing attributes which are useful for the selection and improvement of yield. In the present investigation, genotypic correlation coefficient was higher than phenotypic coefficient of correlations. (Table 1). The characters *viz*., days to maturity, plant height, first branch initiation height, 1000 seed weight, and glucosinolates exhibited positive significant correlation with seed yield. Therefore, selection of these traits might result in higher seed yield/plant in *Brassica* spp. Oil percent shows negative non-significant correlation with glucosinolates. These results can help a breeder in selecting good breeding material and for creation of new varieties. These findings were confirmed by Pal *et al.*, (2019) in *Brassica juncea*, Tantuway *et al*, (2018) in *Brassica juncea*, Saroj *et al.*, (2021) in *Brassica juncea.* Path analysis based on genotypic correlation revealed that plant height and number of seeds/siliqua, first branch initiation height, number of primary branches, 1000 seed weight and glucosinolates had positive direct effect on seed yield/plant in desirable direction.

The genotypes MYS-172 (*Brassica rapa* var. yellow *sarson)* and MN-2 (*Brassica nigra)* showed high and low oil content, respectively, whereas, genotype TM309-1 (*Brassica juncea)* and MBT-4 (*Brassica tournefortii*) showed the highest and the lowest glucosinolates, respectively.

Seed yield/plant had positive significant phenotypic and genotypic correlation with days to maturity, plant height, first branch initiation height, 1000 seed weight, and glucosinolates. A positive and non-significant phenotypic and genotypic correlation for seed/plant with days to 50% flowering, number of primary branches/plant and siliqua density was also observed. These traits can be utilised for correlated response while performing selection. A negative and non-significant genotypic and phenotypic correlation with number of siliquae/plant, siliqua length, number of seeds/siliqua and oil content with seed yield/plant was also found, which suggests negative relationship of these traits. Although, none of the character exhibited negative and significantly correlation with the seed yield/plant.

Path coefficient analysis revealed that the positive direct effect of all the characters at both genotypic and phenotypic levels except siliqua density, number of siliquae/plant and siliqua length. At both phenotypic and genotypic level, plant height had the highest positive direct effect on seed yield/plant followed by 1000 seed weight, days to maturity and oil content, whereas, the highest indirect effect was observed by first branch initiation height via plant height.

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Table:1. Phenotypic and genotypic correlation coefficients for seed yield and its contributing traits in *Brassica* spp. Genotypes

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	First branch initiation height (cm)	Number of primary branches per plant	Siliqua density of main shoot	Number of siliqua per plant	Siliqua length (cm)	Number of seeds per siliqiua	1000 seed weight (gm)	Oil content (%)	Glucosinolate (µmol/gm)	Seed yield per plant (gm)
Days toflowering	P	1.000	0.761**	0.444**	0.363**	0.621**	0.320**	0.592**	-0.284**	-0.172	-0.548**	-0.298 **	-0.255*	0.116
	G	1.000	0.803**	0.469**	0.404**	0.682**	0.336**	0.614**	-0.357**	-0.198*	-0.587**	-0.336**	-0.267*	0.125
Days to maturity	P		1.000	0.656**	0.493**	0.614**	0.372**	0.591**	-0.450**	-0.357**	-0.447**	-0.536 **	0.069	0.356**
	G		1.000	0.693**	0.533**	0.651**	0.386**	0.612**	-0.597**	-0.376**	-0.474**	0.595**	0.073	0.378**
Plant height(cm)	P			1.000	0.788**	0.476**	0.432**	0.455**	-0.375**	-0.373**	-0.104	-0.447**	0.274*	0.698**
	G			1.000	0.800**	0.502**	0.452**	0.456**	-0.494**	-0.409**	-0.096	-0.501**	0.285**	0.729**
First branch	P				1.000	0.323**	0.290**	0.206*	-0.152	-0.223*	-0.079	-0.329**	0.190*	0.575**
initiation height (cm)	G				1.000	0.340**	0.312**	0.206*	-0.231*	-0.257**	-0.073	-0.362**	0.198*	0.616**
Number of primary	P					1.000	0.652**	0.838**	-0.581**	-0.327**	-0.666**	-0.424**	-0.110	0.106
branches/plant	G					1.000	0.672**	0.874**	-0.765**	-0.342**	-0.719**	-0.463**	-0.121	0.120
Siliqua density of	P						1.000	0.691**	-0.545**	-0.278**	-0.640**	-0.457**	-0.118	0.050
main Shoot	G						1.000	0.712**	-0.714**	-0.291**	-0.666**	-0.501**	-0.119	0.053
Number of	P							1.000	-0.634**	-0.404**	-0.741**	-0.526**	-0.190*	-0.005
siliquae/plant	G							1.000	-0.848**	-0.431**	-0.777**	-0.578***	-0.195*	-0.009
Siliqua length (cm)	P								1.000	0.536**	0.540**	0.466**	-0.101	-0.084
	G								1.000	0.695**	0.683**	0.633**	-0.127	-0.090
Number of	P									1.000	0.313**	0.627**	-0.218*	-0.079
seeds/siliqua	G									1.000	0.340**	0.711**	-0.231*	-0.097
1000 seed	P										1.000	0.530**	0.377**	0.322**
weight (gm)	G										1.000	0.585**	0.398**	0.332**
Oil content (%)	P											1.000	-0.074	-0.053
	G											1.000	-0.076	-0.071
Glucosinolates	P												1.000	0.437**
(µmol/gm)	G												1.000	0.454**
Seed yield	P													1.000
per plant (gm)	G													1.000

*, ** represent significant at 5% and 1% levels respectively P=Phenotypic, G- Genotypic.

Table: 2. Phenotypic (P) and genotypic (G) correlation coefficient for seed yield and its contributing traits in *Brassica* spp.

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	First branch initiation height (cm)	Number of primary branches /plant	Siliqua density of main shoot	Number of siliqua /plant	Siliqua length (cm)	Number of seeds /siliqiua	1000 seed weight (gm)	Oil content (%)	Glucosinolate (µmol/gm)
Days to flowering	P	**-0.110**	-0.083	-0.048	-0.040	-0.068	-0.035	-0.065	0.031	0.018	0.060	0.032	0.028
	G	**0.113**	0.090	0.053	0.045	0.077	0.038	0.069	0.040	0.022	0.066	0.038	0.030
Days to maturity	P	0.140	**0.185**	0.121	0.091	0.113	0.068	0.109	-0.083	-0.066	-0.082	-0.099	0.012
	G	-0.084	**-0.104**	-0.072	-0.055	-0.068	-0.040	-0.064	0.062	0.039	0.049	0.062	-0.007
Plant height(cm)	P	0.335	0.495	**0.754**	0.594	0.359	0.326	0.343	-0.283	-0.282	-0.078	-0.337	0.207
	G	0.396	0.585	**0.843**	0.675	0.424	0.381	0.385	-0.417	-0.345	-0.081	-0.423	0.0240
First branch	P	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	-0.000	-0.000	0.000	-0.000	0.000
initiation height (cm)	G	0.013	0.017	0.026	**0.033**	0.011	0.010	0.006	-0.007	-0.008	-0.002	-0.012	0.006
Number of	P	0.065	0.064	0.050	0.033	**0.105**	0.068	0.088	-0.061	-0.034	-0.070	-0.044	-0.011
primary branches/plant	G	0.068	0.065	0.050	0.034	**0.100**	0.067	0.088	-0.077	-0.034	-0.071	-0.046	-0.012
Siliqua density	P	0.007	-0.008	-0.010	-0.006	-0.015	**-0.023**	-0.016	0.012	0.006	0.015	0.010	0.002
Of main Shoot	G	-0.057	-0.066	-0.077	-0.053	-0.115	**-0.171**	-0.122	0.122	0.049	0.114	0.086	0.020
Number of	P	-0.126	-0.126	-0.097	-0.044	-0.179	-0.148	**-0.214**	0.125	0.086	0.158	0.112	0.040
siliqua/plant	G	-0.282	-0.282	-0.210	-0.094	-0.402	-0.328	**-0.460**	0.390	0.198	0.357	0.266	0.898
Siliqua length	P	0.009	0.015	0.012	0.005	0.019	0.018	0.021	**-0.033**	-0.017	-0.016	-0.015	0.003
(cm)	G	0.174	0.192	0.242	0.113	0.374	0.349	0.415	**-0.489**	-0.340	-0.334	-0.309	0.062
Number of	P	-0.014	-0.030	-0.031	-0.018	-0.027	-0.023	-0.034	0.045	**0.084**	0.026	0.053	-0.018
seeds/siliqua	G	0.059	-0.113	-0.123	-0.077	-0.103	-0.087	-0.130	0.209	**0.301**	0.102	0.214	-0.069
1000 seed	P	-0.106	-0.086	-0.020	-0.015	-0.129	-0.124	-0.143	0.097	0.060	**0.193**	-0.102	0.073
weight (gm)	G	-0.146	-0.118	-0.024	-0.018	-0.177	-0.166	0.194	0.170	0.085	**0.249**	0.146	0.099
Oil content (%)	P	-0.041	-0.075	-0.062	-0.046	-0.059	-0.064	-0.073	0.065	0.088	0.074	**0.140**	-0.010
	G	0.004	0.007	0.006	0.005	0.005	0.006	0.007	-0.007	-0.008	-0.007	**-0.012**	0.000
Glucosinolates	P	-0.028	0.007	0.030	0.020	-0.012	-0.020	-0.020	0.065	-0.024	0.041	-0.008	**0.109**
(µmol/gm)	G	-0.014	0.004	0.015	0.010	-0.006	-0.006	-0.010	-0.006	-0.012	0.021	-0.004	**0.053**
Seed yield /plant (gm)	P	0.116	0.356	0.698	0.575	0.106	0.050	-0.005	-0.084	-0.079	0.321	-0.053	0.437
	G	0.125	0.378	0.729	0.616	0.120	0.053	-0.009	-0.090	-0.097	0.332	-0.071	0.454

Table: 3. Gucosinolates content in genotypes of different spp.

S. No.	Genotype	Glucosinolates (μmol/gm)	S.No.	Genotype	Glucosinolates (μmol/gm)
1.	TM303-1	172.7	21.	MYS-152	68.9
2.	TM304-1	135.2	22.	MYS180	39.3
3.	TM309-1	183.3	23.	MYS-183	132.6
4.	TM-310-3	43.9	24.	MYS-179	102.9
5.	TM312-1	38.0	25.	MYS-172	40.8
6.	TM114-1	111.0	26.	MBT-4	9.1
7.	TM-316	175.2	27.	MBT-19	16.7
8.	TM108-1	82.7	28.	MBT-27	10.9
9.	TM267-3	122.1	29.	MBT-121	14.2
10.	TM-273	186.8	30.	MBT-115	19.2
11	NRCHB-101	75.9	31.	MN-1	46.9
12.	RH749	78.2	32.	MN-2	37.9
13.	BIO-902	93.7	33.	BHAWANI	64.0
14.	KRANTI	127.2	34.	TAPESHWARI	55.1
15.	GDM-4	138.0	35.	PT-303	65.5
16.	RMYS-1	51.9	36.	PANCHALI	71.2
17.	RMYS-2	37.3	37..	PT-30	88.4
18.	RMYS-3	134.2	38.	PUSA SWARNA	167.9
19.	YSH-0401	33.4	39.	PUSA ADITYA	114.2
20.	NRCYS-05	79.1	40.	PC-5	108.3

Virtual mode of disseminating oil palm technologies during Covid-19 – An Appraisal

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ABSTRACT

Development of oil palm across the country necessitates organizing capacity building programmes on oil palm which is taken up regularly by ICAR-IIOPR. During Covid-19 pandemic situation ICAR-IIOPR opted for online mode for disseminating oil palm technologies. ICAR-IIOPR had organized 13 virtual trainings to about 632 officers during 2020-2022. Feedback of IIOPR virtual trainings was collected from the participants by using standardized questionnaire and data was compiled and statistical tools such as frequencies and percentages were used to know the results and draw inferences. Data was tabulated for parameters viz., devices used, interaction, virtual communication, time management etc. and it was found that 45.16 % trainees expressed that their overall feeling about IIOPR virtual trainings was good.

Keywords: Oilpalm, Technologies, Virtual

Oil palm development programme is spreading across length and breadth of the country and about 4.0 lakh hectares is under oil palm cultivation. Capacity building programmes are organized round the year to stakeholders to disseminate oil palm technologies. Covid-19 pandemic forced social distancing as a measure to prevent community transmission which shifted, training from offline to online. As part of ICT intervention in dissemination of oil palm technologies, video conference system was established at ICAR-IIOPR during 2014-15 in the institute to reach the stakeholders overcoming spatial and temporal barriers and reached the stakeholders. The positive feedback gained in using video conferencing for dissemination of oil palm technologies, helped in transiting in a smooth manner from offline to online capacity building programmes during the Covid-19 pandemic.

MATERIALS AND METHODS

About 13 online capacity building programmes were organized for about 632 officers in oil palm development programme during 2020-2022. Random sample of 31 officers were selected as respondents to get feedback on the virtual training programmes on oil palm organized by IIOPR. Structured and standardized questionnaire was prepared and administered to the participants. The responses received were compiled and tabulated. Statistical tools viz., frequency and percentage were used to obtain the results and draw inferences.

RESULTS AND DISCUSSION

Of 31 officers who attended IIOPR virtual training programmes on oil palm 61.29% were in the initial years of job experience i.e. 1 to 5 years which indicated that they require updating their knowledge on oil palm. 80.65 % officers informed that they used smartphone for attending these virtual programmes and 54.84 % officers expressed that they had limited internet access. This indicated that they had access to devices, however internet connectivity was not stable and continuous, which could disrupt attending the virtual classes. 54.84 % said they preferred to ask their queries to the trainer during / after the online lecture. 87.10 % of the trainees said they were punctual in attending virtual trainings which showed their interest in attending the virtual trainings. 38.71 % officers expressed that they received moderate help from their organizations for necessary resources to learn virtually and 38.71 % said that virtual learning was stress free during the Covid-19 pandemic. About 54.84 % felt that IIOPR faculty was very helpful during the virtual trainings. 83.87% officers expressed that their objective of attending IIOPR training was met. 51.61% expressed that face-to-face communication was very important compared to virtual training programmes. 67.74 % officers expressed that they were good at using the computer and 70.97 % of them told that they were comfortable in communicating electronically (Table 01). This showed that the trainees were well equipped in handling the electronic devices used for virtual communication. 41.94 % trainees expressed that they could manage the time for virtual trainings inspite of their work schedule. 32.26 % officers expressed that they were moderately interested in virtual training programmes. Regarding suggestions for improving IIOPR virtual training programmes, 35.48 % said that no improvement is required with respect to interaction. 83.87 % expressed that all intended topics were covered during IIOPR virtual training programmes and 45.16 % expressed that their overall feeling about IIOPR virtual trainings was good (Table 02).

During Covid-19 lockdown, online teaching was found to be the best way of ensuring that learners are engaged and safe through social distancing barring spatial and temporal issues.

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Comfortability in electronic communication		
Comfort	Frequency	Percentage
Strongly Agree (A)	5	16.13
Agree (B)	22	70.97
Neutral (C)	4	12.90
Overall Feeling about ICAR-IIOPR Virtual Trainings	31	100
Training	Frequency	Percentage
Average	1	3.23
Above Average	8	25.81
Good	14	45.16
Excellent	8	25.81
	31	100

Evaluation of compatibility and bio-efficacy of insecticide and fungicide combinations on thrips and fusarial wilt of castor

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ABSTRACT

Field experiment was conducted during *Kharif 2018* -19 at Tapioca and Castor Research Station, Yethapur to evaluate the compatibility and efficacy of six insecticides and three fungicides at recommended concentration against thrips and fusarial wilt of castor. The pooled mean population of thrips was lowest in the treatment Buprofezin 25 SC + Propiconazole 25 EC which recorded 3.25thrips/spike. The highestper cent wilt reduction percent of 91 % was recorded in Acetamiprid 20 SP+ Carbendazim 50 WP followed by Novaluron 10EC + Carbendazim 50 WP which recorded 89.5 % over control.

Keywords: Bio-efficacy, Castor, Compatibility, Fungicides, Fusarial wilt, Insecticides, Thrips

Castor (*Ricinus communis Linn)* is an important industrially valued non – edible oilseed crop. The average productivity is low (309 kg/ha) in Tamil Nadu where the crop is cultivated mostly as rain fed with low input management. The biotic stresses mostly the thrips were major reasons for low yields of castor cultivated during *Kharif* season. Thrips are suspected to cause withering of emerging spike or drying up of newly formed capsules besides making plant stunted in case of severe infestation. The seed yield loss due to thrips was found to be 12.2 %. Similarly fusarial wilt in castor causes highest yield loss in various life stages of castor plant, during flowering phase it causes 77 % yield loss and during 63 % yield loss during 90 days old crop and 39 % yield loss during secondary branch forming stages (Pushpavathi *et al*, 1998). Therefore, a combined application of effective insecticides and fungicides is a practical necessity for effective control and highly economic way of saving spraying cost. Keeping in view, the present study was undertaken with effective and recommended insecticides at recommended rates to find their efficacy on thrips and fusarial wilt of castor as well as the compatibility of the test insecticides and fungicides.

MATERIALS AND METHODS

The experiment was conducted during *Kharif* 2018 - 19 at Tapioca and Castor Research Station, Yethapur, Salem District, Tamil Nadu. Six insecticides *viz.*, Clothianidin 50 WDG, Acetamiprid 20 SP, Flonicamide 50 WG, Buprofezin 25 SC, Novaluron 10EC, Dimethoate 30 EC @ 0.1 g/l, 0.2 g/l, 0.2 g/l, 1.5 ml/l, 1ml/l, 1.7ml/l respectively and three fungicides *viz.*, Propiconazole 25 EC 1 ml/l, Carbendazim 50 WP 1 g/l and carbendazim 12% + Mancozeb 63% WP 2 g/l were evaluated as tank mix of insecticide and fungicide combination for their efficacy against thrips and fusarial wilt of castor as well as to investigate their compatibility as tank mix application for the purpose of reducing the application cost in the event of simultaneous occurrence of both pest and disease during any stage of crop growth. The castor hybrid DCH 519 was sown in plots of 5.4m x 6.0m with the spacing of 90 cm x 90 cm. The experiments was conducted in a randomized block design with twelve treatments and three replications. Two sprays were applied at 15 days intervals with hand operated knapsack sprayer (500 liters/hectare). Twelve treatments *viz.*, Clothianidin 50 WDG + Propiconazole 25 EC, Acetamiprid 20 SP + Propiconazole 25 EC, Flonicamide 50 WG + Propiconazole 25 EC, Buprofezin 25 SC + Propiconazole 25 EC, Novaluron 10EC + Propiconazole 25 EC, Clothianidin 50 WDG + Carbendazim 50 WP, Acetamiprid 20 SP+ Carbendazim 50 WP, Novaluron 10EC + Carbendazim 50 WP, Clothianidin 50 WDG+carbendazim 12% + Mancozeb 63% WP, Acetamiprid 20 SP+carbendazim 12% + Mancozeb 63% WP, Novaluron 10EC +carbendazim 12% + Mancozeb 63% WP along with an untreated control was imposed. Absolute population/spike recorded on 10 plants at random/plot. Observations were taken before and after 1, 3, 7, 10 and 14 days after spraying. For fusarial wilt percent wilt incidence was recorded at 30 DAS and 45 DAS on 10 plants at random/pot. The physical compatibility of 18 combinations involving 6 insecticides (Clothianidin 50 WDG @ 0.1 g/l, Acetamiprid 20 SP@ 0.2 g/l, Flonicamid 50WG@ 0.2 g/l, Buprofezin 25SC @1.5 ml/l, Novaluron 10EC @ 1ml/l and Dimethoate 30EC@1.7 ml/l) and 3 fungicides (Propiconazole 25EC @ 1ml/l, Carbendizm 50 WP @ 1g/l and Carbendizm 12% + Mancozeb 63% WP @ 2G/l) were evaluated with jar compatibility test. Pot culture experiment was conducted to study the phytotoxic effects of combinations of treatments (6 insecticides and 3 fungicides) along with untreated control. For each treatment 2 liter of tank mix of insecticide and fungicide were prepared as/the dosages in two replications.

RESULTS AND DISCUSSION

The initial mean population of castor thrips in various experimental plots including untreated control a day before spray varied from 12.30 to 24.20 thrips/spike (Table 1). The pooled mean thrips population (Table 1) indicated that all the insecticidal treatments were significantly superior over control (44.73 thrips/spike), the pooled mean population of thrips was lowest in the treatment Buprofezin 25 SC + Propiconazole 25 EC which recorded 3.25 thrips/spike followed by Flonicamide 50 WG + Propiconazole 25 EC which recorded 9.13. Percent reduction over control indicated that Buprofezin 25 SC + Propiconazole 25 EC reduced the thrips population up to 88.65 per cent followed by Acetamiprid 20 SP + Propiconazole 25 EC registered 81.52 per cent over control respectively. Based on physical and phytotoxic compatibility studies a total of 11 combinations gave compatible reaction with fungicides and insecticides along with control. A total of 11 combinations tested against Fusarium wilt in castor under green house condition by using sick pot method. Almost all combinations gave better reduction over control. But the combination Acetamiprid 20 SP + Carbendazim 50 WP (T7) gave highest per cent reduction *i.e.* 91 % followed by Novaluron 10EC + Carbendazim 50 WP (T8) 89.5 % and Clothianidin 50 WDG + Carbendazim 50 WP*i.e.* 88 % over control

In treatment Dimethoate + Propiconazole (T6), top most leaves started scorching and leaf drying observed on 4^{th} day and completely dried upon 14^{th} days after treatment. Flonicamide + Carbendazim (T9), Buprofezin + Carbendazim (T10), Dimethoate + Carbendazim (T12) scorching and leaf drying observed on 4^{th} day and completely dried upon 14 days after treatment. Flonicamide + Carbendizm 12% + Mancozeb 63% WP (T9), Buprofezin + Carbendizm 12% + Mancozeb 63% WP (T16), Dimethoate + Carbendizm 12% + Mancozeb 63% WP (T18) scorching and leaf drying observed on 14^{th} day and completely dried upon 14 days after treatment. Remaining all other treatment combinations were phytotoxically compatible with phytotoxicity scale ranging from 0-1 scale. All the combinations of insecticides and fungicides were physically compatible without formation of any precipitation, sedimentation foaming or caking.(Kamala *et al.*, 2004 and Kubendran *et al.*,2009). The quality of water can be an important factor in optimum pest control.

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Table 1. Bio- efficacy of combinations of insecticides and fungicide against thrips and fusarial wilt in castor

Treatment	Pesticide combination	Dosae g/l	Mean population of thrips/spike Pooled mean			Per cent wilt at 30 DAS	Per cent wilt at 45 DAS	Pooled Mean	PRC
			PTC	Pooled	PRC				
T1	Clothianidin 50 WDG + Propiconazole 25 EC	0.1 + 1	19.20 (4.48)	11.30 (3.45)	74.73	31.11 (33.87)	40.00 (39.16)	35.55 (36.51)	52.31
T2	Acetamiprid 20 SP + Propiconazole 25 EC	0.2 + 1	22.30 (4.81)	9.60 (3.17)	81.52	37.78 (37.89)	44.44 (41.78)	41.11 (39.83)	44.80
T3	Flonicamide 50 WG + Propiconazole 25 EC	0.2 + 1	16.50 (4.17)	9.13 (3.14)	76.24	33.33 (35.23)	40.00 (39.20)	36.66 (37.21)	50.80
T4	Buprofezin 25 SC + Propiconazole 25 EC	1.5 + 1	12.30 (3.63)	3.25 (2.00)	88.65	40.00 (39.20)	46.67 (43.06)	43.33 (41.13)	41.80
T5	Novaluron 10EC + Propiconazole 25 EC	1 + 1	18.60 (4.41)	11.60 (3.51)	73.23	37.78 (37.89)	53.33 (46.89)	45.55 (42.39)	38.90
T6	Clothianidin 50 WDG + Carbendazim 50 WP	0.1 + 1	22.50 (4.83)	12.45 (3.59)	76.24	6.67 (14.94)	11.11 (19.44)	8.89 (17.19)	88.00
T7	Acetamiprid 20 SP+ Carbendazim 50 WP	0.2 + 1	19.60 (4.52)	11.55 (3.48)	74.81	4.44 (12.15)	8.89 (17.32)	6.66 (14.73)	91.00
T8	Novaluron 10EC + Carbendazim 50 WP	1 + 1	17.50 (4.28)	14.68 (3.91)	63.99	6.67 (21.38)	8.89 (17.32)	7.78 (16.13)	89.50
T9	Clothianidin 50 WDG+carbendazim 12% + Mancozeb 63% WP	0.1 + 2	19.30 (4.49)	13.70 (3.78)	69.53	13.33 (24.91)	15.56 (23.20)	14.44 (22.29)	80.60
T10	Acetamiprid 20 SP+carbendazim 12% + Mancozeb 63% WP	0.2 + 2	22.00 (4.78)	16.18 (4.09)	68.43	17.78 (19.44)	20.00 (26.53)	18.89 (25.72)	74.60
T11	Novaluron 10EC +carbendazim 12% + Mancozeb 63% WP	1 + 2	24.20 (5.00)	20.60 (4.59)	63.46	11.11 (19.44)	15.56 (23.20)	13.33 (21.32)	82.10
T12	Control	-	19.20 (4.48)	44.73 (6.36)	-	69.20 (56.35)	79.90 (63.63)	74.55 (59.99)	0.00
	CD (0.05 %)		0.06			1.76	2.70	0.75	
	CV %		0.86			3.57	4.74	4.16	

ICAR-IIOR sunflower: an android mobile app for knowledge dissemination

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ABSTRACT

India has become the fastest growing mobile market in recent years. In India, there are enormous opportunities for utilizing the smart phones as a part of agribusiness improvement. Usage of smart phones is exponentially increasing in rural areas hence, providing information to large number of farmers. In this context ICAR-IIOR-SUNFLOWER, mobile app was developed by ICAR-IIOR to provide entire package of practices required for sunflower cultivation. The App supports English language and available on Google play store. Features include offline and online mode and offer valuable information to the extension workers, farmers, sunflower researchers and other stakeholders.

Keywords: Android, ICT, Mobile App, Package of practices, Sunflower

Access to timely, adequate, correct technology and related information is among the most important enablers for smallholders to improve productivity sustainably (Davis, 2008; Birner *et al.*, 2009). Smart phone apps revolutionized the connectivity and used for transferring agri-information for farmers (EMarketer, 2016). In India, with a 1.4 billion people, the wireless subscription as on October 2022 was 1016 millions. Increasing penetration of smart phones in India and affordable prices, it has been considered necessary to create mobile Apps. Hence, a mobile application on sunflower production technologies was developed by ICAR-IIOR, Hyderabad aiming to empower sunflower farmers and other stakeholders with knowledge on sunflower for better yield. In the present research paper, the unique features of ICAR IIOR Sunflower Mobile App developed by ICAR-IIOR are discussed.

MATERIALS AND METHODS

ICAR-IIOR Sunflower mobile application on sunflower management practices was developed by ICAR-Indian Institute of Oilseeds Research to facilitate the stake holders with handy information. The App was developed using Android Studio an open source software for developing Mobile Apps through Java object oriented programming language. The application was created in English and works both in online and offline mode.

Minimum system requirements: Operating System: Microsoft windows 7/8/10, 64-bit; RAM: Minimum 3 GB, Recommended up to 8 GB and 1 GB for Android Emulator; Disk space: Minimum 2 GB of available disk space, Recommended up to 4 GB; Java Version: Java Development Kit (JDK) 8.

RESULTS AND DISCUSSION

The Mobile App ICAR-IIOR Sunflower can be downloaded from google play store at: https://play.google.com/store/apps/details?id=in.org.icar_iior.icariiorsunflower. The App has 85 screens with relevant photographs and text for different aspects. The main home screen has the drop menu option with information on general information, agronomic practices, preferred cultivars, hybrids and varieties, cropping systems, insect pests, diseases, AICRP centres and commodity markets (Fig.1).

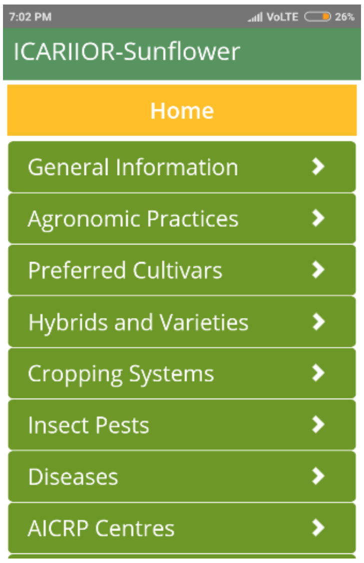

Fig.1

The aim of developing the Mobile app is to provide handy information in a cost effective way on sunflower to the end users including farmers, researchers, extension workers, NGOs and students. The increasing popularity,access, use of mobile phone technology and its diffusionin all the section of the society in India give adistinctive opportunity in ICT mediated extension for communicating agricultural information (Lahiri *et al.*, 2017). The ICAR-IIOR Sunflower Mobile has been developed to offer valuable information on improved and latest varieties/hybrids and package of practices of sunflower to extension professionals, farmers, researchers, students and other stakeholders. The Apps can contribute significantly toproduction and productivity of sunflower and boost sunflower farming in India.

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J 87 (GG 36): A high yielding Spanish bunch groundnut variety for zone-I

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ABSTRACT

Groundnut genotype J-87 was evaluated in AICRP-G trials over the 6 locations and three years during the *Rabi*/Summer seasons of 2014-15 to 2018-19. Mean pod yield 4165 kg/ha, which was higher than the check varieties *viz*., TAG 24 (3680 kg/ha), Dh 83 (3671 kg/ha), and SG 99 (3237 kg/ha). Thus, this genotype expressed an overall improvement of 13.18%, 13.45%, and 28.66% in pod yield over the zonal check varieties. J 87 recorded average 100-kernel weight of 63.00 g, shelling out-turn of 71.00% and oil content 50.00%. The damage due to insect pest was at par while diseases showed comparable reactions.

Keywords: Groundnut, J-87, Yield

Groundnut (*Arachis hypogaea* L.) is the world's third and fourth most important sources of vegetable protein and edible oil, respectively. It has gained a lot of economic and nutritional importance worldwide. It is regarded as poor man's cashews and has become a replacement for expensive nuts such as almonds, cashews and pistachio in urban snack bars. The area under groundnut in India during 2020-21 was 60.93 lakh hectares having 102.09 lakh tones production along with productivity of 1676 kg/ha (Anonymous, 2021). Main objectives were to replace the old varieties and to develop high yielding Spanish bunch varieties suitable for *rabi/*summer cultivation in Zone-I.

MATERIALS AND METHODS

The Spanish bunch groundnut variety J 87 was developed by hybridization JVR-244 x JB-866 followed by pedigree method of selection. The genotype was evaluated under AICRP-G trials during *rabi/*summer, 2014-15 to 2018-19 at 6 AICRP-G locations of Zone-I. The yield data were analyzed as per randomized block design as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

On the basis of mean pod yield data from the AICRP-G trials, J 87 had proven its superiority by giving higher pod yield by 13.18%, 13.45% and 28.66% over the zonal check varieties (Table 1). Average kernel yield of J 87 was 3000 kg/ha, which was 12.23%, 12.25% and 27.51% higher over the zonal check varieties over the 6 locations and three years in rabi/summer seasons (Table 2). Ancillary observations of economic attributes of J 87 along with the checks are presented in Table 4. Major pests and diseases were compared along with J 87 and presented in (Table 4). Based on its consistent superior performance over locations and years, J 87 has been proposed for release for general cultivation in the rabi/summer groundnut growing areas of Zone–I

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Table 1 Mean pod yield (kg/ha) performane of J 87 in the AICRP trials in Zone-I

Particular	Year of testing and stage		No. of trials	Proposed variety J 87	Check varieties			C.D. at 5%	C.V. %
					TAG 24 (ZC)	Dh 86 (ZC)	SG 99 (ZC)		
Mean yield (kg/ha)	IVT(SB)-I	2014-15	2	4393	3598	3970	2946	-	-
	IVT(SB)-II	2015-16	2	4059	3688	3611	3492	-	-
	AVT(SB)	2018-19	2	4042	3754	3432	3274	429	9.1
			Weighted Mean (6)	4165	3680	3671	3237	-	-
Per cent increase/ decrease over checks	IVT(SB)-I	2014-15	2	-	22.11	10.65	49.14	-	-
	IVT(SB)-II	2015-16	2	-	10.06	12.41	16.25	-	-
	AVT(SB)	2018-19	2	-	7.69	17.77	23.46	-	-
			Weighted Mean (6)		13.18	13.45	28.66	-	-

Table 2 Mean kernel yield (kg/ha) performance of J 87 in the AICRP trials in Zone-I

Particular	Year of testing and stage	No. of trials	Proposed variety J 87	Check varieties TAG 24 (ZC)	Dh 86 (ZC)	SG 99 (ZC)	C.D. at 5%	C.V. %
Mean yield (kg/ha)	IVT(SB)-I 2014-15	2	3203	2738	2988	2154	-	-
	IVT(SB)-II 2015-16	2	2899	2634	2654	2600	-	-
	AVT(SB) 2018-19	2	2896	2645	2374	2303	294	8.8
	Weighted Mean (6)		3000	2672	2672	2352	-	-
Per cent increase/ decrease over checks	IVT(SB)-I 2014-15	2	-	17.00	7.21	48.72	-	-
	IVT(SB)-II 2015-16	2	-	10.04	9.23	11.48	-	-
	AVT(SB) 2018-19	2	-	9.55	21.97	25.75	-	-
	Weighted Mean (6)			12.23	12.25	27.51	-	-

Table 3 Ancillary observations of economic attributes of groundnut variety J 87 along with zonal checks

Character	Variety J 87	Zonal Check Varieties TAG 24	Dh 86	SG 99
Pod yield (kg/ha)	4165	3680	3671	3237
Kernel yield (kg/ha)	300	2672	2672	2352
Shelling out-turn (%)	71	72	72	72
Oil content (%)	50	50	50	50
100- kernel wt. (g)	63	47	52	48

Table 4 Reaction of groundnut variety J 87 along with zonal checks against insect-pests and diseases at various AICRP-G centers

Insect-Pests	**Highest score**	**Check varieties** **Proposed variety J 87**	**TAG 24 (NC)**	**Dh 86 (ZC)**	**SG 99 (ZC)**
Thrips	9	2-8	2-8	2-8	2-8
Jassids	7	2-6	2-5	2-5	2-6
Jassids (% damage)	9	1-5	1-9	1-6	1-5
Spodoptera litura	5	1-3	1-3	1-3	1-3
Leaf miner	9	2-8	2-8	2-8	2-8
Diseases					
Rust	6	1-4	1-5	1-5	1-5
LLS	9	1-8	1-8	1-9	1-8
ELS	3	1-2	1-2	1-2	1-2
Alternaria leaf blight	6	1-6	1-5	1-4	1-5
Stem rot %	15	9	10	9	8
Collar rot %	11	4	6	4	4
PBND %	9	4	4	3	2
Dry root rot %	13	9	5	6	2

Effect of scheduling of irrigation on yield and economics of safflower genotypes under limited water availability conditions

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ABSTRACT

A field experiment was carried out to find out the effect of irrigation schedules for a suitable variety of safflower (*Carthamus tinctorius* L.) using 3 genotypes and seven irrigation schedules.. The seed yield of safflower was significantly influenced by safflower genotypes. The seed yield of safflower was significantly higher in DSH-

184 (1253 kg /ha) which was followed by TSF-1 (1123 kg /ha). While NARI-6 recorded the lowest yields (972 kg /ha). The seed yield of safflower differed significantly due to the application of irrigation at critical stages of the crop. The crop received 3 irrigations each at the Stem elongation stage + Early flowering stage + Seed filling stage resulting in significantly superior yields (1489 kg/ha) which was followed by 2 irrigations each at the Stem elongation stage + Early flowering stage (1408 kg/ha) and 2 irrigations each at the Stem elongation stage + Seed filling stage (1303 kg/ha). Crop grown completely under rainfed conditions recorded the lowest yield (776 kg/ha). The seed yield increased up to 47.88% by providing 3 irrigations each at Stem elongation, Early flowering and Seed filling stages as compared to rainfed conditions.

Keywords: Irrigation, Safflower, Variety

Safflower (*Carthamus tinctorius* L.) belongs to the family Asteraceae and is one of the oldest crops in the world cultivated since ancient times for orange-red dye and for oil. Dye was used primarily for colouring in food and textile industry. Safflower produces oil, rich in poly-unsaturated fatty acids (PUFA) which lowers blood cholesterol levels and is considered as a healthy cooking medium. Plants are 30-150 cm tall with globular flower heads (capitula) and strong taproot which enables it to thrive in dry climates. Major producers of safflower in the world are Kazakhstan, USA, Mexico and India. In world it occupies 0.62 M ha area with an annual production of 0.69 MT and average productivity of 903.3 kg /ha (Indiastat, 2019-20). In India safflower is grown in winter dry season "*rabi*" in a mixture with other "*rabi*" crops, such as wheat and sorghum. In India, it is grown in an area of 46,000 ha with a production of 25,000 tonnes and productivity of 537 kg /ha (Indiastat, 2019-20). Cultivation of safflower is largely confined to states of Karnataka, Maharashtra, Telangana, Andhra Pradesh, Jharkhand, Odisha, Arunachal Pradesh, Chhattisgarh and Bihar. Karnataka is leading safflower-producing state. Safflower occupies an area of 2000 ha with production and productivity of 2210 tonnes and 1105 kg /ha respectively in Telangana state (Indiastat, 2019-20). Growth of domestic production of oilseeds has not been able to keep pace with the demand. Technology Mission on Oilseeds (TMO) launched in 1986 was the first comprehensive intervention by government of India aiming at self-sufficiency in edible oils. The mission was met with early success. However, increasing demand for edible oils necessitated imports in large quantities leading to substantial drain of foreign exchange. Despite having largest area under oilseeds in the world, India imported 11.95 MMT of edible oils in 2019-20 (Indiastat, 2019-20). Under irrigated conditions, safflower can give almost double the yield of a rainfed crop. Under scanty soil moisture conditions in dry lands, yield can be boosted by 40 to 60 % by providing one life-saving irrigation (5 to 8 cm) at critical phases of crop growth (early stem elongation or flowering) or before soil moisture becomes limiting for crop growth (Hegde, 2002). Higher productivity can be achieved by scheduling irrigation at critical stages (Suryavanshi *et al*., 2007) and scheduling irrigation three times for safflower crop, increased plant growth and yield parameters resulting in higher seed yields (Chordia and Paur, 1986). The information on Irrigation scheduling based on critical stages under limited water availability in Telangana is very meager. Safflower production can be increased by developing high yielding varieties having a high degree of tolerance against biotic and abiotic stresses. Hence, the experiment was conducted to identify critical stages of safflower for irrigation under limited water resources and to find out the performance of different safflower genotypes under different irrigation schedules.

MATERIAL AND METHODS

A field experiment was carried out during *rabi*, 2020-21 at the Agriculture Research Station, Tandur, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Telangana which is geographically situated at an altitude of 461 m above mean sea level (MSL) (17^o 15' N latitude and 77^o 35' E longitude). The experiment was carried out in split-plot design with three safflower genotypes assigned to main plots and seven irrigation schedules allotted to sub plots which were replicated thrice. The main plots consisted of three safflower genotypes *i.e.*, M1 - TSF-1, M2 - DSH - 185 (Hybrid) and M3 - NARI-6 (Non-Spiny). The horizontal (split) plots contained seven irrigation schedules T1: If one irrigation is available - at 50 DAS (Stem elongation stage), T2: If one irrigation is available - at 75 DAS (Early flowering), T3: If two irrigations were available - Each at 50 & at 75 DAS (Early flowering), T4: If three irrigations were available - Each at 50, 75 & at 100 DAS (Seed filling), T5: If two irrigations were available - Each at 50 & 100 DAS, T6: If two irrigations were available - Each at 75 & 100 DAS, T7: Control (Purely Rainfed). Soil of the experimental field was clay loam in texture, non-saline (0.30 dSm^{-1}), neutral in reaction (pH 7.91), low in organic carbon (0.37%), medium in available nitrogen (228 kg /ha) and phosphorus (23 kg /ha) and high in available potassium (405 kg /ha). Safflower was hand-dibbled on flat bed at a spacing of 45 cm × 20 cm. The recommended dose of phosphorus (40 kg /ha) was applied through single super phosphate in the last ploughing and nitrogen and potassium (40 and 30 kg /ha, respectively) through urea and muriate of potash fertilizers, respectively were applied after sowing of seed followed by irrigation by check basin method. Measured quantity of water through water meter was applied as per treatments with the formula of Area × depth = discharge × time. The crop was grown as per recommended package of practices except irrigation and need based plant protection measures were adopted. The data was analyzed statistically as per standard procedure. The experimental data obtained at different growth stages was compiled and subjected to statistical analysis by adopting Fischer's method of analysis of variance technique as outlined by Gomez and Gomez (1984). The level of significance used in 'F' test was p = 0.05. The critical difference (CD) value was given in the table at 0.05per cent level of significance.

RESULTS AND DISCUSSION

Yield

Safflower Genotypes: Seed yield of safflower was significantly influenced by safflower genotypes. Seed yield of safflower was significantly higher in DSH-184 (1253 kg /ha) which was followed by TSF-1 (1123 kg /ha). While, NARI-6 recorded the lowest yields (972 kg /ha).

Irrigation Schedules: Seed yield of safflower differed significantly due to application of irrigation at critical stages of the crop. The crop received 3 irrigations each at Stem elongation + Early flowering + Seed filling stages resulted in significantly superior yields (1489 kg/ha) which was followed by 2 irrigations each at Stem elongation stage + Early flowering stage (1303 kg/ha) and 2 irrigations each at Stem elongation stage + Seed filling stage (1184 kg/ha). Crop grown completely under rainfed conditions recorded the lowest yield (776 kg/ha). The seed yield increased up to 47.88% by providing 3 irrigations each at stem elongation, early flowering and seed filling stages as compared to rainfed condition. This might be due to scheduling irrigation at all growth stages created differential soil moisture resulted in positively increased number of fertile flowers consequently number of capitula and number of seed/plant thereby increased seed yield. The similar results were observed by Eslam (2011), Khadtare (2018) and Orange and Ebadi, 2012. Reduced seed yield under rainfed condition mainly attributed to unavailability of moisture during different phenological stages and also increased competition for moisture between the plants thereby reduced the number of capsules/plant, number of seeds/capsules, 100 seed weight, were significantly different and positive correlation with seed yield, this is mainly attributed to accelerated aging and reduced length of growing period and net photosynthesis. These findings are in close conformity with those of Koutroubas *et al*. (2000) and Clavel *et al*., (2005).

Economics

Safflower Genotypes: Higher gross returns, net returns and B:C Ratio was noticed with DSH-184 (Rs. 60004 /ha, Rs. 42853 /ha and 3.48) which was followed by TSF-1 (Rs. 53943 /ha, Rs. 36804 /ha and 3.14), respectively. Lowest gross returns (Rs. 46281 /ha), net returns (Rs. 29177 Rs /ha) and B:C Ratio (2.69) was recorded in NARI-6.

Irrigation Schedules: Higher gross returns, net returns and B:C Ratio was noticed with 3 irrigations each at 50, 75 & at 100 DAS (Rs. 70221/ha, Rs. 52403/ha and 3.94) which was followed by 2 irrigations each at 50 & at 75 DAS (Rs. 63535/ha, Rs. 46218/ha and 3.67), respectively. Lowest gross returns (Rs. 37897/ha), net returns (Rs. 21580/ha) and B:C Ratio (2.32) was noticed when the crop was grown completely under rainfed conditions. Similar effect of irrigation schedules on economics of wheat crop has been reported by Kumar *et al*., (2015) and Meena *et al*., (2015).

Water Use Efficiency

Safflower Genotypes: Higher water use efficiency was recorded by TSF-1 (12.38 kg /ha/mm) which was on par with DSH-185 (11.75 kg /ha/mm). Lowest water use efficiency was noticed under NARI-6 (10.70 kg /ha/ mm).

Irrigation Schedules: Higher water use efficiency was recorded with one irrigation at Stem elongation stage (23.33 kg /ha/mm) which was on par with one irrigation at Early flowering stage (17.24 kg /ha/ mm). Lowest water use efficiency was observed with three irrigations each at stem elongation + early flowering + seed filling stages (9.93 kg /ha/mm). Water use efficiency showed declined trend with increasing number of irrigations. This was due to the fact that with increased water supply, the rate of evapotranspiration was proportionally higher than the increase in yield up to certain limit. Similar result was reported by Mahajan *et al*., (2007) and Sani *et al*., (2008).

Among safflower genotypes, DSH-185 was superior. Significantly higher seed yield of safflower were obtained at 3 irrigations each at stem elongation + early flowering + seed filling stages. Farmers may adopt DSH-185 genotype with 3 irrigations each at stem elongation + early flowering + seed filling stages for maximum production in limited condition of water.

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Table 1: Effect of Scheduling of Irrigation on Yield and Economics of Safflower Genotypes Under Limited Water Availability Conditions

Treatments	Seed yield (kg /ha)	Biological yield (kg /ha)	Harvest Index (%)	Cost of Cultivation (Rs /ha)	Gross Returns (Rs /ha)	Net Returns (Rs /ha)	B:C Ratio
Main plots - Safflower Genotypes (3)							
M1	1123[b]	3866[b]	22.31[b]	17104	53943[b]	36840[b]	3.14[b]
M2	1253[a]	4211[a]	22.72[a]	17151	60004[a]	42853[a]	3.48[a]
M3	972[c]	35686[b]	21.17[b]	17104	46281[b]	29177[b]	2.69[b]
SEd±	18.7	84.4	0.29	-	624.9	624.9	0.04
C.D (p=0.05)	37.2	180.0	0.61	-	1332.3	1333.3	0.08
Sub-plots - Irrigation Schedules (7)							
S1	1172[d]	4103[d]	22.20[d]	16818	54409[d]	37591[d]	3.23[d]
S2	862[f]	3417[d]	20.14[f]	16818	40736[f]	23918[f]	2.42[f]
S3	1303[b]	4204[a]	23.62[b]	17318	63535[b]	46218[b]	3.67[b]
S4	1489[a]	4411[a]	25.22[a]	17818	70221[a]	52403[a]	3.94[a]
S5	1184[c]	4040[b]	22.66[c]	17318	56810[c]	39492[c]	3.28[c]
S6	1030[e]	3864[c]	20.97[e]	17318	49812[e]	32493[e]	2.88[e]
S7	776[g]	3163[e]	19.67[g]	16318	37897[g]	21580[g]	2.32[gf]
SEd±	37.7	214.2	0.499	-	1273.1	1273.1	0.07
CD (0.05)	76.5	250.9	1.013	-	1332.3	2581.8	0.15
Interaction	NS	NS	NS	-	NS	NS	NS

Table 2: Water use efficiency (kg ha/mm) in safflower as influenced by genotypes and irrigation scheduling

Treatments	Quantity of Irrigation Water Applied/ha (mm)	Water Use Efficiency (kg ha /mm)
Main plots - Genotypes (3)		
M1	-	12.38[a]
M2	-	11.75[a]
M3	-	10.70[b]
SEd±	-	0.36
C.D (p=0.05)		1.65
Sub-plots - Irrigation Schedules (7)		
S1	50.0	23.44[a]
S2	50.0	17.24[b]
S3	100.0	13.03[c]
S4	150.0	9.93[f]
S5	100.0	11.84[d]
S6	100.0	10.30[e]
S7	-	-
SEd±	-	0.39
CD (0.05)	-	1.07
Interaction	NS	NS

Evaluation of yield stability in sunflower hybrids by AMMI analysis

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ABSTRACT

A total of 15 sunflower hybrids and 3 checks with three season experimental data for seed yield have been utilized for stability analysis in sunflower. Study revealed that presence of significant difference among genotypes/seasons and also due to interaction of significance for PCA1, PCA2 and PCA3. Among these, PCA1 alone recorded 92.30 percent of total sum of squares. High yielding sunflower hybrids *viz.,* CSFH 19004, CSFH 19087 and CSFH 19086 had PCA1 score close to zero indicating that these genotypes were less influenced by environments. Hence, the above said hybrids were stable and had general adaptability for both *Kharif* and *Rabi* seasons.

Keywords: AMMI analysis, Stability, Sunflower hybrids

Sunflower is an important oilseed crop and holding in fourth position in world vegetable oil production after palm oil, soybean and canola (Dimitrijevic and Horn, 2018). Sunflower is widely accepted for its high quality oil with lot of health benefits. In sunflower plant breeding programme, development of hybrids with high yield is a major objective because of their agronomic and economic advantages over varieties (Ahmad and Abdella, 2009). Identification of stable high yielding hybrids suitable for various environments/locations is essential factor to enhance the sunflower productivity. Hence, present investigation has been focused for evaluating the stability of newly developed sunflower hybrids over environments for assessing the yield potential of hybrids for each environment.

MATERIALS AND METHODS

The study comprised of fifteen sunflower hybrids evolved at the Department of Oilseeds, CPBG, TNAU Coimbatore with three checks (COH 3, DRSH 1, and GK 2002). The experiments were conducted in a Randomized Complete Block Design (RCBD) with three replications during three season's *viz.,Kharif* 2019, *Rabi* 2019-20 and *Kharif* 2020. Each entry was raised in 6 rows of 4.5m length with a spacing of 60cm x 30cm. Recommended package of practices were performed for raising of good crop. The replicated data on seed yield (kg/ha) were analyzed as individual location-wise followed by pooled analysis. Further the data were subjected to stability analysis of AMMI model as per the standard method by using PB Tools Software-IRRI, Philippines.

RESULTS AND DISCUSSION

AMMI analysis showed that existence of significant difference among genotypes, among seasons and also due to interaction of significance for PCA1, PCA2 and PCA3. Among these, PCA 1 alone recorded 92.30 percent of total sum of squares. Hence, IPCA1 alone may decide the G x E interaction within study.

Among the high yielding genotypes *viz.*, CSFH 19004, CSFH 19087 and CSFH 19086 had IPCA 1 score close to zero indicating that these genotypes were less influenced by environments (Fig. 1.). Hence, the above said genotypes were stable and had general adaptability for both *Kharif* and *Rabi* seasons. The checks, COH 3 and DRSH 1 were high yielders with moderate interaction with environments. Genotypes CSFH 19097 and CSFH 19045 were high yielders with high interaction with environment. Hence, these genotypes are not stable and further study must be done for identifying the factors which influencing the high response to environment. The genotypes CSFH 19089 and CSFH 19096 were high yielders and moderately interacting with environment (Tyagi *et al.*, 2018). Hence, sunflower hybrids *viz.*, CSFH 19004, CSFH 19087 and CSFH 19086 can be recommended for all seasons. Among the environments, E2 (Rabi season) was high yielding environment.

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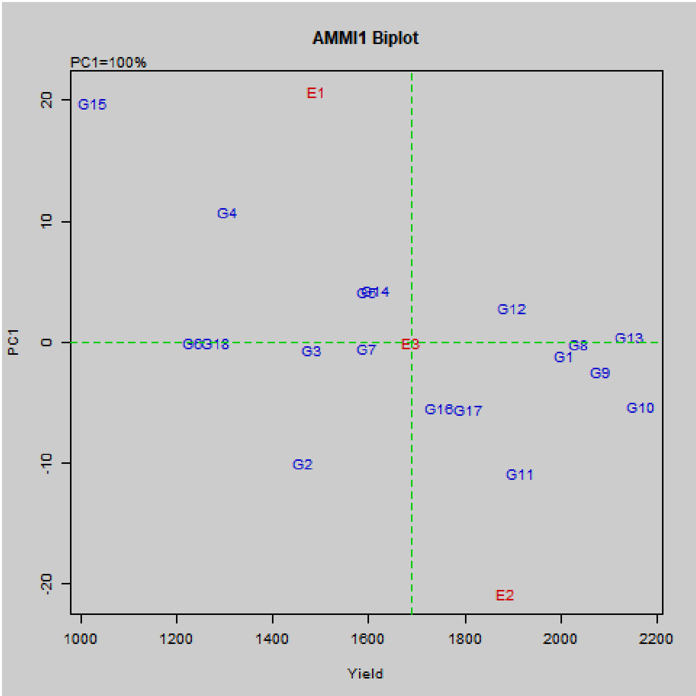

Augmented screening of sunflower inbreds for Alternariaster leaf blight disease under polyhouse conditions

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ABSTRACT

A total of 206 sunflower inbreds were screened for Alternariaster leaf blight resistance under poly house conditions. The results showed that eight sunflower inbreds including maintainer line, prebred lines and restorer lines *viz.*, HA24B, PB-898, PB-904, PB-205, PB-905, ID-32, PB-889, RGP-278-2 showed tolerant reaction to Alternariaster leaf blight and able to set good seeds under high pathogen pressure.

Keywords: *Alternariaster,* Inbreds, Sunflower

Sunflower Alternariaster leaf spot/blight is caused by *Alternariaster helianthi*. The disease is particularly destructive in tropical and sub-tropical regions where a combination of high temperature and extended periods of wet weather causes rapid epidemic development. The yield loss varied between 10-80%. Symptoms start with circular, dark brown to black lesions appears on leaves with concentric rings that resemble a target pattern. Under disease favorable conditions lesions coalesce, leading to necrosis, withering and blighting of entire leaves. Large, blackened stem lesions can girdle the plants and cause even stem breakage. This study aimed to identify sunflower inbreds, purebreds and restorer lines with *Alternaria*ster blight tolerance by screening under controlled augmented pathogen inoculated conditions.

MATERIAL AND METHODS

A total of 206 sunflower inbreds developed through random mating, prebred derived using diploid wild species *H. annuus* (wild), *H. debilis*, *H. petiolaris*, *H. argophyllus* and maintainer lines were used in this study. Sowing was taken under controlled poly house condition on 16, June 2022 in Randomized Block Design with 45 x 15 cm spacing. Sunflower accession TSG-208 was used as susceptible check. Artificial inoculation of pathogen was performed with spaying pathogen spore suspension on 30 and 45 days after sowing (DAS). Regular agronomic practices were followed and 28 ºC temperature and 90% RH were maintained during cropping season. Disease scoring was performed on 3 randomly in a row with 0-9 scale (Mayee and Datar, 1986) at every weekly interval from date of pathogen inoculation.

RESULTS

The results revealed that none of the sunflower genotypes tested showed resistance to Alternariaster leaf blight. However, 8 lines *viz.,* HA24B, PB-898, PB-904, PB-205, PB-905, ID-32, PB-889 and RGP-278-2 could show tolerance and able to set seeds even under high pathogen pressure under poly house screening.

The eight sunflower genotypes which showed tolerance under high disease pressure screening may be further tested for field performance for *Alternariaster* blight tolerance under multi-location trials and confirmed tolerant lines could be utilized in resistance breeding.

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Disease reaction of sunflower breeding material under poly house conditions

Disease scale	Disease reaction	Sunflower breeding material
0	Immune	Nil
1	Highly resistant	Nil
3	Resistant	Nil
5	Moderately resistant/tolerant	/HA24B, PB--898, PB--904, PB--205, PB--905, ID-32, PB--889, RGP-278-2
7-9	Susceptible/ Highly susceptible	RGP-202,RGP-255,RGP-248,RGP-236,RGP-137, RGP-201, RGP-278-1, RGP-252-2, RGP-252,RGP-238, RGP-231, RGP-293, RGP-273, RGP-302, RGP-265, RGP-306, RGP-217, RGP-161, RGP-162, RGP-163, RGP-164, RGP-166, RGP-167, RGP-168, RGP-169, RGP-170, PB--897, PB--881, PB--907, PB--910, PB--903, PB--902, R-177, RGP-166-1, RGP-160, RGP-132-1, RGP-193, RGP-172, RGP-158, RGP-209, RGP-264, RGP-253, PB--1198, PB--1162, RGP-170, RGP-152, PB--889, PB--893,TSG-027, PB--885, PB--888, PB--886, PB--882, PB--1201, PB--1142, CMS-108613, RGP-249, RGP-1-1254, EC-601624, RGP-237, RGP-241, RGP-233, TSG-204, EC-282338, TSG-401, RGP-1224, RGP-301, RGP-147, RGP-288, RGP-298, RGP-173, CMS-1007B, IC-75646, R/HA-1, EC-434372, RGP-172, RGP-139, RGP-218, RHA-601, RGP-256-2, IR-1, RGP-171, RGP-143, RGP-199, RGP-197, RGP-198, RGP-195, RGP-289, RGP-172-1, RGP-252-1, RGP-176, RGP-178, RGP-189, RGP-209, RGP-204, RGP-193, RGP-201, RGP-224, RGP-264, RGP-191, RGP-210, RGP-202, PB--883, PB--896, PB--901, PB--890, PB--900, PB--908, RGP-112, RGP-127, RGP-147, PB--892, PB--891, RGP-149, RGP-196-2, RGP-139, RGP-165, RGP-131, RGP-132, RGP-132-1, RGP-125, RGP-121, RGP-122, RGP-276, RGP-174, RGP-186, RGP-307, RGP-296-1, RGP-180, RGP-226, PB--906, PB--909, RGP-156, RGP-143, RGP-118, RGP-159, RGP-158, RGP-157, RGP-138, RGP-131, RGP-173, RGP-257, RGP-222, RGP-29, RGP-297, RGP-244, RGP-211, RGP-294, RGP-265-2, RGP-283, RGP-165, RGP-116, RGP-137, RGP-210, RGP-292, RGP-166-1, RGP-137-1,RGP-134,TSG-208, RGP-258, RGP-286, RGP-203, RGP-200, RGP-223, RGP-219, RGP-240, TSG-227, TSG-266, RGP-213, RGP-251, RGP-248, TSG-256, RGP-155, TSG-284, TSG-297, TSG-291

Influence of weather factors on male *Spodoptera litura*(Fab.) moth catches in pheromone trap in groundnut ecosystem

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ABSTRACT

A regular field monitoring was done since five years at AICRP on Groundnut, MARS, Dharwad, Karnataka during *Kharif* &*rabi*/summer (2017 to 2021). In nutshell, the highest and lowest moths collected/trap were in *Kharif*-2021 and *Kharif*-2019 respectively. Collections were more in *Kharif* compared to *rabi.* Overall, the highest trap catches were in the month of July & August. The minimum temperature, relative humidity and rainfall had a positive correlation with the moth trapping, while the maximum temperature had a negative correlation**.** Pheromone traps can be used an effective tool in IPM to assess population fluctuations and forewarn the needy.

Keywords: Groundnut**,** Pheromone trap, *Spodoptera litura*, Weather

Spodoptera litura (Noctuidae:Lepidoptera) is the most significant pest of groundnut during *Kharif* at Dharwad and has been recognised as hot spot, with a yield loss upto 66.6 percent(Mohammad Saleem *et al*., 2019). Chemical management seem to be harmful and not feasible with increasing reports of pest resistance.So, pheromone traps have shown to be an effective alternate tool for assessing population density variations and forewarn. In order to implement need-based IPM, it is crucial to understand the variations in *S. litura* moth catches in pheromone traps, and their interactions with weather parameters and hence the study.

MATERIALS AND METHODS

The male moths of *S. litura* were caught in pheromone traps installed at MARS, Dharwad fields at a distance of 100 m and lures were changed once in every 15 days during *Kharif* & *rabi*/summer (2017 to 2021). Observations on the number of moths caught in each traps were recorded weekly (26 to 42 standard meteorological weeks: SMW) and correlated with weather factors.

RESULT AND DISCUSSION

Incidence of *Spodoptera litura* peaked in 2021 may be because of congenial weather factors. In contrast to that, *Spodoptera* trap catches were fell to its lowest level in 2019 may be because of high (1345.5mm) annual rainfall compared to the actual (900-1000 mm). In general, highest trap collections were in the months of July & August irrespective of the years. Moth collections were more in *Kharif* compared to *rabi* season. Moth captures had a significant negative correlation (-0.762) with maximum temperature and a positive correlation (0.389, 0.490, 0.786and 0.382) with minimum temperature and morning evening relative humidity and rainfall respectively. It was determined that *Spodoptera* population growth is favoured by congenial climatic conditions.

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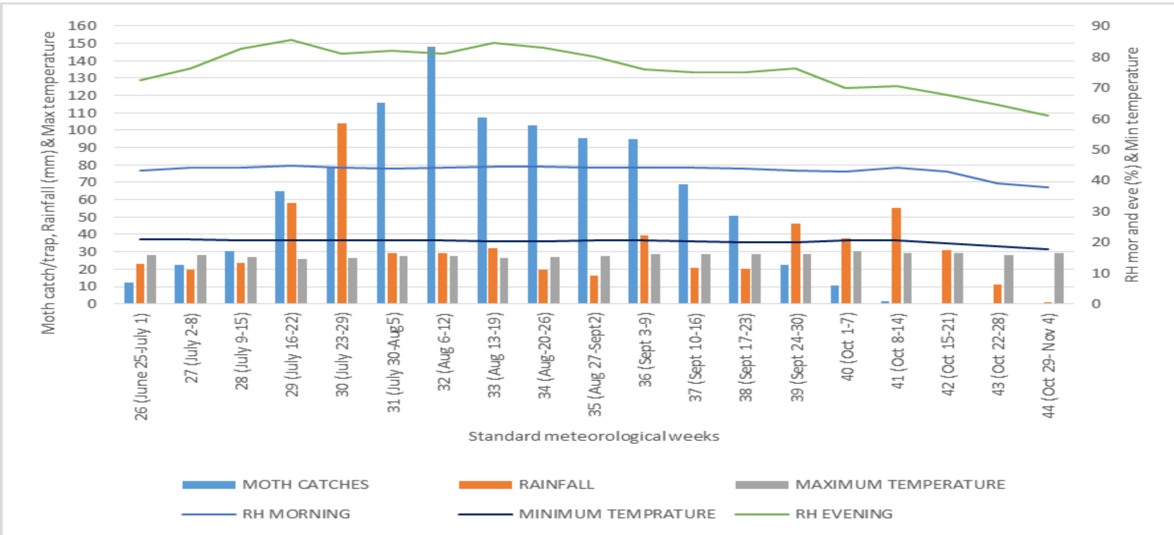

Fig1: Monitoring of *Spodopteralitura* male moths in groundnut using pheromone traps at Dharwad (*Kharif:* 2017-2021)
*values are mean of five years

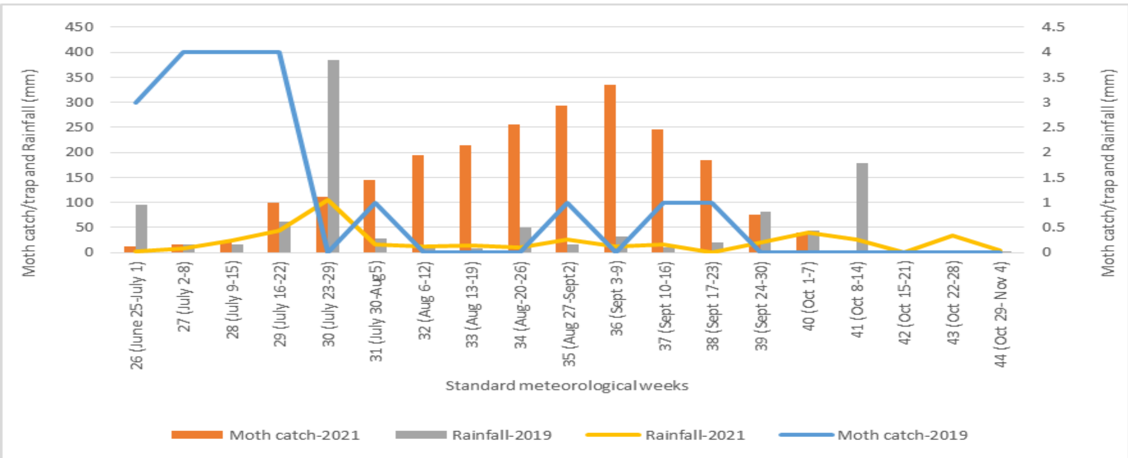

Fig 2:*Spodoptera litura* male moth pheromone trap catchesin groundnut during *Kharif*-2019 & 2021at Dharwad

Effect of nitrogen and sulphur nutrition on growth, yield and quality parameters in linseed (*Linum usitatissimum*) varieties

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ABSTRACT

The experiment was conducted with eighteen treatment combinations consisting of two varieties *viz.* LSL-93 (V_1) and NL-260 (V_2), three levels of N (0,40,60 kg/ha), three levels of S (0,25,50 kg/ha) replicated twice. The results indicated that the growth and yield attributing characters like number of branches, number of capsules, number of seeds/capsule, seed yield, oil content were appreciably better in the variety LSL-93 than NL-260. The application of N@ 60kg/ha and S@ 50kg/ha showed better results in improving the growth and productivity of linseed. Among the treatment combinations, $V_1N_3S_3$ (LSL-93:N60:S50) was found to be the most effective treatment.

Keywords: Growth, Linseed, Nitrogen, Sulphur, Varieties, Yield

Linseed (*Linum usitatissimum* L.) is an important oilseed crop and one of the approximately 230 species of the family Linaceae. Almost every part of the linseed plant is utilized either directly or after processing for commercial purpose. The seed contains a fine percentage of oil which varies from 33 to 47% depending on the varieties. The seeds contain 23% (18:3) Omega-3 fatty acids (mostly ALA) and 6% (18:2) Omega-6 fatty acids.

Plant nutrition is the route for increasing productivity and production capability of any crop depends mainly on the essential nutrients supplied for their growth. The average yield of 544 kg/ha in India was found to be very low compared to the world average yield of 927 kg/ha and highest average yield of 1497 kg/ha in Canada (FAOSTAT, 2018). The major factors responsible for low yield of oilseed crops are poor conditions of the soil, traditional management practices and inadequate supply of fertilizers. Among these, the imbalance of nutrients appears to be the most crucial one. Research studies have validated that the crop yield can be elevated by considerable supply of nutrients and choosing varieties that are high yielding. Among the major and essential elements, nitrogen and sulphur play an indispensable role in enhancing the produce quality and marketability. Nitrogen being a structural component of chlorophyll and protein, adequate supply is essential for carbohydrate and protein metabolism (Lawania *et al*., 2015). It promotes cell division and enlargement, resulting in more leaf area and thus ensuring better growth, development, plant vigour and yield (Patel *et al*., 2017). Sulphur also plays an important role in increasing yields. It is essential for formation of amino acids, chlorophyll and oil (Singh and Singh 2007). Taking this into account, this experiment was undertaken to evaluate the effects of different levels of nitrogen and sulphur on growth and yield in linseed varieties.

MATERIAL AND METHODS

The experiment was carried out at the research farm of All India Coordinated Research Project (AICRP) on Safflower, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra during *rabi* season of 2021-22 in a factorial randomized block design with eighteen treatment combinations replicated twice. The treatments consisted of combination of three rates each of nitrogen (0, 40, 60 kg N/ha), sulphur (0, 25, 50 kg S/ha) and two linseed varieties, LSL-93 and NL-260. Nitrogen and sulphur were supplied through urea and bensulf respectively according to the treatments at the time of sowing.

RESULTS AND DISCUSSION

The application of nitrogen and sulphur enhanced the growth and yield attributing characters of linseed *viz.* number of branches/plant, number of capsules/plant, number of seeds/capsule, seed yield, dry matter accumulation, test weight (g) and oil content of linseed (Table 1). Among the varieties, LSL-93 showed better performance and was significantly more effective in producing higher seed yield, oil yield and protein content over the variety NL– 260. Among the different levels of nitrogen, application of N@ 60 kg/ha was found to be most effective for improving the growth, productivity and protein content of linseed, whereas among the different sulphur levels, S@ 50 kg/ha showed better results w.r.t oil yield compared to the other levels of sulphur. Amongst all the eighteen treatment combinations, $V_1N_3S_3$ (LSL-93:N60:S50) was found to be the most effective treatment compared to the rest of the treatment combinations.

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Table 1: Growth and yield studies of linseed as influenced by different treatments of nitrogen and sulphur.

Treatments	No. of branches Per plant	No. of capsules Per plant	Dry matter accumulation (AH)	No. of seeds per capsule	1000 Seed Weight	Seed Yield (kg/net plot)	Straw Yield (kg/net plot)	Oil content (from seed)	Protein content (from seed)
A Varieties (V)									
V1 – LSL-93	8.62	28.47	3.52	9.21	8.79	0.373	0.467	37.73	15.60
V2 - NL-260	6.62	20.44	3.22	8.84	7.12	0.338	0.432	32.12	13.79
S.E. ±	0.004	0.25	0.06	0.06	0.004	0.005	0.008	0.04	0.20
C.D. at 5%	0.011	0.73	0.18	0.19	0.012	0.015	0.024	0.12	0.59
B Nitrogen Levels (N)									
N1 - @ 0 kg/ha	6.64	18.26	2.50	8.67	7.83	0.303	0.377	34.79	12.57
N2 - @ 40 kg/ha	7.58	22.92	3.23	9.02	7.95	0.355	0.459	34.93	14.53
N3 - @ 60 kg/ha	8.63	32.18	4.38	9.37	8.07	0.409	0.513	35.05	16.98
S.E. ±	0.004	0.30	0.07	0.08	0.005	0.006	0.010	0.05	0.24
C.D. at 5%	0.013	0.90	0.21	0.23	0.015	0.019	0.029	0.15	0.73
C Sulphur Levels (S)									
S1 - @ 0 kg/ha	7.38	22.53	3.10	8.90	7.91	0.338	0.415	34.43	14.39
S2 - @ 25 kg/ha	7.62	24.25	3.35	9.02	7.95	0.357	0.453	34.97	14.74
S3 - @50 kg/ha	7.85	26.58	3.66	9.15	8.00	0.372	0.481	35.37	14.96
S.E. ±	0.004	0.30	0.07	0.08	0.005	0.006	0.010	0.05	0.24
C.D. at 5%	0.013	0.90	0.21	NS	0.015	0.019	0.029	0.15	NS
D Interactions (4)									
V x N									
S.E. ±	0.006	0.43	0.10	0.11	0.007	0.009	0.014	0.07	0.34
C.D. at 5%	0.018	1.27	NS	NS	0.021	NS	NS	NS	1.03
V x S									
S.E. ±	0.006	0.43	0.10	0.11	0.007	0.009	0.014	0.07	0.34
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	0.21	NS
N x S									
S.E. ±	0.005	0.52	0.12	0.13	0.008	0.011	0.017	0.09	0.42
C.D. at 5%	0.015	1.56	NS	NS	NS	NS	NS	NS	NS
V x N x S									
S.E. ±	0.011	0.74	0.17	0.19	0.012	0.016	0.024	0.12	0.60
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
General Mean	7.62	24.45	3.37	9.02	7.95	0.355	0.449	34.92	14.69

Studies on response of seed quality parameters and chemical composition to nitrogen and sulphur nutrition in linseed (*Linum usitatissimum*) varieties

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ABSTRACT

A field experiment was carried out to evaluate the effects of different levels of nitrogen (0,40,60 kg/ha) and sulphur (0,25,50 kg/ha) on linseed varieties *viz.* LSL-93 and NL-260. The results indicated that the growth attributing characters like chlorophyll content; seed quality parameters like germination and vigour index were enhanced with the supply of nutrients, resulting in better growth of the crop. The nitrogen and sulphur content of seed were also improved and found highest with the application of N@ 60 kg/ha and S@ 50 kg/ha. The treatment combination, $V_1N_3S_3$ (LSL-93:N60:S50) was found to be the most effective amongst all the eighteen treatments.

Keywords: Growth, Linseed, Nitrogen, Sulphur, Seed vigour

Linseed (*Linum usitatissimum* L.) is an annual herbaceous plant grown for seed, oil and strong fibre produced in the stems, commonly known as flax. Every part of the crop is endowed with commercial and medicinal importance. Linseed being a rich source of Omega-3 fatty acids is helpful in the regulation of metabolism in the human body and also helps prevent many neurological and brain related problems. For commercial purpose, good quality lustrous fibre is obtained from linseed straw which blends well with cotton, wool and the pulp is used for making currency notes, reinforced plastic and other artisan purposes. Linseed cake, which is the oilcake left after the oil has been pressed out, is a very good source of manure and animal feed. It is also used as an organic manure which contains about N (5%), P_2O_5 (1.4%) and K_2O (1.8%) (Ahlawat, 2008).

The essential nutrients supplied to any crop mainly determine the growth, quality and productivity. Nitrogen (N), an essential macronutrient for the functioning of plants is an important component of chlorophyll whose role is very widely known in photosynthesis. It is also an important constituent of protein, enzymes and is involved in all processes associated with protoplasm and enzymatic reactions that play a key role in oil production (Franzen, 2004). Sulphur (S) is one of the seventeen essential nutrient elements which are necessary for the growth and development of the plants. It helps in the synthesis of cysteine, methionine, chlorophyll, vitamins, carbohydrate metabolism, oil content, protein content and is also associated with growth and metabolism (Najar *et al*., 2011). This experiment was undertaken to study the effects of different levels of nitrogen and sulphur on chlorophyll content, chemical composition and seed quality parameters in linseed varieties.

MATERIAL AND METHODS

The experiment was conducted in a factorial randomized block design with eighteen treatment combinations replicated twice during *rabi* season of 2021-22 at the research farm of All India Coordinated Research Project (AICRP) on Safflower, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. The combination of treatments consisted of three levels of sulphur (0, 25, 50 kg S/ha), nitrogen (0, 40, 60 kg N/ha), and two linseed varieties, LSL-93 and NL-260.Nitrogen and sulphur were supplied at the time of sowing, according to the treatments through urea and bensulf respectively.

Table 1: Chemical composition and seed quality parameters of linseed as influenced by different treatments of nitrogen and sulphur

	Treatments	Chlorophyll Content 35 DAS	Chlorophyll Content 60 DAS	Nitrogen Content (from seed)	Sulphur Content (from seed)	Germination Percentage	Seed Vigour Index I	Seed Vigour Index II
A	Varieties (V)							
	V1 – LSL-93	49.70	59.28	2.49	0.78	86.61	1099.53	69.35
	V2 - NL-260	46.68	56.03	2.21	0.73	85.75	1056.18	67.76
	S.E. ±	0.92	0.81	0.03	0.012	0.32	13.39	0.35
	C.D. at 5%	2.74	2.42	0.09	0.037	NS	39.97	1.04
B	Nitrogen Levels (N)							
	N1 - @ 0 kg/ha	38.97	52.46	2.01	0.74	83.83	988.47	63.15
	N2 - @ 40 kg/ha	48.39	58.60	2.32	0.75	86.83	1065.38	68.37
	N3 - @ 60 kg/ha	57.20	61.91	2.72	0.77	87.87	1179.72	74.15
	S.E. ±	1.12	0.99	0.04	0.015	0.39	16.40	0.42
	C.D. at 5%	3.35	2.96	0.12	NS	1.18	48.96	1.27
C	Sulphur Levels (S)							
	S1 - @ 0 kg/ha	45.13	56.27	2.30	0.69	85.58	1038.45	66.93
	S2 - @ 25 kg/ha	47.54	57.97	2.36	0.73	86.17	1077.63	68.71
	S3 - @50 kg/ha	51.90	58.71	2.39	0.85	86.79	1177.48	70.03
	S.E. ±	1.12	0.992	0.04	0.015	0.39	16.40	0.42
	C.D. at 5%	3.35	NS	NS	0.046	NS	48.96	1.27
D	Interactions (4)							
	V x N							
	S.E. ±	1.59	1.40	0.05	0.012	0.56	23.20	0.60
	C.D. at 5%	NS	NS	0.16	NS	NS	NS	NS
	V x S							
	S.E. ±	1.59	1.40	0.05	0.012	0.56	23.20	0.60
	C.D. at 5%	NS	NS	NS	0.036	NS	NS	NS
	N x S							
	S.E. ±	1.95	1.72	0.07	0.029	0.68	28.41	0.74
	C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
	V x N x S							
	S.E. ±	2.75	2.43	0.09	0.038	0.97	40.18	1.04
	C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
	General Mean	48.19	57.65	2.35	0.76	86.18	1077.85	68.55

RESULTS AND DISCUSSION

The application of nitrogen and sulphur resulted in improved chlorophyll, nitrogen and sulphur content enhancing the growth and quality of the produce. The seed quality parameters such as germination, seed vigour were also found to be improved with the increment in levels of nutrients (Table 1).

Among the varieties, LSL-93 showed better performance than NL– 260 w.r.t seed quality parameters, nitrogen content and sulphur content which are the major factors responsible for protein and oil content respectively. Application of N@ 60 kg/ha and S@ 50 kg/ha were found to be most effective for improving the growth attributes, chemical composition (nitrogen and sulphur content) and seed quality parameters of linseed, compared to the other levels of nitrogen and sulphur. Amongst all the eighteen treatment combinations, V1N3S3 (LSL-93:N60:S50) was found to be the most effective treatment compared to the rest of the treatment combinations.

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Study on the exploitation of heterosis for yield and yield contributing traits in sesame (*Sesamum indicum* L.)

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ABSTRACT

The present investigation was undertaken with the objective to study the magnitude of heterosis involved in 32 hybrids obtained by crossing 4 (female) x 8 (male) genotypes in L x T fashion along with their 12 parents and 2 standard checks (JLT-408 and PRACHI) evaluated during summer2019-20 at Oilseeds Research Station, Latur. The analysis of variance for experimental design revealed significance differences among the parents, hybrids and parents *vs* hybrids for most of the characters indicated the presence of genetic variability among the experimental material. The crosses *viz*., Swetha til x V-25, V-34 x TBS-12, V-32 x TBS-7, Swetha til x R-26 and Swetha til x TBS-12 found with high heterobeltiosis and standard heterosis over check JLT-408 and PRACHI for seed yield along with other yield contributing traits. Significant heterobeltiosis and standard heterosis for seed yield observed for majority of yield and yield attributing traits.

Keywords – Heterosis, Heterobeltosis, Standard heterosis, Sesame

Sesame (*Sesamum indicum* L.) is an ancient oil yielding crop and popularly known as “Queen of oil seeds” due to its excellent quality of the seed, oil and meal (Virani *et al.* 2017). It domesticated well over from 3000 years. Worldwide, it is used for its nutritional, medicinal, and industrial purposes. The genus Sesamum consists of many species and the most cultivated is *Sesamum indicum* L. has 2n=26 chromosome number. India is the largest producer of sesame in the world and ranks first in terms of sesame-growing area in which cultivated area of 19.53 lakh hectares with an annual production of 8.32 lakh tonnes and productivity of 478 kg/ha (Source: Ministry of Agriculture, Govt. of India).

In a self-pollinated crop like sesame there is a good scope for exploitation of heterosis. Heterosis is defined as the deviation of F_1 hybrid over its mid parent (Relative heterosis), better parent (heterobeltiosis) and standard parent (standard heterosis) as the consequence of hybridization. This evidently indicates the potentiality of the crop for improvement in yields. Commercial exploitation of heterosis is feasible only if the means of producing hybrid seeds economically could be made available. Commercial exploitation of heterosis was confined to cross pollinated group of plants with the success of hybrid rice, tomato etc. Efforts are under way to develop hybrids in sesame. Keeping all these facts in view, the present investigation including 32 crosses made by using line x tester mating design with eight genotypes were evaluated in randomized block design with two check varieties (JLT-408 and PRACHI) to estimate heterosis.

MATERIALS AND METHODS

The experiment was laid out in a randomized block design with two replications at Oilseed Research Station, Latur during *Summer* 2020. A total of 46 treatments, comprising 4 females, 8 males, 32 F_1`s and 2 checks. Crossing programme was carried out in line x tester design. The experimental material consisting of 4 lines (V-34, R-22, V-32, SHWETHA) and 8 testers (TBS-2, TBS-9, TBS-12, TBS-7, V-18, R-26, V-17 and V-25) along with two checks (JLT-408 and PRACHI). Five representative plants/treatment in each replication were selected randomly, tagged and observations were recorded on these plants for different characters *viz.* Days to 50% flowering, Days to maturity, Plant height (cm), Number of branches/plant, Number of capsules/plant, Number of seeds/capsule, Length of capsule (cm), Width of capsule (cm) 1000 seed weight (g), Seed yield/plant (g), Oil content (%).The mean values of all the treatments for the characters under study were worked out. Standard error and critical difference at 1 and 5per cent level of significance were calculated by using the formula (Panse and Sukhatme, 1985).per cent heterosis was estimated for all the characters under study over mid parent, superior parent and over standard check (Rai, 1979).

RESULT AND DISCUSSION

The analysis of variance revealed that, all the eleven characters showed highly significant differences in all treatments and crosses. Parents showed significant differences for all characters except plant height (cm) and number of branches/plant, indicating the presence of considerable amount of variability in all characters of experimental material.

The magnitude of heterobeltosis and standard heterosis was observed for all eleven characters. The genotypes with early flowering and maturity have a special significance in multiple cropping systems. Negative heterosis was considered as desirable for the character days to 50% flowering and days to maturity, for other characters positive heterosis was considered as desirable. The crosses exhibiting significant negative heterotic effects for this trait were considered as superior. Among 32 crosses, The Cross SWETHA x R-26, SWETHA x V-18 (-11.23%) and SWETHA x V-18 exhibited the highest significant negative heterosis over better parent. Similar result earlier reported by Patel *et al* (2016). Among the crosses V-32 x V-17 showed highest significant positive heterosis over better parent for plant height, similar results was reported by Chaudhari *et al.* (2015). Cross combinations V-34 x TBS-9, R-22 x TBS-9, SWETHA x TBS-9, V-32 x V-17 and V-34 x TBS-7 showed highest significant positive heterosis over check G-1 and JLT-408 respectively for plant height. Virani *et al.* (2017) reported similar results for plant height. For character number of branches/plant, the cross SWETHA x TBS-7 exhibited the highest significant positive heterosis over better parent followed by V-34 x TBS-2. For number of capsules/plant positive heterosis is desirable. The cross SWETHA x V-25, V-32 x TBS-7, V-32 x V-25, V-34 x TBS-9 and R-22 x V-25 showed highest significant positive heterosis over better parent. The cross combinations SWETHA x V-25, V-34 x TBS-9, V-32 x TBS-9, SWETHA x R-26 and V-34 x TBS-12 showed highest significant positive heterosis over standard checks. These results are in agreement with the result obtained by Jadhav *et. al.* (2013). For number of seeds/capsule, positive heterosis is desirable. Among the 32 crosses evaluated eight, three and three crosses showed significant positive heterosis over better parent, checks JLT-408 and PRACHI respectively. For the character length of capsule range of heterosis was from -40.84% to 17.54% over better parent, whereas -15.24 to 19.05 and -13.87 to 20.97 over checks JLT-408 and PRACHI. Similar results have been reported earlier by Chaudhari *et al.* (2015).

Among the evaluated 32 crosses six, ten and twelve crosses showed significant positive heterosis over better parent, checks JLT-408 and PRACHI respectively for 1000 seed weight. The cross V-34 x V-25 exhibited the highest significant positive heterosis over better parent for 1000 seed weight. Similar results earlier reported by Sundari and Kamala (2012). For seed yield/plant cross R-22 x V-18 exhibited the highest significant positive heterosis over better parent. The cross SWETHA x V-25, V-34 x TBS-12, V-32 x TBS-7, SWETHA x R-26 and SWETHA x TBS-12 exhibited the highest significant heterosis over check JLT-408 and PRACHI. These results are in agreement with the results of Beniwal *et al.* (2018). For oil content trait, cross R-22 x V-17 exhibited the highest significant positive heterosis over better parent followed by SWETHA x V-18 and V-32 x TBS-2. The crosses V-32 x TBS-2, R-22 x V-17 and SWETHA x V-18 exhibited the positive significant heterosis for oil content over the checks. These results are in similar with Virani *et al.* (2017) for oil content in sesame.

High heterotic hybrids for seed yield having high *per se* performance as well as significant desirable heterosis for other yield attributing traits were observed in the present study (Table 1). Therefore, selection of these hybrids either on the basis of *per se* performance or on the basis of magnitude of heterotic effects for sesame improvement would be reliable.

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Table 1: Heterosis of best five crosses on the basis of their/se performance for seed yield/plant and related traits in sesame

Crosses	Per se performance Seed yield / plant (g)	Heterosis (%)			Significant better parent heterosis for other traits in desirable direction	Better parent heterosis for other traits in desirable direction
		BP	SC 1	SC 2		
SWETHA x V-25	14.90	40.57**	39.25**	30.11**	DF, DM, PH, NC, NS	NB, SW, OC
V-34 x TBS-12	13.80	40.10**	28.97**	20.52**	DF, NC, NS	DM, PH, NB, WC, OC
V-32 x TBS-7	13.60	20.35	27.10**	18.78*	DF, NC, SW	DM, WC
SWETHA x R-26	13.40	26.42**	25.23**	17.03*	DF, DM, NC	PH, NB, NS, SW
SWETHA x TBS-12	13.20	23.53**	23.36**	15.28*	DM, NS, LC	DFF, PH, NC

*Significant at 5 % level, ** Significant at 1 % level

Whereas, DF = Days to 50 % flowering; NC = No. of capitulum/plant; OC = Oil content (%)
DM = Days to maturity; NS = No. of seeds/capitulum; LC = Length of capsule (cm)
PH = Plant height (cm); SW = 1000 -seed weight (g); WC = Width of capsule
NB = No of Branches

Identification of resistant sources against wilt disease in castor (*Ricinus communis* L.)

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ABSTRACT

An experiment was carried out under wilt sick plot at Regional Agricultural Research Station, Palem during *kharif*, 2019 to identify the potential sources of resistance against wilt disease in castor. A total of 99 germplasm accessions were screened under sick plot conditions. Observations were recorded as per cent wilt incidence periodically at thirty days interval up to 150 days in each germplasm accession. The national checks *viz*., JI-35 & 48-1 were used as susceptible and resistant checks respectively and were sown after every five test entries. Among the accessions, nine entries have shown immune reaction to wilt disease and 48 accessions were recorded less than 20% wilt incidence and the range of wilt incidence in the remaining accessions was 21.4 to 75 %. The wilt incidence in susceptible (JI-35) and resistant (48-1) checks were 100% and 0% respectively.

Keywords: Castor, Genotypes, Resistance, Wilt

Castor (*Ricinus communis*L.) is an important non-edible oilseed crop majorly grown in arid and semi-arid regions of the world. The castor oil has tremendous demand worldwide due to its industrial uses. Many biotic and abiotic factors were responsible for the low production and productivity of castor crop. Among these, biotic factors (pests and diseases) cause huge losses in castor. Wilt (*Fusarium oxysporum* f.sp. *ricini*) is one of the major diseases in castor crop sometimes it may cause nearly 80% yield loss in castor (Bindu Priya *etal*, 2016). The disease is soilborne in nature and which may not controlled easily by using all available management practices like cultural, chemical and biological methods. Host plant resistance is the alternative for the wilt management in castor crop.

Although severalwilt resistant hybrids, varieties were developed in recent past years but over a period of time the due to breakdown of resistance cultivars are becoming susceptible (Patel *et al*., 1991) and this can be due to the evolution of new pathotypes or environmental factors. In this regard, the present study was undertaken to identify the stable resistance sources against castor wilt from the germplasm accessions by screening under sick plot conditions.

MATERIAL AND METHODS

The field experiment was conducted in wilt sick plot during *kharif*, 2019 at Regional Agricultural Research Station, Palem, Nagarkurnool Dist., Telangana. The experiment was conducted in augmented block design and each accession was sown in one row of 6m length with 20 dibbles and a total 99 germplasm accessions were screened and the susceptible (JI-35) and resistant (48-1) were sown after every 5 accessions in the entire field. The sufficient inoculum load (2×10^3) was maintained throughout the experimentation period. The wilt incidence was recorded periodically after every 30 days till 150 days. The per cent wilt was calculated as per the formula given by Ahmad *et al*., 2010 & Ahammed and Reddy, 2009.

RESULTS AND DISCUSSION

Among the 99 germplasm lines, six lines with low population (< 9 plants) were excluded from the screening. Nine entries *viz.,* ICI-RG-2774-1, RG-4007, 4011, 4014, 4017, 4025, 4026, 4139 and 3390 showed immune reaction against *Fusarium* wilt with zero per cent incidence whereas 48 lines showed resistant reaction with less than 20 per cent disease incidence. Remaining lines showed susceptible reaction with an incidence of 21.4 to 75 per cent. Wilt incidence in standard checks JI-35 and 48-1 was 100 and zeroper cent respectively.

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Table: 1 Categorisation of castor germplasm accessions based on percent wilt incidence

Category	Percent Disease Incidence (PDI)	Germplasm accessions
Highly Resistant	0.0 %	ICI-RG-2774-1, RG-4007, 4011, 4014, 4017, 4025, 4026, 4139 and 3390
Resistant	1-20 %	ICI-RG-2800-4, ICI-RG-277-1, ICI-RG-2787-152-9, ICI-RG-2661-7-3-5-6, ICI-RG-2787-181-12, ICI-RG-3425-5, ICI-RG-2787-89-20, RG-3758, 3975, 3807, 3432, 3976, 3854, 4001, 4002, 4004, 4005, 4006, 4008, 4009, 4012, 4015, 4016, 4018, 4019, 4020, 4021, 3783, 3787, 4132, 4134, 4135, 4136, 4137, 4138, 4142, 4144, 4145, 4148, 3776,4163, 3772,3425, 3427, 3460, 3466 and 3482
Moderately Resistant	20.1-40.0 %	ICI-RG-2787-192-12, ICI-RG-2661-7-9-1-3, RG-4010, 4023, 4024, 4027, 4122, 4123, 4124, 3782, 4131, 4133, 4143, 4147, 3763, 3765, 3777, 3779, 3780, 4161, 4162, 3424, 3781, 3435, 3457, 3461, 3484, 3489, 3494, 3497 and 3502
Moderately Susceptible	40.1-50.0 %	RG-3759, 3786, 3491 and 4125
Susceptible	50.1-75 %	RG- 4003, 3786, 3429 and 3789
Highly Susceptible	>75%	Nil

Seed yield and quality parameters of mustard as influenced by organic manures, sulphur and foliar application of zinc and boron in northern Telangana zone

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ABSTARCT

Field experiment was conducted to study the effect of organic manures, sulphur and foliar application of Zn and Bon seed yield and quality parameters of mustard crop. Eleven treatment combinations were tested in the field. The treatment with 100% NPKS+ Foliar spray of 0.5% Zinc-EDTA and 0.2% Boric acid at flower initiation and at 50% flowering resulted in highest seed yield and quality parameters of mustard under Northern Telangana zone.

Keywords: Organic manures, Quality, Sulphur and micronutrients, Seed yield

Oilseeds are energy rich crops and obviously the requirement of major nutrients is very high (Yadav *et al*., 2017). Adoption of intensive and modern cropping practices with high yielding crop cultivars and unbalanced fertilizer application resulted in emergence of widespread secondary and micronutrient deficiency in soils and crops of India leadingto reduced crop yield and low micronutrient concentration in agricultural produce. Sulphur is a crucial element for mustardin determining its seed yield, oil content, quality and resistance to various biotic and abiotic stresses. Mustard, in general isvery sensitive to micronutrient deficiency, especially zinc and boron. Zinc plays an important role in building and growingplants through its participation in many vital processes, including photosynthesis and energy production (Mousavi, 2011). Boron plays a vital role in cell wall synthesis, root elongation, glucose metabolism, nucleic acid synthesis, lignification andtissue differentiation (Karthikeyan and Shukla, 2008). Application of organic manures substantially increased the seed andstoveryield of mustard dueto overall improvementin soil physico-chemical properties of soil and favored greater availability of essential plant nutrients and their steady supply throughout growth for optimum development (Srikanth *et al.,* 2020).

METHODOLOGY

The field experiment was conducted at Agricultural College, Jagtial during *rabi* 2021-2022 in Randomized Block Design (RBD) with 3 replications and 11 treatment combinations with recommended NPK dosages and differ in application of organic manures, sulphur and foliar spray of Zn and B. The soil of the experimental field was sandy clayloam in texture, slightly alkaline pH (7.74), EC (0.18 dSm^{-1}), organic carbon (0.58%), $CaCl_2$ extractable sulphur (9.2 ppm), DTPA extractable Zn (0.57 ppm), hot water-soluble B (0.45ppm) and available N, P and K of the soil was 179.2 kg/ha, 13.8 kg/ha and 310 kg/ha respectively.

RESULTS

Application of 100% NPKS+ Foliar spray of 0.5% Zinc-EDTA and 0.2% Boric acid at flower initiation and at 50%flowering recorded maximum seed yield (1271 kg /ha) while, the control treatment recorded minimum seed yield (526 kg/ha).

Significantly higher oil content (33.7%) and oil yield (427 kg /ha) in mustard was recorded with 100% NPKS+Foliar spray of 0.5% Zinc-EDTA and 0.2% Boric acid at flower initiation and at 50% flowering. Inturn the lowest oil content (26.4%) and oil yield (136 kg/ha) was recorded in control.

There is no significant difference in protein content of mustard under different nutrients management treatments.However, significantly highest protein yield was noticed in treatment with 100% NPKS+ Foliar spray of 0.5% Zinc-EDTA and 0.2% Boric acid at flower initiation and at 50% flowering (Table:1).

CONCLUSION

Based on the results obtained from current experiment, it can be concluded that application of sulphur (40 kg/ha) and foliar spray of Zn-EDTA (0.5%) and Boric acid (0.2%) at flower initiation and 50% flowering along with recommended dose of NPK recorded highest seed yield and quality parameters ofmustard.

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Table 1 Seedyieldandqualityparametersofmustardasinfluencedbyorganicmanures,sulphurandfoliarapplicationof Zn and B

Treatment	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)	Protein content(%)	Protein yield (kg/ha)
T_1-Control	526	26.4	136	16.2	80
T_2-100%NPK@60-40-40NPK kg/ha	834	28.4	237	20.5	171
T_3-100%NPKS@60-40-40-40 NPKSkg/ha	944	32.9	310	20.4	191
T_4-100% NPK+ Vermicompost@2.5t/ha	1086	31.8	347	20.1	217
T_5-100%NPK+FYM@5 t/ha	1073	31.3	337	20.0	215
T_6-100% NPK+ Foliar spray of0.5%Zinc-EDTAatflower initiationandat50%flowering	1027	31.2	319	18.9	194
T_7-100% NPKS + Foliar sprayof0.5%Zinc-EDTAat flower initiationandat50%flowering	1065	33.3	356	19.8	207
T_8-100% NPK + Foliar spray of0.2%Boricacidatflower initiationandat50%flowering	960	31.1	298	20.3	193
T_9-100% NPKS + Foliar sprayof0.2%Boricacidatflower initiationandat50%flowering	1036	33.2	345	19.1	198
T_{10}-100% NPK+ Foliar spray of0.5% Zinc-EDTA and 0.2%Boricacidat flowerinitiation andat 50%flowering	1101	32.7	361	20.5	224
T_{11}-100% NPKS+ Foliar sprayof 0.5% Zinc-EDTA and 0.2%Boricacidatflowerinitiation andat 50%flowering	1271	33.7	427	18.4	234
SEm±	67.92	1.34	25.35	1.66	14.02
CD(P=0.05)	200.36	3.95	74.79	NS	41.37

Effect on growth attributes, yield, and economics of mustard on different levels of irrigation and microbes

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ABSTRACT

The plant height, number of branches/plants, number of siliqua/plants, yield/plant, and test weight was greater in two irrigations along with seed treatment with MRD 17. A similar trend was noticed with respect to seed yield; however, it was on par with M_2S_2 (One Irrigation at 35 DAS along with MKS 6). seed yield/ha was observed highest in the treatment of two irrigation at 35 DAS and 65 DAS along with the microbial application of MRD 17 as a seed treatment during sowing.

Keywords: Growth attribute, Irrigation, Mustard, Microbes, Yield

Drought stress is one of the main issues lowering crop output and productivity in many arid and semi-arid parts of the world today, according to the current state of agriculture (Vurukonda et al., 2016). One of the most significant oilseed crops is *Brassica juncea* L, sometimes known as "Indian mustard," and it is widely grown in countries like India, Canada, Australia, China, and Russia. India leads Asia in both acreage and production of mustard, which accounts for about 23.7% and 26% of all oilseed production, respectively.

Rain-fed mustard is grown on all of the farmed lands, although severe droughts frequently affect the crop, causing substantial output losses and lowering the oil's nutritional value. Therefore, it is crucial to lessen the negative impacts of drought stress on mustard to boost farmers' revenue and decrease yield losses. Only a few researchers have documented how beneficial rhizobacterial inoculation can reduce drought stress in mustard and other crops. Bacillus sp. MRD-17, an osmotolerant plant growth promoting rhizobacterial (PGPR) strain, increased seed germination, increased seedling fresh weight, and decreased ethylene levels. Three different strains of Bacillus, Bacillus sp. MRD-17, MKS 6, Biophos + Biophos $^{+}$, CRIDA MI,I and CRIDA MI II were PGP positive. Under extreme moisture stress, injection with these rhizobacterial strains improved germinating seeds and increased plumule and radicle length in mustard and clusterbeansn.

It has been investigated to use enhanced agronomic methods, conventional breeding, and transgenic approaches to increase the plant's capacity to withstand drought stress. However, these methods need a lot of labor and money because they entail such complex technological elements. The use of rhizobacteria that promote plant growth is a successful option for combating drought stress in plants. PGPRs live inside plants' rhizospheres or are endophytic. Through a variety of direct and indirect processes, they have positive impacts on the plants during drought stress (Vikram K.V *et al*, 2022). These helpful microorganisms colonize the rhizosphere and endorhizosphere of plants and confer drought tolerance by producing exopolysaccharides (EPS), phytohormones, 1-aminocyclopropane-1-carboxylate (ACC) deaminase, volatile compounds, inducing osmolyte accumulation, antioxidants, up-or down-regulation of stress-responsive genes, and alteration in root morphology (Vurukonda. S. 2015).

MATERIALS AND METHODS

An experiment was conducted in *rabi* season of 2021-22 at AICRP on Linseed, College of Agriculture, Nagpur on Variety of TAM-108-1 with different irrigation levels and seed treatment with microbes in factorial Randomised block design with three replications. The treatment details are given below in Table 1.

RESULTS AND DISCUSSION

The plant height, number of branches/plants, number of siliqua/plants, yield/plant, test weight were greater in two irrigations along with seed treatment with MRD 17. These results are in conformity with the finding of Vikram K.V *et al*. (2022). A similar trend was noticed with respect to seed yield; however, it was on par with M_2S_2 (One Irrigation at 35 DAS along with MKS 6). Seed yield/ha was observed highest in the treatment of two irrigation at 35 DAS and 65 DAS along with the microbial application of MRD 17 as a seed treatment during sowing.

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Table 1

Treatments	Plant height (cm)	No. of Branches/plant	No. of Siliqua/plant	Yield/ plant (g)	Test weight (g)	Seed Yield Kg/ha
Factor A: Irrigation level						
M_1 - No Irrigation	113.22	2.54	135.19	7.05	6.23	1052
M_2 - One Irrigation at 35 DAS	134.14	3.03	216.00	9.02	6.18	1302
M_3 - Two Irrigation at 35 and 65 DAS	146.89	4.23	269.17	10.58	7.41	1539
SE(m)+	2.92	0.07	4.71	0.06	0.13	1.51
CD at 5%	5.29	0.19	13.56	0.17	0.37	4.33
Factor B: Seed treatment with microbes						
S_1 - MRD 17	139.73	3.33	224.38	9.67	7.59	1323
S_2 - MKS 6	137.92	3.02	214.71	9.07	6.58	1314
S_3 - Biophos + Biophos^{+}	136.44	3.04	205.51	8.99	6.62	1306
S_4 - CRIDA MI-I	123.58	2.87	188.87	8.80	6.50	1293
S_5 - CRIDA MI-II	115.78	2.76	180.60	8.58	6.39	1283
S_6 - No culture (Control)	108.16	2.58	179.58	8.20	5.97	1270
SE(m)+	4.20	0.09	6.67	0.08	0.18	2.13
CD at 5%	7.36	0.26	19.17	0.24	0.52	6.12
Interaction						
SE(m)+	7.28	0.16	11.54	0.20	0.31	55
CD at 5%	NS	NS	NS	0.58	NS	NS

Assessment of cadmium concentration in predominant Indian linseed cultivars

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ABSTRACT

Humans require consuming low quantities of cadmium (Cd), a non-nutritive and potentially toxic heavy metal, primarily *via* the dietary intake of grains. An analysis was conducted to investigate concentration of Cd content in 10 predominant linseed (Flaxseed) cultivars available at ICAR-IIOR. The objective of study was to provide information that will assist in the breeding of low Cd-accumulating linseed cultivars. Hence, efforts were made to identify varietal differences in the uptake of Cd in various seeds among 10 linseed cultivars grown in India in natural environment. The cadmium concentration in Indian cultivars ranged from 0.85 to 1.05mg/kg. Minimum Cd was noticed in cultivar BRLS and highest in Shekhar.

Keywords: Cadmium, Cultivars, Daily requirement, Linseed

Cadmium (Cd), a heavy, non-nutritive, and potentially toxic metal, is found naturally in the environment at low levels, although anthropogenic activities have resulted in substantially higher levels in the soil (Toppi and Gabbrielli, 1999). Soil-borne Cd is not a direct concern for human health. However, food borne Cd is the major route of exposure for most people (WHO, 1992). Cadmium is readily taken up by plants through their roots and some crops may accumulate higher levels of Cd in their seeds (Li et al. 1995 and Yan et al. 2010). Though linseed is included or recommended as one of the health foods to reduce the cholesterol, there is no information regarding the levels of Cd in linseed . However; the recommended weekly maximum dietary intake set out by the European Food Safety Authority is 2.5µg of Cd/kg of body weight. The concentration of Cd in flaxseed may influence food processor and consumer choices, particularly in the health food sector. To improve marketability and healthfulness of linseed, breeding of linseed cultivars for low Cd-accumulating genotypes may become an important choice in future.

MATERIAL METHODS

Ten predominantly cultivated linseed cultivars were obtained from the Crop Improvement Section of ICAR Indian Institute of Oilseeds Research, Rajendranagar Hyderabad. Sample preparation for wet acid digestion was done by powdering seeds in pestle and mortar. An amount of 0.5g ground powder for each cultivar was weighed and taken into 100 ml conical flasks. 10ml of nitric acid was added and kept overnight in fume hood for pre-digestion. Again 10 ml of diacid mixture (9:4 Nitric acid: Perchloric acid) to the predigested samples and kept in digestion chamber at 200^0C till white fume appeared. Digestion was completed when the clear precipitate was noticed. The digest was filtered and made up to the 100 ml volume with 1% nitric acid (AOAC, 1990). Appropriate aliquot of the digest was diluted and subjected to estimation of Cadmium concentration in Flame type Atomic Absorption Spectrometer of Perkin Elmer make (Model: PinAAcle 900F). Cadmium content in seeds was estimated by multiplying the content with dry weight. The daily intake of linseed for dietary requirement of cadmium for human nutrition was worked out based on the recommendation set out by European Food Safety Authority is 2.5µg of Cd/kg of body weight (EFSA, 2011).

RESULTS AND DISCUSSION

Ruling Indian varieties of linseed seed were analyzed for cadmium (Cd) concentration a toxic heavy metal and the results are presented in Table 1. Among the 10 linseed cultivars available at IIOR, the cadmium concentration ranged from 0.85 to 1.05mg/kg, respectively. Similarly, the Cd concentration in Canadian flax seed in the study ranged from 0.57mg/kg in AC McDuff to 1.40mg/kg in AC Emerson (House *et al*., 2020). A quick calculation shows that, even using the lowest accumulator included in the study, it would not be difficult to exceed the weekly-recommended 2.5µg Cd/kg of body weight/week after consuming flax seed. The health claim for whole flaxseed states that the daily amount of ground flax seed to reduce cholesterol is 40 g (0.28 kg/week). Based on the European Food Safety Authority, the recommended weekly maximum dietary intake of Cd is 2.5 ug/kilogram of body weight. This works out to be an intake of 150 ug/week for a person weighing 60kg. The intake of each cultivar on daily basis is worked out in Table 1 as per the recommendations. So based on the daily requirement of 40g linseed consumption for health benefits a person may intake cadmium to the extent of 238 to 412 µg/week which is too high than the requirement of 150 ug/week. This indicates there is more scope for breeding linseed varieties with low levels of Cd and studying the causes for excess presence of Cd in Indian conditions. Similarly, House et al. (2020) showed that Canadian flax seed contained 0.57 mg/kg (*i.e*. concentration in AC McDuff), an individual following the health claim could be inadvertently ingesting 160µg of Cd/week from flaxseed alone.This rough calculation puts into perspective the need to effectively and efficiently breed low Cd-accumulating cultivars.

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Table 1 Cadmium concentration in predominant Indian cultivars and its intake based on linseed consumption for health perspective as perEFSA

Cultivar	Cd concentration (mg/kg)	Cd in 40g intake of linseed (µg)	Weekly intake of Cd (µg)	Excess intake of Cd (µg)
T-397	0.97	38.8	271	121
RLC148	0.97	38.8	271	121
LMS-9-2K	0.99	39.6	277	127
Priyam	0.89	35.6	249	99
NL-503	1.01	40.4	283	133
KL-263	0.96	38.4	269	119
BRLS-119	0.85	34.0	238	88
Aparna	0.90	36.0	252	102
Shekhar	1.03	41.2	288	138
RLC-153	0.94	37.6	263	113

Screening of advanced breeding lines of castor against sucking pests

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ABSTRACT

Sucking pests *viz*., leafhopper and thripsare the major yield limiting biotic factors in castor. Growing resistant cultivars is an effective, eco-friendly and economical approach to manage these insect pests. Thirty three advanced breeding lines of castor were screened against the sucking pests along with susceptible and resistant checks during late *kharif* 2021.Among the 33 advanced lines screened, nine lines *viz*., MHC-9, JHB-1080, JHB-1098, SHB-1075, JHB-1099, SLCH-286, MHC-46, MHC-26 and ICH-277 exhibited highly resistant reaction to leafhopper (hopper burn grade 0 on 0-4 scale). Eight lines *viz*., MHC-9, JHB-1080, ICH-901, JHB-1099, MHC-46, MHC-26, SHB-1073 and ICH-277 were found promising against thrips.

Keywords: Advanced breeding lines, Castor, Leafhopper, Resistance, Screening, Thrips

Castor (*Ricinus communis* L.) is an industrially important non-edible oilseed crop of India.The current castor production in the country is 16.1 lakh tonnes from 8.3 lakh hectares with a productivity of 1937 kg/ha. One of the major constraints in exploiting higher productivity in castor is the damage due to insect pests. Among the insect pests, leafhopper (*Empoasca flavescens*) and thrips (*Scirtothrips dorsalis*) are the most important sucking pests during both *kharif* and *rabi* seasons. Use of host plant resistance as a key component of Integrated Pest Management system has greater potential than any other methods for pest management. Hence, the presentstudy was undertaken to screen the resistantsources inadvanced breeding lines of castor against leafhopper and thrips.

MATERIALS AND METHODS

A total of 33 advanced lines of castor [7 IAVHT-SD (short duration) lines, 20 IVHT-ND (normal duration) lines and 6 AVHT-I & II lines) were screened against leafhopper and thrips along with susceptible and resistant checks. Each line was sown in a single row of 6 m length with the spacing of 90 x 60 cm and replicated twice. The experiment was conducted in randomized block design at the Rajendranagar farm of the ICAR-Indian Institute of Oilseeds Research during late *kharif* 2021. Single row of susceptible check (DPC-9) was grown on both the sides of test entries in sandwich method. The data on leafhopper was recorded on three leaves, representing top, middle and lower canopy of each genotype and the respective hopper burn was recorded on 0-4 scale (Anjani *et al*., 2018).

Thrips population was observed on the immature spike (Duraimurugan and Alivelu, 2017).

RESULTS AND DISCUSSION

Among the 33 advanced lines screened, MHC-9 from IAVHT-SD; JHB-1080, JHB-1098, SHB-1075, JHB-1099, SLCH-286, MHC-46 and MHC-26 from IVHT-ND; and ICH-277 from AVHT-I&II exhibited highly resistant reaction to leafhopper (hopper burn grade 0 on 0-4 scale) and also recorded low population of leafhopper infestation as compared to susceptible check DPC-9, which recorded hopper burn grade of 4 on 0-4 scale (Fig. 1). MHC-9 from IAVHT-SD; JHB-1080, ICH-901, JHB-1099, MHC-46, MHC-26, SHB-1073 from IVHT-ND; and ICH-277 from AVHT-I&II were found promising with low infestation of thrips on immature spike (< 10 thrips/spike), while the susceptible check, DPC-9 recorded 36.5 thrips/spike. The resistance lines identified in this study can be used by breeding programs to develop castor cultivars resistant to sucking pests.

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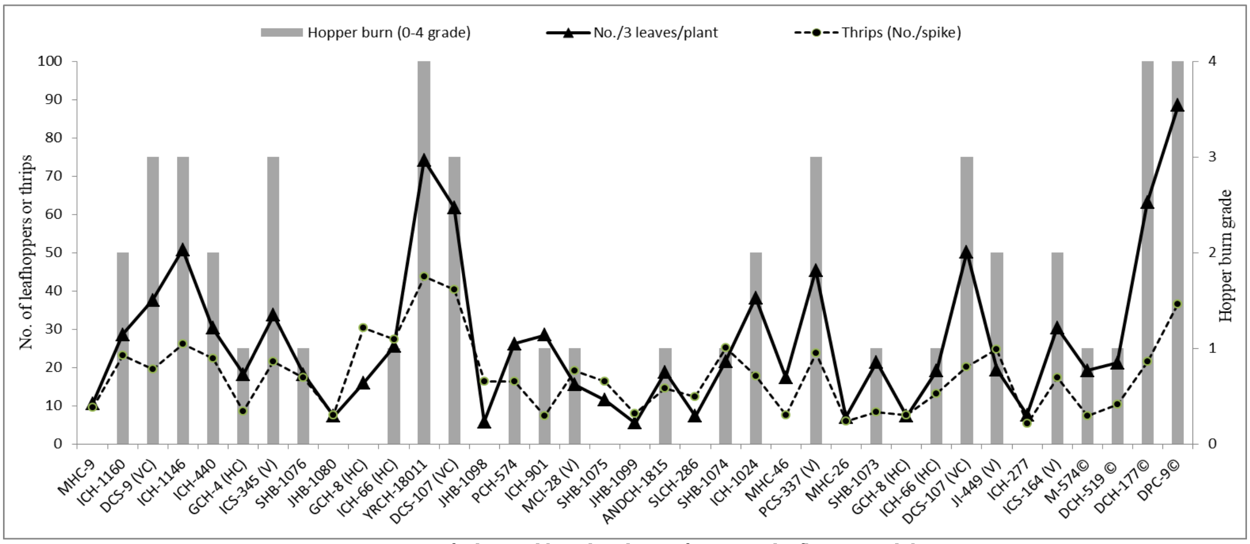

Fig. 1. Reaction of advanced breeding lines of castor to leafhopper and thrips

Study on exploitation of heterosis for yield and yield contributing traits in sesame (*Sesamum indicum* L.)

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ABSTRACT

The experiment was undertaken to study the magnitude of heterosis of 32 hybrids obtained by crossing 4 (female) x 8 (male) genotypes in L x T fashion including their 12 parents and 2 standard checks (JLT-408 and PRACHI). The ANOVA revealed significant differences among parents, hybrids and parents *vs* hybrids for most of the characters, indicating the presence of genetic variability. The crosses SWETHA x V-25, V-34 x TBS-12, V-32 x TBS-7, SWETHA x R-26 and SWETHA x TBS-12 showed high heterobeltiosis and standard heterosis over both checks for seed yield and yield contributing traits. Significant heterobeltiosis and standard heterosis observed for majority of yield and yield attributing traits.

Keywords: Heterosis, Heterobeltosis, Standard heterosis, Sesame

Sesame (*Sesamum indicum* L.) is an ancient oil yielding crop, popularly known as “Queen of oilseeds” due to its excellent quality of the seed, oil and meal (Virani *et al*., 2017). Worldwide, it is used for its nutritional, medicinal, and industrial purposes. The genus Sesamum consists of many species and the most cultivated is *Sesamum indicum* L. having chromosome number 2n=26. India is the largest producer of sesame in the world and ranks first in terms of area of 19.53 lakh hectares with an annual production of 8.32 lakh tonnes and productivity of 478 kg/ha(Source: Ministry of Agriculture, Govt. of India).

In a self-pollinated crop like sesame there is a good scope for exploitation of heterosis. Heterosis is defined as the deviation of F1 hybrid over its mid parent (relative heterosis), better parent (heterobeltiosis) and standard parent (standard heterosis) as the consequence of hybridization. This evidently indicates the potentiality of the crop for improvement in yields. Commercial exploitation of heterosis is feasible only if the means of producing hybrid seeds economically could be made available. Commercial exploitation of heterosis was confined to cross pollinated group of plants with the success of hybrid rice, tomato etc. Efforts are under way to develop hybrids in sesame. Keeping all these facts in view, the present investigation was carried out including 32 crosses made by using line x tester mating design in eight genotypes and two check varieties (JLT-408 and PRACHI) to estimate heterosis.

MATERIAL AND METHODS

The experiment was laid out in a randomized block design with a total of 46 treatments, comprising 4 females, 8 males, 32 F_1`s and 2 checks replicated twice at Oilseed Research Station, Latur during *Summer* 2020. Crossing programme was carried out with the help of line x tester design. The experimental material consisted of 4 lines (V-34, R-22, V-32, SHWETHA) and 8 testers (TBS-2, TBS-9, TBS-12, TBS-7, V-18, R-26, V-17 and V-25) along with two checks (JLT-408 and PRACHI). Five representative plants/treatment in each replication were selected randomly, tagged and observations were recorded for different characters *viz.* Days to 50% flowering, Days to maturity, Plant height (cm), Number of branches/plant, Number of capsules/plant, Number of seeds/capsule, Length of capsule (cm), Width of capsule (cm) 1000 seed weight (g), Seed yield/plant (g), Oil content (%). The mean values of all the treatments for the characters under study were worked out per cent heterosis was estimated for all the characters under study over mid parent, superior parent and over standard check (Rai, 1979).

RESULTS AND DISCUSSION

The analysis of variance revealed that, all the eleven characters showed highly significant differences in all treatments and crosses. Parents showed significant differences for all characters except plant height (cm) and number of branches/plant, indicating the presence of considerable amount of variability in all characters of experimental material.

Table 1: Heterosis of best five crosses on the basis of their/se performance for seed yield/plant and related traits in sesame

Sr. No.	Crosses	*Per se* performance Seed yield / plant (g)	Heterosis (%)			Significant better parent heterosis for other traits in desirable direction	Better parent heterosis for other traits in desirable direction
			BP	SC 1	SC 2		
1	SWETHA x V-25	14.90	40.57**	39.25**	30.11**	DF, DM, PH, NC, NS	NB, SW, OC
2	V-34 x TBS-12	13.80	40.10**	28.97**	20.52**	DF, NC, NS	DM, PH, NB, WC, OC
3	V-32 x TBS-7	13.60	20.35	27.10**	18.78*	DF, NC, SW	DM, WC
4	SWETHA x R-26	13.40	26.42**	25.23**	17.03*	DF, DM, NC	PH, NB, NS, SW
5	SWETHA x TBS-12	13.20	23.53**	23.36**	15.28*	DM, NS, LC	DFF, PH, NC

* Significant at 5 % level, ** Significant at 1 % level

Where,

DF= Days to 50 % flowering NC = No. of capitulum/plant OC = Oil content (%)
DM = Days to maturity NS = No. of seeds/capitulum LC = Length of capsule (cm)
PH = Plant height (cm) SW = 1000 -seed weight (g) WC = Width of capsule
NB = No of Branches

The cross V-32 x V-17 showed highest significant positive heterosis over better parent for plant height similar results was reported by Chaudhari *et al.* (2015). For number of branches/plant, the cross SWETHA x TBS-7 exhibited the highest significant positive heterosis over better parent followed by V-34 x TBS-2. For number of capsules/plant SWETHA x V-25, V-32 x TBS-7, V-32 x V-25, V-34 x TBS-9 and R-22 x V-25 showed highest significant positive heterosis over better parent.

For number of seeds/capsule eight, three and three crosses showed significant positive heterosis over better parent, checks JLT-408 and PRACHI respectively. For seed yield/plant cross R-22 x V-18 exhibited the highest significant positive heterosis over better parent. The cross SWETHA x V-25, V-34 x TBS-12, V-32 x TBS-7, SWETHA x R-26 and SWETHA x TBS-12 exhibited the highest significant heterosis over check JLT-408 and PRACHI. For oil content trait, cross R-22 x V-17 exhibited the highest significant positive heterosis over better parent followed by SWETHA x V-18 and V-32 x TBS-2. The crosses V-32 x TBS-2, R-22 x V-17 and

SWETHA x V-18 exhibited the positive significant heterosis for oil content over the checks.

High heterotic hybrids for seed yield having high *per se* performance as well as significant desirable heterosis for other yield attributing traits were observed in the present study (Table 1). Therefore, selection of these hybrids either on the basis of *per se* performance or on the basis of magnitude of heterotic effects for sesame improvement would be reliable.

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Relationships between morphological features of inflorescence and capsule borer incidence in castor

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ABSTRACT

The association of morphological features of inflorescence *viz*., presence/absence of spine on the capsule, presence/absence of bloom and compactness on the incidence of capsule borer was studied in breeding populations segregating for these traits. The spine and bloom on capsules were significantly correlated with per cent capsule damage whereas weak correlation was observed between spike compactness and pest incidence. Castor genotypes with non-spiny capsules and less or no bloom are expected to be less prone to capsule borer damage.

Keywords: Bloom, Capsule borer, Castor, Spike compactness, Spine on capsule

Shoot and capsule borer (*Conogethes punctiferalis*) is a serious pest of castor affecting the inflorescence (spike) and causing severe yield loss. It is commonly known as yellow peach moth. It is widely distributed and affect several crop species. Control of shoot and capsule borer (SCB) is a challenge because the larvae are concealed under fibrous material which does not allow contact with pesticide. For such pests, host plant resistance is an economical, environment friendly and sustainable option for management. It has been observed that castor genotypes differ in their susceptibility to SCB and the spike morphology plays a role in the extent of capsule damage. Therefore, this study was undertaken to verify the relationship between morphological features of inflorescence and SCB incidence.

MATERIALS AND METHODS

The SCB incidence was recorded on 100 randomly chosen F_3 plants of five different crosses raised in an experimental plot at ICAR-IIOR Research Farm, Narkhoda during *kharif*-2022. Severe incidence of SCB was noticed during October month. The spike characteristics *viz*., spine on capsules, presence/absence of bloom and compactness of the spike were recorded for all the selected plants. The per cent capsule damage for all the plants were worked out by counting the damaged and healthy capsules. As the independent variables are nominal and the dependent variable is continuous, point-biserial correlation was used to assess the relationship. Significance was calculated using forecasting efficiency (Vorhees, 1926).

RESULTS AND DISCUSSION

Out of 100 plants scored, 47 had compact spike and 53 had loose spike; 65 had spiny capsules and 35 had non-spiny capsules; 78 had bloom on capsules and 22 had no bloom capsules. The capsule damage ranged from 20 – 100%. The results of point-biserial correlation between the morphological features and the capsule damage indicated that spine on capsules exhibited significant correlation with per-cent capsule damage ($r = 0.463$). Similarly, significant correlation ($r = 0.577$) was found for presence/absence of bloom with per-cent capsule damage. However, no correlation ($r = -0.177$) was observed between compactness and per-cent capsule damage. The forecasting efficiency values of the independent variable *viz*., bloom, spine and compactness were found to be 18%, 11% and 1% respectively. Therefore, it is inferred that genotypes with non-spiny capsules with less or no bloom would be less prone to capsule borer damage. Earlier, Lakshminarayana (2005) has studied SCB preference on 12 castor lines differing in spike characteristics and reported moderate preference of SCB to the lines with small and non-spiny capsules and least preference to loose spikes. However, in this study, no correlation was found between spike compactness and capsule borer damage. The present study is based on larger pedigree population. Correlation results are expected to be more reliable in a familial population than diverse germplasm.

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GG HPS-2: A high yielding and large seeded Virginia bunch groundnut (*Arachis hypogaea* L.) variety for Gujarat state

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ABSTRACT

A Virginia bunch large seeded groundnut variety GG HPS 2 was developed from the cross JVB HPS 2 and GG 20. It recorded a higher mean pod yield (2835 kg/ha) and kernel yield (1945 kg/ha) as compared to the checks. GG HPS 2 recorded an average 100 kernel weight of 66.71 g, shelling out-turn of 68.61% and oil content of 48.82%. GG HPS 2 showed restistance reaction to tikka (leaf spot) and rust reaction, whereas it showed comparable resistance to stem rot, collar rot, damages due to leaf defoliators and thrips under field conditions with check varieties. Based on the superior performance, it has been released for kharif groundnut growing areas of the Gujarat State.

Keywords: GG HPS 2, Groundnut, High yield, Virginia bunch variety

Groundnut (*Arachis hypogaea* L.) is the world's fourth most important sources of edible oil and third most important source of vegetable protein. Gujarat is the leading groundnut growing state. The area under groundnut in Gujarat during 2020-21 was 21.63 lakh ha having 41.27 lakh tones production and a productivity of 1908 kg/ha (Anonymous, 2021). Presently, a *kharif* Virginia runner GJG HPS 1 is old and ruling variety under cultivation. Hence, with an objective to replace the old runner variety and develop a new Virginia bunch variety with desired agronomic features this research was understaken.

MATERIALS AND METHODS

The Virginia bunch groundnut genotype GG HPS 2 was developed by hybridization followed by pedigree method of selection. It is a derivative of JVB HPS 2 x GG-20. The genotype was tested and evaluated under multilocation trials in Gujarat state during *kharif*, 2013 to 2017. The genotype was evaluated under AICRP-G LSVT during *kharif* 2017 and 2018. It was screened for reaction to insect-pest and diseases under field conditions. All the recommended package of practices was followed for a good and healthy groundnut crop. The yield data were analyzed as per the randomized block design as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

On the basis of pod yield performance of GG HPS 2 proved its superiority in all the years. The mean pod yield of GG HPS 2 was 2835 kg/ha as compared to the checks *viz*., GJG HPS 1(2505 kg/ha) and ICGV 86564 (2478 kg/ha), which was 13.2% and 14.4% higher than the checks *viz*., GJG HPS 1 and GG-20, respectively (Table 1). The mean pod yield in the AICRP-G trials also revealed that the GG HPS 2 had recorded the highest pod yield of 2449 kg/ha as compared to the check varieties (Table 2).

The ancillary observations of economic attributes of GG HPS 2 along with the checks from the state trials at Junagadh centre are presented in Table 3. Average kernel yield of GG HPS 2 was 1945 kg/ha, which was higher over the check varieties. GG HPS 2 exhibited higher 100-kernel weight (66.71 g) over both the check varieties andshelling out-turn of this variety (68.61%) was at par with the check varieties.

The variety GG HPS 2 was screened for pests and diseases. It showed comparable reaction against damage due to thrips and leaf defoliator to both the check varieties. The GG HPS 2 was more resistant to tikka and rust as compared to the check varieties under field conditions. While, reaction against stem rot and collar rot was comparable to the check varieties under field condition. (Table 4).

By virtue of all the superior performance for high yields of pod, kernel and oil with better quality characteristics, the newly developed variety GG HPS 2 was identified for release by 14th Combined Joint AGRESCO Sub-committee Meeting of SAUs held at

Junagadh during 3-5 April, 2018 (Anonymous, 2018) for general cultivation in the groundnut growing areas of the Gujarat State.

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Table 1. Mean yield performance of GG HPS 2 in the Gujarat State

Season/Year	Name of Trial	No. of Locations	Pod yield (kg/ha)		
			GG HPS 2	GJG HPS 1(C)	ICGV 86564(C)
Kharif-2013	PET-LS	1	1806	1505	1357
Kharif-2014	SSVT-LS	2	3516	290	3349
Kharif-2015	LSVT-LS	3	2741	2564	2249
Kharif-2016	LSVT-LS	4	3091	2679	2707
Kharif-2017	LSVT-LS	3	2477	2266	2197
Overall Mean		(13)	2835	2505	2478
Overall % increase over the checks			-	**13.2**	**14.4**

Table 2. Mean yield performance of GG HPS 2 in the AICRP-G LSVT trials, in India

Season/Year	Name of Trial	No. of Locations	Pod yield (kg/ha)		
			GG HPS 2	Mallika (Z.C.)	TKG 19A (Z.C.)
Kharif-2017	LSVT-I	5	2444	2289	1899
Kharif-2018	LSVT-II	5	2454	2605	2647
Overall Mean		(10)	2449	2447	2273
Overall % increase over the check			-	0.08	7.18

Table 3. The ancillary observations GG HPS 2 along with checks at Junagadh centre

Character	Variety		
	GG HPS 2	GJG HPS 1(C)	ICGV 86564(C)
Pod yield (kg/ha)	2835	2505	2478
Kernel yield (kg/ha)	1945	1724	1408
Shelling out-turn (%)	68.61	68.81	69.26
Oil content (%)	48.82	49.05	50.00
100-kernel wt. (g)	66.71	50.88	56.81
Maturity days	121	121	123

Table 4. Mean rating of incidence of insect-pests and diseases at Junagadh centre

Diseases/Pests	Variety		
	GG HPS 2	GJG HPS 1(C)	ICGV 86564(C)
I. Diseases			
Tikka score (0-9)	3-5	4-6	3-6
Rust score (0-9)	0-6	0-6	0-4
Stem rot incidence (%) (In field conditions)	0.5-8.6	0.3-10.5	0.7-10.1
Collar rot incidence (%) (In field conditions)	1.2-9.4	1.6-9.1	1.8-6.3
II. Pests			
% leaf damage by thrips	0.0-36.0	0.0-32.5	0.0-37.2
% leaf damaged by *Helicoverpa* + *Spodoptera*	2.0-36.0	2.0-16.8	1.0-37.2

Compatibility study of bio control agents with agro chemicals

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ABSTRACT

Agrochemicals were tested for their compatibility with *Trichoderma harzianum* and *Pseudomonas fluorescens* under *in vitro*. Carbendazim @ 50, 100, 250 and 500 ppm, and copper oxychloride @ 1000, 1500, 2000 and 2500 ppm concentrations, completely inhibited growth of *T. harzianum*. However, chlorpyrifos and cartap hydrochloride @ 250 and 500 ppm were moderately compatible. At initial two lower concentrations, pendimethalin @ 500 and 1000 ppm and fenoxyprop-p-ethyl @ 50 and 100 ppm were compatible with *T. harzianum*. All the fungicides/combination of fungicides, insecticides and herbicides tested at all their concentrations were completely compatible with *Pseudomonas fluorescens* isolate-.

Keywords: Agrochemicals, *Trichoderma* spp. *Pseudomonas* spp.

Notable success of disease control with the use of antagonistic microorganism in the laboratory, glass house and field have been achieved during past several years and based on the information, there is a possibility of developing biological control of plant disease under field condition. The commercial formulations of different bio-control agents is already available in the market. However, inadequate information on the performance of the antagonists under varying conditions is a major constraint in the large scale adoption of this technology.

MATERIALS AND METHODS

The effect of nine agro chemicals, on the growth of *T. harzianum* was studied using poisoned food technique (Mayer, 1962). The per cent inhibition of growth over control was calculated by Vincent's formula (1947).

$$I = \frac{C - T}{C} X\ 100$$

Where,
I = per cent inhibition of mycelium growth
C = Radial growth of bio agents in control
T = Radial growth of bio agents in treatment

RESULTS AND DISCUSSION

Carbendazim @ 50, 100, 250 and 500 ppm and copper oxychloride @ 1000, 1500, 2000 and 2500 ppm, more or less inhibited growth of *T. harzianum*. Combination of mancozeb 50% + carbendazim 25% @ 50 and 100 ppm were found to be compatible, however this combination at 250 and 500 ppm was not compatible. Methyl-o-demeton at 250, 500, 1000 and 1500 ppm were found incompatible with 94.44% growth inhibition. However, chlorpyrifos and cartap hydrochloride at 250 and 500 ppm were moderately compatible, but with increased concentrations they also found incompatible. Quizalofop-ethyl at 500, 1000, 1500 and 2000 ppm produced incompatible reaction showing 94.44% growth inhibition. Pendimethalin and fenoxyprop-p-ethyl at lowest concentrations were moderately compatible.

The highest radial growth inhibition of 8.89% of *Pseudomonas fluorescens* isolate-1 at all the concentrations was observed in the treatment of copper oxychloride. Methyl-o-demeton at all the four concentrations i.e. @ 250, 500, 1000 and 1500 ppm were found compatible with maximum growth inhibition of 7.78% by cartap hydrochloride. All the three molecules at their four concentrations tested, produced compatible reaction with *Pseudomonas fluorescens* isolate-1 showing 7.13% maximum growth inhibition by fenoxyprop-p-ethyl. *P. fluorescens* was found to be more tolerant to fungicides than *T. harzianum* fungus and this might be due to the reason that some bacteria might use pesticides as nutrient source and hence can tolerate higher concentrations of chemicals (Aislabie and Jones, 1995).

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Gene action studies in sunflower (*Helianthus annuus* L.)

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ABSTRACT

The present investigation was conducted to study the gene action in sunflower. Thirty-two hybrids developed by using Four CMS and eight restorer lines in L x T design. The hybrids and parents were evaluated in RBD at ORS, Latur during *Rabi*-2021-22 for ten quantitative traits. Analysis of variance for means revealed significant differences for all the ten characters studied. CMS-249A was found to be good general combiner for head diameter, 100-seed weight, volume weight, hull content, oil content and seed yield/plant. Among the testers R/HA-1 was found good general combiner for days to 50 % flowering, days to maturity, plant height, head diameter, seed filling (%), 100-seed weight, volume weight (g/100ml), hull content and seed yield/plant. For oil content IR-1-1 exhibited high gca effect. Out of 32 hybrids the hybrids CMS-47A x EC-279309-1 was with good sca effect for seed yield and component traits. The variance due to SCA was greater than that of GCA for all the characters except days to maturity and plant height. Which indicated that the non-additive gene action played important role for the inheritance of these traits whereas days to maturity and plant height were governed by additive gene action.

Keywords: GCA, Gene action, L xT design, Qunatitative traits, SCA, Sunflower

Sunflower (*Helianthus annuus* L.) is an annual flowering plant which belongs to the family *Asteraceae* with chromosome number 2n=34. It is the second most important oilseed crop in the world after soybean with an account of its wide range of adaptability and high oil content (40-50 %) and protein (23%). BSH-1 was the first sunflower hybrid created by 'Heterosis breeding' and released in India in 1980. Sunflower is one of the India's most important oilseed crops, ranking fifth in terms of edible oil production after soybean, mustard, groundnut, and sesame. Sunflower was grown on 2.26 lakh hectares in India in 2020-21, with a total production of 2.28 lakh tonnes and average productivity of 1011 kg/ha. Sunflower is grown on 0.28 lakh hectares in Maharashtra, with a yield of 0.13 lakh tonnes and a productivity of 466 kg/ha. Karnataka, Maharashtra, Odisha, Andhra Pradesh and Tamil Nadu are the important sunflower growing states.The selection of parent is one of the important aspects in developing the potential hybrid which is practiced after testing of parents for their combining ability [general combining ability (GCA)] effects. It is also useful in understanding the type of gene action controlling various traits to develop suitable breeding strategy.

Line x tester analysis has been widely used for genetic analysis in large number of crop plants. It is an efficient technique for evaluating large number of inbreds for their combining ability.

MATERIALS AND METHODS

Four CMS lines as female parents and eight restorers as male parents were crossed in line x tester method to produce 32 F_1 hybrids in *kharif*-2021. The resulting 32 hybrids, 12 parents and 2 checks were evaluated in randomized block design with two replications during *Rabi*-2021-22 at ORS, Latur. The observations on ten quantitative characters were recorded by selecting randomly three plants in each plot and in each replication. The mean values of all treatments for the characters under study were worked out. Standard error and critical difference at 1 and 5 % level of significance were calculated by using the formula (Panse and Sukhatme, 1967). Combining ability analysis and the testing of significance of different genotypes was based on the procedure given by Kempthorne (1957). In order to understand the nature of gene action, the ratio was worked out by taking in to account the estimated variance of *gca* and *sca*.

RESULTS AND DISCUSSION

The mean sum of squares for parents and crosses showed significant differences for all the characters, indicating presence of the sufficient variability in the genetic material. The analysis of variance showed highly significant differences in treatments for all the ten characters. The analysis of variance for combining ability revealed that the mean sum of squares for variance due to tester were significant and large as compared to lines. The magnitude of specific combining ability variances was larger than general combining ability variances for the characters *viz.*, days to 50 % flowering, seed filling (%), head diameter, volume weight(g/100ml), 100- seed weight, hull content, seed yield/plant and oil content. The magnitude of general combining ability variances was larger than specific combining ability for days to maturity and plant height.

Perusal of *gca* effects of 12 parents for ten characters revealed that the CMS-249 A was a good general combiner for head diameter, 100-seed weight, volume weight, hull content, oil content and seed yield/plant. Also, CMS-234A exhibited significant gca effect in desirable direction for most of the traits. Among restorer R/HA-1 registered a good GCA for most of the traits and Downey mildew resistant reaction. For the character oil content IR-1-1 recorded good GCA.

For days to 50% flowering, plant height, days to maturity and hull content negative *sca* effects are considered to be desirable. On the basis of estimates of sca effects it was observed that two hybrids recorded positive significant sca effect for head diameter. i.e., CMS-249A x IR-1-1 (2.372**) and CMS-47A x EC-279309-1 (2.272**). Similar finding in sunflower was reported earlier by Patil *et al*. (2012). For seed filling, 100- seed weight, volume weight and oil content five, four, four and five hybrids respectively exhibited the significant positive *sca* effect. For hull content negative value is desirable and it was observed that among 32 crosses five crosses recorded negative significant SCA effect for hull content.

For oil content, among the 32 crosses, five crosses recorded positive significant sca effect. For seed yield/plant four crosses showed high significant positive sca effect *viz.*, CMS-249A x IR-1-1 (12.602**), CMS-47A x EC-279309-1 (10.797**), CMS-10A x MRHA-2 (8.866**) and CMS-10A x 12R-1 (8.191**) and these hybrids can be exploited commercially. These results are in agreement to Kale *et al*. (2018).

In the present study the variance due to SCA was greater than variance due to GCA for all characters, except days to maturity and plant height.

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Identification of resistance source for gall fly, *Asphondylia sesami* Felt (Diptera: Cecidomyiidae) in sesame

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ABSTRACT

The incidence of the gall fly (*Asphondylia sesami* Felt) was found during flowering period of sesame. The sesame genotypes (n=61) were screened for *A. sesami* and incidence of *A. sesami* varied from 0 to 15.77%. Two genotypes *viz.*, ISWG-20-05 and IIOS-1103 were found free from *A. sesami* incidence. The highest *A. sesami* incidence was noted in GT 10 (10.12%) and RJR 170 (15.77%).

Keywords: *Asphondylia sesame*, Gall fly, Genotypes, Incidence, Population, Sesame

Sesame (*Sesamum indium*.L.) has earned a poetic label 'Queen of Oilseeds' due to high quality polyunsaturated stable fatty acid, which restrains oxidative rancidity. The present growth rate of domestic oilseed production is not sufficient to fulfil the rising demand. Under such circumstances, serious research efforts are required to enhance the production and productivity using latest breeding tools to mine and utilize the germplasm with desired traits. Biotic stresses such as leaf webber/capsule borer (*Antigastra catalaunalis* Duponchel), leafhopper (*Orosius albicinctus* Distant), gall fly (*Asphondylia sesami* Felt) are a major constraint for increasing the production and productivity of this crop. *A. sesami* is mostly restricted to Southern India and East Africa (Ahuja, et al. 2001). The sesame gall midge reported as a major pest from Maharashtra (India). The incidence of the pest is common during flowering period of sesame and number of generation will be increased due to staggered sowing as well as inclusion different verities of sesame (Baskaran, et. al. 1997). Unfortunately, there are very few control strategies for management of the biotic stresses. Researchers are probably working on more eco-friendly management methods, such as plant resistance. Host plant resistance can be a suitable method for pest control within integrated pest management strategies. There is an urgent need to use Indigenous sesame germplasm to build genomic resources to discover genetic variants for genetic enhancement of sesame especially for control of *A. sesami*.

MATERIALS AND METHODS

The present study was carried out during 2020-21 in the research farm of ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad, Telangana, India. For the seasons 2020–21, field experiments were conducted with 61 advanced breeding lines of sesame in randomized block design (RBD) with three replication.All the recommended agricultural practices were followed in raising the crop. No plant protection measure was taken throughout the crop season. Observation on the incidence of *A. sesami* was recorded at weekly intervals starting from initial appearance to final disappearance or up to harvest. Observations on the incidence were recorded from 10 randomly selected plants by counting number of infested capsules.The percentage of galled capsules/cultivar was used for analysis of variance. Means were separated using Fisher's protected Least Significant Difference test, at 5% probability level. The resistance was categorised by the scale of 0–10 (resistance), 11–20 (moderate resistance), 21–30 (moderate susceptible), 31–50 (susceptible) and above 50 (highly susceptible) used by Solanki et al. (2006) for categorising resistance for leaf webber, and capsule borer in sesame was used.

RESULTS AND DISCUSSION

The incidence of the *A. sesame* is common during flowering period of sesame (Fig. 1). The sesame genotypes (n=61) were screened for *A. sesami* (Fig. 2). Percent incidence of *A. sesami* varied from 0 to 15.77. Two genotypes, ISWG-20-05 and IIOS-1103 were found free from *A. sesami* incidence. The highest *A. sesami* incidence was noted in GT 10 (10.12%) and RJR 170 (15.77%). Similar results were reported by Ogwal et al. (2003) among breeding lines in Uganda. Genotype Sesim2, a commercial variety in Uganda showed moderate resistance to sesame gall midge compared with other local variety. Orientation of insects towards the plant is influenced by plant architecture and colour, but the colour stimulus plays the most important role.

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Fig. 1 Nature of damage and symptoms of *Asphondylia sesame*

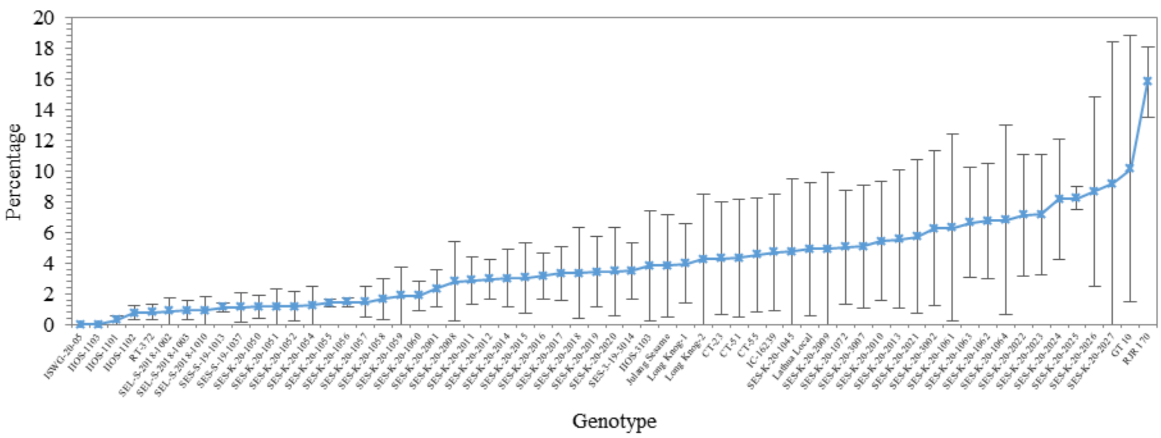

Fig. 2Reaction of sesame genotypes to *Asphondylia sesami*

Morpho-physiological trait variability in oilseed brassica (*Brassica juncea* L) germplasms under rainfed climates

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ABSTRACT

One hundred and forty-seven advance progenies of oilseed brassica germplasms along with three check varieties were evaluated in an augmented block design with seven blocks. Observations were recorded on fourteen morpho-physiological characters. Analysis of variance revealed that the mean squares due to progenies were significant for all the characters under study except number of primary branches/plant, seeds/silique and siliquae length. Heritability estimates were high (>50%) for most of the characters. High heritability along with high genetic advance was found for siliquae/plant, biological yield/plant and seed yield/plant. Progenies, BPR-1733-72-2, BPR-1743-98-1, BPR-1686-34-11, BPR-1758-12-56, BPR-1733--71-1, BPR-1758-7-49, BPR-1758-30-64, BPR-1743-92-1, BPR-1733-38-1, and BPR-1758-11-52 were selected on the basis of significant superiority in terms of seed yield/plant over the best check RH 406. The best progenies may further be used in hybridization programme as parents to develop high yielding varieties for rainfed conditions.

Keywords: *Brassica*, Genetic variability, Heritability,Rainfed, Seed yield

Varieties/germplasm which can withstand the water and environmental stresses under rainfed conditions can improve the yield levels of oilseed brassica. The identification of drought tolerant genotypes and also transfer of physiological traits responsible for drought tolerance in high yielding and agronomically superior cultivars is a prerequisite. The information on the nature and magnitude of variability for different morpho-physiological traits is necessary to judge the potentiality of particular genotype.

MATERIALS AND METHODS

The present investigation was carried out at ICAR-Directorate of Rapeseed-mustard Research, Bharatpur during *rabi* 2019-20 with 147 advanced breeding lines derived from various diverse sources. The material was divided into 07 blocks, each block having 21 lines. A set of three check varieties (RH 406, DRMR 150-35, RH 749) were repeated in each block. Each entry/check was sown in three rows of 5 meter length having row to row and plant to plant distance 30x 10 cm respectively. The experimental area was kept unirrigated throughout the season. It is worthwhile to mention here that crop received 39.6 mm rains during the crop season. Observations were recorded on fourteen morpho-physiological characters. The mean data were subjected to analysis of variance as/the method suggested by Fedrer (1956) and elaborated by Sharma (1998).Genetic parameters were calculated as/standard procedure

RESULTS AND DISCUSSION

Results showed that analysis of variance for the primary branches/plant, seeds/siliquae, siliquae length and main shoot were significant. Biological yield ranged between 33-130g/plant,seed yield 3.75-33.86g/plant, harvest index 11.37-34.44%,test weight 4.18-7.39 g, SPAD 35.27-54.97 and WUE 2.89-17.36. Secondary branches/plant and seed yield/plant showed higher estimate of GCV and PCV i.e. more than 30%. Genotypic coefficients of variation (GCV) was moderate (11-30%) for siliquae/plant, siliquae on main shoot, biological yield/plant, and water use efficiency. Moderate estimates of phenotypic coefficients of variation (PCV) was recorded for fruiting zone length, main shoot length, siliquae/plant, siliquae on main shoot, biological yield/plant, harvest index and water use efficiency Whereas, low estimates (<10%) were obtained for rest of the characters. Heritability estimates were high (>50%) for all the characters which showed significant variation due to progenies. The genetic advance expressed as percentage of mean was high (>30%) for siliquae/plant, biological yield/plant and seed yield/plant. Moderate (11-30%) genetic advance expressed as percent of mean was observed for plant height, fruiting zone length, main shoot length, siliquae on main shoot, harvest index, test weight, and SPAD. while low genetic advance was recorded for secondary branches, and water use efficiency.

Among the 147 progenies evaluated, 10 progenies were selected based on seed yield performance. These progenies were also characterized for 14 morphological and physiological traits. Progenies, BPR-1733-72-2, BPR-1743-98-1, BPR-1686-

34-11, BPR-1758-12-56, BPR-1733--71-1, BPR-1758-7-49, BPR-1758-30-64, BPR-1743-92-1, BPR-1733-38-1, and BPR-1758-11-52 were selected on the basis of significant superiority in terms of seed yield/plant over the best check (RH 406, a commercial variety for rainfed ecology). The best progenies may further be tested in multi-locational trials and can be used in hybridization programme as parents to develop high yielding varieties for rainfed environments.

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On farm validation of management of leaf curl disease of sunflower

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ABSTRACT

Leaf curl is one of the important diseases causing huge yield losses in sunflower. One of the best treatments from the 3 year experimentation on management of leaf curl disease was validated in on farm validation experiment along with farmers' practice. It was concluded that the treatment i.e., seed treatment with imidacloprid 600FS @ 5ml/kg seed + foliar spray with diafenthiuron 50 WP @ 1.25 g/lit at 30 and 45 DAS (days after sowing) recorded less leaf curl incidence of 10.5% and less whitefly population of 1.75. Same treatment also recorded higher yield of 1798 kg/ha and B:C ratio of 2.4 when compared to control, which recorded more leaf curl incidence of 28.5 and less yield of 1500 kg/ha. Hence, it was concluded that diafenthiuron is one of the best chemicals in management of leaf curl disease by acting on whiteflies.

Keywords: Leaf curl, Management, Onfarm trials, Sunflower, Validation

Sunflower is one of the major oil seed crops grown in India. Leaf curl is a serious disease reported in India apart from necrosis (Govindappa *et al*., 2011) causing heavy yield losses. It is caused by sunflower leaf curl virus and important symptoms of this disease are small size, malformed leaves, leaf and veinal thickening, enations and upward leaf curling, stunting when infected at early stages of crop and no ear head was erected. It significantly affects the plant height, head diameter, seed weight and oil percentage, etc. It is a whitefly (*Bemisia tabaci*) transmitted virus. Hence an experiment was conducted with six different insecticides to manage whitefly population thereby the leaf curl disease for 3 years i.e., from rabi 2017-18 to 2019-20 and concluded that the treatment i.e., seed treatment with Imidacloprid 600FS @ 5ml/kg seed + foliar spray with diafenthiuron 50 WP @ 1.25 g/lit at 30 and 45 DAS was found effective against leaf curl disease, and resulted in higher yield (Venkataramanamma *et al*., 2022). Hence, to see its efficacy on large scale, onfarm validation of the same treatment was done by comparing it with farmers' practice.

MATERIALS AND METHODS

This experiment was conducted at RARS farm, Nandyal, Andhra Pradesh for the year rabi, 2020-21 under AICRP on Sunflower scheme. Susceptible check (KBSH-44) seeds were obtained from IIOR, Hyderabad. Two treatments were imposed i.e., T_1: Seed treatment with Imidacloprid 600FS @ 5ml/kg seed + foliar spray with Diafenthiuron 50 WP @ 1.25 g/lit at 30 and 45 DAS. T_2: Untreated plot (farmers practice) in non replicated blocks and each treatment was sown in 500 m^2 plot. Agronomic practices were followed as per the technical program. The treatments were imposed as per schedule at 30 and 45 days after sowing and data on leaf curl incidence and whitefly population was recorded at monthly interval i.e, at 30 and 60 days after sowing. Leaf curl incidence was calculated by using the following formula:

$$\text{Disease incidence} = \frac{\text{No.of plants infected with leaf curl}}{\text{Total number of plants}} \text{X100}$$

Whitefly population was calculated as an average of population counted on bottom, top and middle leaves of 10 plants/plot. Seed yield, cost of cultivation and benefit cost ratio were calculated for each treatment.

RESULTS AND DISCUSSION

The results of on farm validation experiment revealed that disease incidence was observed 2.4%, 10.5% and whitely population was 1 and 1.75 respectively at 30 days and 60 days after sowing in T_1 (Seed treatment with Imidacloprid 600FS @ 5 ml/kg seed + foliar spray with Diafenthiuron 50 WP @ 1.25 g/l at 30 and 45 DAS). In T_2 (control plot or farmers practice), disease incidence observed was 7.25%, 28.5% and white fly population was 1.5 and 2.8 respectively at 30 and 60 DAS. Yield was also higher in T_1 plot i.e.1798 kg/ha, having B:C ratio of 2.4 while the control plot (T_2) recorded less yield of 1500 kg/ha and B:C ratio of 2.2. These results are in conformity with Singh *et al*. (2002), who suggested that seed treatment with imidacloprid (Gaucho 70WS) @5g/kg of seed reduced whitefly (vector population) incidence compared to untreated plot and reduced leaf curl incidence in cotton. Insecticides such as flonicamid 50%WG, thiamethoxam 25% WG, diafenthiuron 50% WP were found effective against sucking pests including whiteflies in cotton (Jagadish Baraskar and Paradkar, 2020). In this experiment also, seed treatment with Imidacloprid 600FS @ 5 ml/kg seed and foliar spray with Diafenthiuron 50 WP @ 1.25 g/l at 30 and 45 DAS has given good control over whitefly population and leaf curl incidence, thus it recorded higher B:C ratio compared to farmers practice.

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Table: Leaf curl incidence, yield and economics in on farm validation trial

Treatments	Leaf curl incidence (%)		Whitefly population/pl		Yield (kg/ha)	CoC (Rs.)	Gross returns	B:C ratio
	30 days	60 days	30 days	60 days				
T1: Seed treatment with Imidacloprid 600FS @ 5 ml/kg seed + foliar spray with Diafenthiuron 50 WP @ 1.25 g/l at 30 and 45 DAS.	2.4	10.5	1.0	1.75	1798	30400	71920	2.4
T2: Control (farmers practice): without any chemical spray.	7.25	28.5	1.5	2.8	1500	27000	60000	2.2

Cost of cultivation: Diafenthiuron 50 wp (polo) (500 g) -- Rs. 1050/-, seed sale price: Rs.35/-/kg

Combining ability for capsule characters in sesame (*Sesamum indicum L.*)

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Abstract

The combining ability for capsule characters was estimated in 8x8 full diallel mating design using 8 elite varieties of sesame which are cultivated across different geographical regions in India. The ratio of GCA: SCA indicated predominance of non- additive gene effects for capsule characters. Among 8 parents, GT-2 was the best general combiner of capsule width, capsule length and seed number/capsule, while TKG-22 was the best combiner for seed weight/capsule.

Keywords: Capsule characters, Combining ability, Sesame

Sesame (*Sesamum indicum* L.) is an important oilseed crop grown in tropical and subtropical conditions. Genetic improvement of seed yield and its associated characters is a continuous effort which is practiced to enhance sesame production and productivity across the globe. Understanding of gene effects of yield and related characters is the primary requirement for developing breeding strategies. Griffing's method of diallel analysis is used to determine additive and non additive gene effects through general combing ability and specific combing ability. The inheritance for yield and its attributing characters along with phenological characters were studied through combing ability studies by Griffing's method of diallel analysis (Das and Gupta 1999, Banerjee and Kole 2009, Pandey *et al.* 2018). Capsule characters are the important characters associated with seed yield in sesame. However, there are limited studies on capsule characters because of labour involved in data recording. In this study, efforts were made to characterise the capsule characters and general combining ability components and the heritability was worked out. Best parents and cross combinations for caspsule characters was identified for further breeding programme.

MATERIALS AND METHOD

The experiment was conducted at experimental farm of ICAR-Indian Institute of oilseeds research, Hyderabad characterized with red sandy loam type of soil. Eight elite varieties *viz.*, E-8 grown in Karnataka (*kharif*), GT-2 in Gujarat (*kharif*), HT-1 in Haryana (*kharif*), PHULE TIL in Maharashtra (*kharif*), RT-351 in Rajasthan (*kharif*), Swetha til in Telangana (Summer), TKG-22 in Madhya Pradesh (*kharif*) and VRI-3 in Tamil Nadu (Summer) were selected as parents. These parents were crossed in a 8 x8 full diallel mating design and F1, reciprocal F1 and parents were raised in the plot size of 4.05 sq m, balanced block design to evaluate for yield and its attributes during *kharif* 2019. Twenty capsules from main branch were harvested from 5 plants at physiological maturity and were kept in oven at 35◦C temperature for 4 days to maintain uniform moisture. Data on capsule width, length, seeds/capsule, seed weight/capsule, number of capsules, oil content and test weight were recorded. The analysis of variance and combining ability (GCA and SCA) was estimated according to method 1 of model –I of Griffing theory (Griffing, 1956). The same model was employed for the assessment of the *gca* effects associated with each parent, the *sca* effects associated with each cross, as well as variance of the effects and narrow and broad sense heritability.

RESULTS AND DISCUSSION

Results of combining ability analysis revealed that mean squares for general combing ability (GCA) and specific combing ability (SCA) were significant. This suggested significant differences among GCA effects of 8 parents and SCA effects of 56 crosses. The significant reciprocal effects indicated the presence of maternal effects for capsule characters except seed weight/capsule. The GCA: SCA ratio <1 indicated predominance of non-genetic variance (Table 1). Rankings of parents based on GCA effects put GT-1 as the best general combiner for capsule width, capsule length and seed number/plant followed by Phule til as the best combiner for capsule width, number of capsules, oil content and plant height. Cross combination between E-8 x HT-1 was superior for capsule width, capsule length, seed number/capsule and seed weight/capsule as indicated by positive and high SCA effect. Heritability (narrow sense) was medium for all capsule character 0.2-0.38). Selection followed by progeny testing at every generation is necessary to improve these traits.

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Table 1: Combining ability variance components and heritability in 8 x 8 diallel

Characters	σ^2gca	σ^2sca	σ^2gca/sca	σ^2a	Phenotypic Variance	Genotypic Variance	Broad-sense Heritability	Heritability in narrow sense
Capsule width	0.08	1.93	0.04	0.20	0.69	0.68	0.99	0.29
Capsule length	3.26	35.72	0.09	5.48	14.53	14.38	0.99	0.38
Number of capsules/plant	86.29	386.02	0.22	108.37	229.42	196.69	0.86	0.47
Oil content (%)	0.80	4.40	0.18	1.06	2.40	2.07	0.86	0.44
Plant Height	28.84	268.64	0.11	44.47	125.59	106.98	0.85	0.35
Seed number/capsule	2.78	178.05	0.02	13.85	59.09	58.12	0.98	0.23
Seed weight/capsule	109.28	7937.60	0.01	582.58	2613.91	2551.34	0.98	0.22
Test weight	0.01	0.15	0.05	0.02	0.06	0.05	0.82	0.27

Niger germplasm evaluation for major morphological and agronomical traits

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ABSTRACT

A panel of niger (*Guizotia abyssinica* (L.f) Cass) accessions were augmented and evaluated to characterize for various morphological and agronomical traits. The analysis of variance has shown that there was a significant variation observed among the genotypes. Variability analysis revealed that the oil content had high GCV with high broad sense heritability. High PCV was observed among the other yield related traits which indicates that these traits are highly influenced by the environmental factors.

Keywords: Genetic variability, Heritability, PCV, GCV

Niger (*Guizotia abyssinica* (L.f) Cass) belongs to the family Asteraceae (Baagoe, 1974) and is a minor oilseed crop that is grown predominantly under rainfed conditions. Niger oil is highly prized for its dietary and therapeutic properties. It is a cross pollinated crop which exhibits homomorphic type of sporophytic self-incompatibility that hinders self-pollination (Getinet and Sharma, 1996). It renders the germplasm heterogenous and exhibits continuous variation for desirable traits. Evaluation and characterisation of niger accessions is one of the most important steps in breeding and conservation measures. Thus, this study was designed to characterize niger accessions collected from major gene banks of India.

MATERIALS AND METHODS

A field trial was carried out during *kharif* 2021-22 in augmented block design in which niger accessions were sown along with three checks (JNS-9, JNS-28 and JNS-30). Data was recorded on eight morphological and 15 agronomical traits. Data was subjected to statistical analysis to characterize and evaluate the diversity in the large panel of accessions. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance, was analysed using R software v.4.2.1 (Aravind *et al.*, 2022).

RESULTS AND DISCUSSION

Characterization of qualitative traits in the panel revealed that most of the accessions had purple, purple green stem pigmentation whereas a single accession (KMS-5-113) exhibited the green colour stem. White bordered ray florets was observed in five accessions (N-87, NSS 5680, IC0203156, BMD-143, NSS-5507) while the rest had yellow and lemon yellow ray florets (Fig 1). Analysis of variance for quantitative traits showed the presence of significant variation among the accessions for most of these traits. High PCV was observed for the yield related traits like number of heads/plant, number of seeds/plant, seed yield, thousand seed weight and harvest index indicating that they are highly influenced by environment. High broad sense heritability was observed for the traits like plant height, days to flowering and days to maturity. Oil content had high GCV (91.24) coupled with high heritability. The traits which had high GCV coupled with heritability could be focused for selection while improving seed yield and variability can be further exploited for the development of trait specific inbreds/population.

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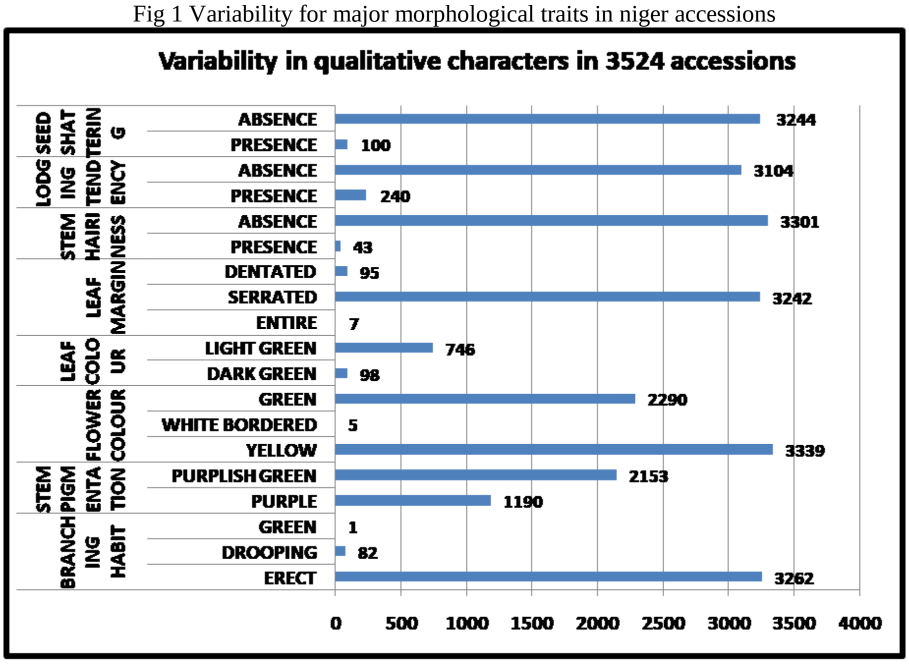
Fig 1 Variability for major morphological traits in niger accessions



Performance assessment of elite coconut genotypes and hybrids for economic and quality traits and oil yield

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Coconut (*Cocos nucifera* L.) is an important plantation crop of the tropics cultivated in more than 80 countries across the globe. Coconut is a monotypic species with two different botanical forms namely tall and dwarf types. India owns a leading position in the world in coconut production and productivity. Coconut is cultivated in an area of 2082.11 thousand ha in more than 16 states of the country producing 23904.10 million nuts with an average productivity of 11481 nuts/ha. The four southern states of India, accounting for more than 92 per cent of the total coconut production in the country include Kerala, Tamil Nadu, Karnataka and Andhra Pradesh (Coconut Development Board, 2018). The major source of coconut production comes from the tall coconut varieties, while dwarf and hybrid varieties meant especially for tender coconut cultivation contribute for about 10 per cent of the total production.

MATERIALS AND METHODS

The present study was conducted at Coconut Research Station, Aliyarnagar of Tamil Nadu during the year 2020, 2021 and 2022 A total number of five genotypes with check variety WCT and five hybrids with VHC 2 as check were chosen based on the field performance for the study. They were evaluated based on the nut, yield, kernel and kernel based products. Tall genotypes viz., CRP 737, CRP 739, CRP 746, CRP 738, CRP 741 and West Coast Tall Check) and the hybrids viz., COD x ALR, COD x WCT, ALR x MGD, MGD x ALR, KTD x ALR and VHC 2 (Check) were used for evaluation. Coconuts of uniform size were taken from the chosen genotypes and hybrids for recording the observation.

RESULTS AND DISCUSSION

The results showed that, the genotype CRP 737 performed better for number of bunches/palm/year (12.82), number of nuts/palm/year (108.51), whole nut weight (1936.88 g) and dehusked nut weight (774.56 g). The same genotype performed better for parameters like kernel yield (331.22 g), copra yield (175.67 g), coconut milk (449.65 ml), coconut cream (166.28g), coconut flour (282. 02g), desiccated coconut (262.48g), virgin coconut oil (21.86ml) and coconut oil (73.68ml).

Among the hybrids COD x WCT performed better for number of bunches/palm/year (13.31), number of nuts/palm/year (136.22), whole nut weight (2042.06 g) and dehusked nut weight (712.28 g). The same genotype performed better for parameters like tender coconut water (425.67 ml), matured coconut water (272.75ml), kernel yield (411.24g), copra yield (165.00g), coconut milk (557.02ml), coconut cream (206.54g), coconut flour (350.21g), desiccated coconut (326.00g), virgin coconutoil (27.02 ml) and coconut oil (72.34ml).

Bai and George (2002) reported that the total nut production per se cannot be considered as an important criterion in breeding programmes, and the partitioning of total dry matter (TDM) towards the economic yield in terms of copra content serves as a basic selection parameter in assessing the production potential of the palms. Geethanjali et al., (2014) also reported that a balanced weightage should be given for the traits, viz., number of nuts and copra content in the selection criteria for elite coconut palms, since these traits are important yardsticks in determining the yield performance of coconut genotypes.

The results of the present study revealed that the genotype CRP 737 and the cross combination COD x WCT recorded maximum values for all the recorded traits. Followed by these, genotypes CRP 738 and CRP 746 were performed better. The genotype CRP 737 recorded maximum value for dehusked coconut weight, kernel content, copra content, yield of coconut milk, coconut cream, coconut flour, desiccated coconut, virgin coconut oil and coconut oil among the evaluated genotypes. The hybrid COD x WCT recorded maximum value for the evaluated traits. Similarly the hybrids COD x ALR and MGD x ALR were the second and third best for yielding various products taken for the study.

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Table 1. Performance of coconut genotypes and hybrids for coconut kernel and oil and kernel based products

Treatments	Genotypes and hybrids	No. of bunches/ palm/ year	No. of nuts/ palm /year	Whole nut weight (g)	Dehusked coconut weight (g)	Kernel weight (g)	Copra weight (grams)	Coconut milk volume (ml)	Coconut cream weight (g)	Coconut flour weight (g)	Desiccated coconut weight (g)	Virgin coconutoil volume (ml)	Coconut oil volume (ml)
T1	CRP 737	12.82	108.51	1936.88	774.56	331.22	175.67	449.65	166.28	282.02	262.48	26.86	73.58
T2	CRP 739	12.24	101.23	1201.50	651.03	255.76	121.00	345.76	127.04	217.32	202.00	16.75	60.74
T3	CRP 746	11.43	100.15	1650.38	636.44	250.32	150.22	339.03	125.66	213.47	198.04	16.43	69.12
T4	CRP 738	10.36	79.46	1502.53	742.52	320.00	152.32	434.00	160.13	273.11	253.87	21.40	70.76
T5	CRP 741	11.64	91.63	1464.81	665.22	260.43	130.75	353.87	130.19	221.09	206.00	17.20	59.95
T6	West Coast Tall (Check)	10.75	73.55	1129.67	602.73	230.00	140.30	312.75	115.20	196.24	183.56	15.10	64.29
T7	COD x ALR hybrid	10.50	125.81	1414.82	700.66	349.17	155.61	473.23	175.09	297.34	276.53	23.68	71.01
T8	COD x WCT hybrid	13.31	136.22	2042.06	712.28	411.24	165.00	557.02	206.54	350.21	326.00	27.02	72.34
T9	ALR x MGD hybrid	12.43	119.76	1642.51	639.77	285.44	138.72	386.39	143.22	242.03	226.65	18.86	63.54
T10	MGD x ALR hybrid	12.26	124.29	1656.59	700.12	341.35	161.11	461.00	170.02	291.09	247.56	22.32	69.93
T11	KTD x ALR hybrid	12.04	120.77	1516.85	668.14	296.00	145.16	400.05	148.78	252.37	219.07	19.45	66.67
T12	VHC 2 hybrid (Check)	12.62	114.54	1601.53	618.23	312.23	142.74	423.00	156.12	266.11	232.00	20.52	65.43
	Mean	**11.87**	**108.00**	**1563.34**	**675.98**	**303.53**	**147.97**	**411.36**	**141.17**	**258.53**	**236.15**	**20.06**	**67.28**
	CD	*1.02*	*5.87*	*30.64*	*9.84*	*11.84*	*4.92*	*13.51*	*6.33*	*8.26*	*7.35*	*1.32*	*1.65*

Evaluation of castor landraces collected from N-W Rajasthan as noval genetic resources for breeding

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ABSTRACT

An exploration was conducted in North-Western Rajasthan state and a total of 114 castor germplasm lines were collected from seven districts. Most of the accessions were tall in plant height. Variability for different traits viz., plant height (50-275 cm), node number (10-35), total length of primary spike (16-60 cm), length of primary spike covered by capsules (6-60 cm), 100 seed weight (7.1-53 g), total seed yield (23-416 g/plant)among the collections were very high. These 114 genotypes were grouped into 11 clusters using D^2 analysis. Among the 11 clusters studied, plant height contributed highest towards genetic divergence (45.8%) followed by total seed yield/plant (36.4%). Principal component (PCA) analysis revealed that first three PC axes explained 64.7% of the total multivariate variation while the first five PC axes explaining 81.7%. Among these diverse germplasm collections few promising accessions identified for node number RG-3840 (10), RG-3841 (11), 100-seed weight, RG-3832 (53.2g), RG-3839 (52.6 g), RG-3831(49.5 g), seed yield/plant, RG-3851-(416 g), RG-3860 (305 g) and RG-3895 (238 g). These landraces were found to be potential source of genetic diversity to castor repository.

Keywords: Castor, D2 analysis, Exploration, Germplasm, North-Western Rajasthan, Variability

In the Euphorbiaceae family the only species of the genus Ricinus is castor (*Ricinus communis* L.). Although self-pollination does occur, it is primarily a cross pollinated species (assisted by wind) (Moshkin 1986). Even though occurrence of castor is wide spread throughout the world, Vavilov (1951) reported East Africa is the centre of origin for castor. It is a non-edible oilseed crop that is primarily farmed in marginal lands in arid and semi-arid countries, contributing significantly to the livelihoods of resource-poor farmers. The castor seed contains a unique oil that comprises more than 80% ricinoleic acid (an uncommon monounsaturated 18 carbon fatty acid) and has a variety of useful industrial qualities. Lubricants, fuel and paints are all made from oil and its derivatives. Castor is also considered a potential crop for biodiesel production (Shrirame *et al.* 2011). The large diversity of genetic resources used ensures the success of a breeding effort and the long-term viability among the cultivars.

MATERIAL AND METHODS

The 114 castor accessions were sown in randomized complete block design with three replications. Each accession/replication was sown in two rows of plot 6 m length, with a spacing of 90 x 60 cm. The recommended packages of practices were adopted to raise a healthy crop. Plant protection measures were taken up as and when required. The accessions were harvested as and when the spikes attained physiological maturity.

RESULTS AND DISCUSSION

The maximum frequency of 28 accessions were collected from drier tracts Bikaner, followed by Jodhpur and Barmer (25), Jaisalmer (15), Hanumangarh (14), Churu (04) and Nagaur comprising three accessions. The analysis of variance revealed highly significant differences among the genotypes for all the characters indicating considerable genetic variation in the material studied. A wide range of variation for agronomic parameters in castor was reported by Anjani (2000) and Anjani (2012). Diversity analysis grouped these castor germplasms into 11 different clusters.

The characters contributing maximum to the divergence need greater emphasis for deciding on the clusters for purpose of further selection and choice of the parents for hybridization. The highest contribution in this regard was made by plant height (45.8%) by ranking 2955 times'first ranking followed by total seed yield/plant (36.4%). Multivariate analysis of the accessions revealed that the first five PCs cumulatively accounted for 88.94% of the total variation. The cumulative proportion of the variation reached 64.7% in the first three PC axes, and 81.7% in the first five axes. The high degree of variation in the first five PC axes indicates a high degree of variation for these characters.

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Wide hybridization in Rapeseed-Mustard

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ABSTRACT

The Brassicas are an important group of crops in India yielding oils and many vegetables. For improving cultivated brassicas, the distant relatives are of considerable value. Wide hybridization is the way which could combine the valuable features of parental species into the hybrid. Crosses among *Brassica*species viz., *B. juncea* (AABB, 2n = 36), *B. Carinata* (BBCC, 2n = 34), *B. napus* (AACC, 2n = 38), *B. campestris* (AA, 2n = 20), wild relative of cultivated species *B. fruticulosa* (2n = 4x=32, FFFF), and *B. tournefortii* (2n=20, TT) were attempted with the objective to find out crossability among them, analyse chromosome association in inter-specific hybrids, generate genetic variability and combine desirable characters in a targeted genotypes/species.

Keywords: Cytology, Homeologous pairing, Meiotic analysis, Wide hybridization

The Brassica group of seed oil and vegetables comprises six cultivated species, out of which three are diploids and three are digenomic tetraploids. *Brassica juncea* L. Czern & Coss is the dominant species covering around 80 % of area under rapeseed-mustard in India while rest of the area covered by three ecotypes of*B. campestris* L. viz. Brown sarson, Yellowsarson and Toria . Both the species are well adapted to drier conditions and mature earlier than other species, but the available varieties of these species do not have a plant type which can be exploited to achieve a substantial increase in yield under intensive cultivation. They are also susceptible to various biotic and abiotic stresses. Both of the species have a limited genetic variation for resistance to these factors. Wide/and or inter-specific hybridization is the important tool which could combine the valuable features of parental species into the hybrid.

MATERIALS AND METHODS

Crosses among *Brassica* species viz., *B. juncea* (AABB, 2n = 36), *B. carinata*(BBCC, 2n = 34), *B. napus* (AACC, 2n = 38), *B. campestris* (AA, 2n = 20), wild relative of cultivated species *B. fruticulosa* (2*n*=4*x*=32, FFFF) induced colchi-autotetraploidy (Kumar *et al*. 2015), and B. *tournefortii* (2n=20, TT) were attempted with the objective to find out crossability among them, morohological, cytological analyses of chromosome association in F_1 inter-specific hybrids were observed.

SSR markers were used for the molecular analysis of parents and the hybrid plants.

RESULTS AND DISCUSSION

The hybrids, in general, were vigorous and intermediate in morphological attributes. The success of crossability was 10.34 % in ABC hybrids, 30% in AF and 3.7% in TA hybrids respectively. The meiotic studies in F_1 plants of hybrids ABC (*B. juncea* x *B. carinata*) exhibited chromosome association of 6II + 23I in most of the meiotic configurations. In AABC *(B. Juncea* x *B. napus)* a maximum of 15 bivalents were observed in two pollen mother cells (PMCs). In *B. tournefortii* x *B. rapa* the F_1 plants showed predominance of univalents (53.66%). The occurrence of chromosome association ranging from bivalents (0-4), trivalent (0-1) and quadrivalent (0-1) in the F_1s hybrids were observed. In *B. juncea x B. fruticulosa* meiotic analyses revealed a mixture of bivalents and univalents in all the PMCs analysed. However, 2II + 14I were the most frequently observed chromosome association autotetraploidy (Kumar *et al*. 2018).The presence of multivalent associations were attributed to the auto- and allosyndetic nature of pairing within and among the different genomes presently investigated. Numerous disjunctional abnormalities including late disjunction of bivalents and laggards were observed at anaphase I and II. However, a few cells were observed with a normal distribution resulting in some fertile pollen grains in the hybrids. Two polymorphic genic-SSR markers showed its presence in co-dominant manner in F_1 hybrids.

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Enhancement of safflower productivity through improved production technology

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ABSTRACT

Experiment was conducted at Research farm of AICRP on Safflower Research scheme, VNMKV, parbhani. Experiment was conducted in un-replicated manner on 2000 sq. m area of improved technology and farmers' practice each. Experiment on production potential of and economic effect of improved technologies comprising high yielding PBNS-12 during *rabi* 2021-22 under residual soil moisture conditions. The additional yield under improved technologies over local practice recorded 1540 kg/ha. In comparison to local practice, there was an increase of 32%. The improved technology with high yielding varieties also resulted in higher benefit cost: ratio of 2.58 with addition returns i.e. Rs. 20736/- over farmer practice.

Keywords: Farmers' practice, Production technology, Safflower

Safflower is an important oilseed crop known as kusumbha in Sanskrit literature. It is grown in dry and semi-arid areas characterised by its strong tap root system through which it can draw water from deeper soil layers and is drought tolerant. Safflower seed contains 24-36% oil content. Safflower oil is traditionally a linoleic type with 71–75% linoleic acid and is a polyunsaturated edible oil. Oleic safflower oil is highly preferred in the food, pharmaceutical, biofuel production, paints, lubricants and cosmetics industries.

MATERIAL AND METHODS

The experiment was conducted on medium black soil at AICRP on Safflower farm during the year 2021-22. One block (2000 m^2) for improved production technology in safflower and one block (2000 m^2) for farmer's practice. Safflower variety PBNS-12 was sown on 26[th] Nov. 2021. The set of practices used for experiment included the following.

Improved Technology used	Farmer Practice
Sowing time and Spacing (45x20 cm), Seed treatment: with PSB+FYM 5t/ha safflower+*Tricodermaherzinum*@ 10 ml/kg seed, Soil application ZnSO4 or FeSO4 @20kg/ha + recommended level of fertilizer and Complete plant protection as/recommendation used	Recommanded production technology , Plant protection not followed and imbalance use of fertilizer

RESULTS AND DISCUSSION

The productivity of safflower under improved production technologies recorded 1540 kg /ha as against the yield 1135 kg/ha under farmers' local practice. The additional yield under improved technologies over local practice ranged from 221to 279 kg/ha with a mean yield of 255 kg/ha. In comparison to local practice, there was an increase of 35% in production of safflower under improved technologies. This increased grain yield with improved technologies was mainly because of inherent potential of the resistant varieties along with seed treatment and maintaining optimum plant population. Sreelakshmi ef al. (2012) also reported similar result for pigeonpea. The economics of IT over the FP (table.2) indicated that the cost of production of safflower under improved technology was Rs 27500/ha as against RS 20222/ha in farmers' practice. The additional cost incurred in the improved technologies was mainly due to more costs involved in the procurement of improved seed variety, fertilizer and plant protection only. Cultivation of safflower under improved variety accrued higher net returns of Rs 49376 /ha as compared to farmers' practice. There was an additional net return from IT of Rs 20736 /ha over farmers' practice. Similar results were reported by P. Satish et al. 2015.

The results from the present study clearly brought out the potential of improved technology in enhancing the safflower production and economic gains in rainfed Condition.

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Table: 1 Effect of improved technology on yield of Safflower over farmer practice

plot Size 2000 m^2	Plant population	Biological yield (kg/ha)	HI	seed yield (kg/ha)	% increase yield
IT	21000	4670	32	1540	35%
FP	20700	3050	37	1135	

*IT- Improved technology *FP- Farmer Practice

Table: 2 Effect of improved technology on economy of Safflower over farmer practice

plot Size 2000 m^2	GMR (Rs/ha)	NMR (Rs/ha)	Addition income	cost of cultivation (Rs./ha)	B:C Ratio
IT	83791	49367	20736	27500	2.58
FP	61755	28631		20500	1.98

Quantitative traits associated with seed yield and yield components in sunflower (*Helianthus annuus* L.)

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ABSTRACT

A total of 66 sunflower germplasm were planted in an augmented block design while adhering to all suggested best practices. According to correlation analyses, plant height, head diameter, and hundred seed weight were positively and significantly correlated with grain yield/plant. Oil content and volume weight were shown to be positively correlated. However, grain yield/plant and volume weight were found to be negatively correlated.

Keywords: Correlation, Genotypes, Seed yield, Sunflower

The sunflower, (*Helianthus annuus L.*, 2n=34) is a significant oilseed crop and a member of the Asteraceae's family. To meet domestic demand, India is still in the process of importing vegetable oil from foreign nations. Sunflower oil is a recommended form of vegetable oil and is advised for heart patients because of its high PUFA content. Sunflower seed yield and oil content are complicated features that are influenced by diverse factors that may independently or communally. Therefore, understanding how these traits relate to yield and to one another will be crucial for developing a breeding programme that is effective (Chandirakala *et al.,* 2015).The strength and direction of the relationship between yields and its constituent parts determines the effectiveness of selection. Correlation describes the interdependence of the factors and aids in the simultaneous development of many traits. As a result, an evaluation of the relationship between yield and yield components has been made.

MATERIALS AND METHODS

Sixty-six sunflower germplasm accessions and seven checks were characterized as part of the current study at the Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore. In an augmented block design, the evaluation and characterization of the germplasm were done during kharif 2020. Eight traits, including days to 50% flowering, days to maturity, plant height (cm), head diameter (cm), hundred seed (g), volume weight/100ml (g), oil content (%), and seed yield / plant(g), were observed for each germplasm. In this study a simple correlation was carried out among 66 germplasm with seven checks using “Factoshiny of R-Studio”.

RESULTS AND DISCUSSION

A breeding program's selection of better genotypes based on linked traits depends heavily on association studies (Singh *et al.,* 2018). In this investigation, a simple association between eight characters was established**.** The results revealed a high positive and substantial association between days to 50% flowering, days to maturity (0.992), plant height (0.287), and hundred seed weight (0.370). Plant height (0.260) and hundred seed weight demonstrated a strong positive and significant connection with days to maturity (0.361). There was a substantial and positive correlation between head diameter (0.496), hundred seed weight (0.343), and grain yield/plant (0.363) and plant height. Reavanth *et al.,* 2022 reported a similar association.The connection between head diameter and hundred seed weight (0.310) and grain yield/plant (0.867) was also favourable and significant. Volume weight (0.287) had a strong and positive link with oil content, and hundred seed weight (0.288) had a direct correlation with grain yield/plant. By Kamalnathu *et al.,* 2022, similar positive associations with those characters were first reported. Figure 1 shows a heat map illustrating the link between yield and the qualities that contribute to it in sunflower.

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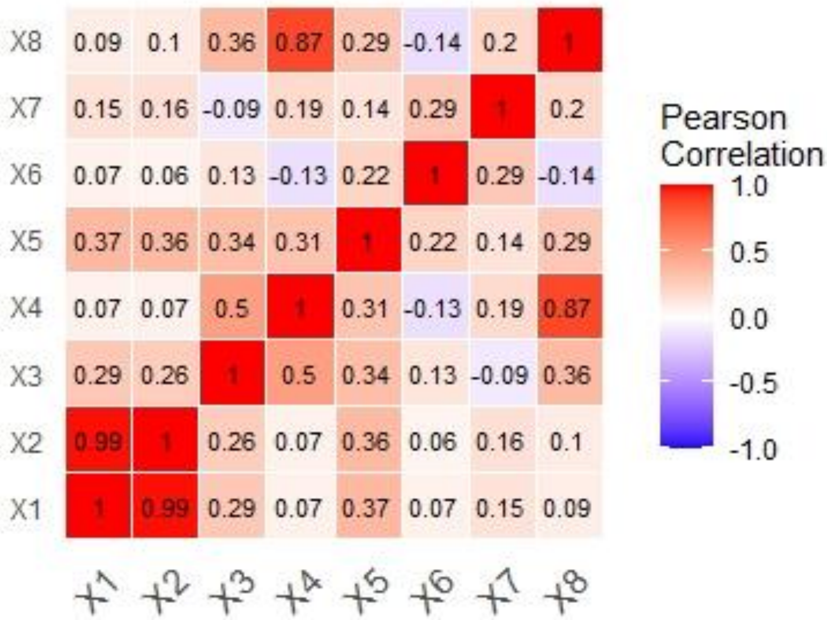
Fig 1: Pictorial representation (Heat map) of correlation for yield and its contributing traits in Sunflower



X1 - Days to fifty percent flowering; ***X2*** - Days to maturity; ***X3*** -Plant height (cm); ***X4*** - Head Diameter (cm); ***X5*** -Hundred seed weight (gm); ***X6*** - Volume weight/100 ml; ***X7*** - Oil Content (%); ***X8*** - Seed yield/plant (gm)

GG-35: A high yielding Spanish bunch groundnut, *Arachis hypogaea* L. variety for Gujarat State

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ABSTRACT

A Spanish bunch groundnut genotype GG 35 was developed on the basis of mean pod yield from the state level trials. It has recorded the highest pod yield of 3177 kg/ha as compared to the checks *viz*., GG 7 (2452 kg/ha), GJG 9 (2471 kg/ha) and TG 37A (2758 kg/ha). GG 35 had recorded average 100 kernel weight of 42.79 g, average 100 pod weight of 101.93 g and average shelling out-turn of 71.36%. The reaction against tikka, rust, stem rot and collar rot, the variety was comparable to the check varieties under field conditions whereas, the damages due to thrips was not observed in the released variety as well as check varieties. Based on the superior performance, GG 35 has been released for general cultivation in the *kharif* bunch groundnut growing areas of Gujarat state.

Keywords: GG35, Groundnut, Gujarat, Spanish bunch, Variety

Groundnut (*Arachis hypogaea* L.) is one of the most protein rich vegetable oilseed crops of India. Gujarat is the leading groundnut growing state. Presently *kharif* Spanish bunch groundnut varieties *viz*., GG 7, GJG 9 and TG 37A are under the cultivation, which were old varieties. Hence, with an objective to replace the old varieties, an attempt was made to develop a new variety with desired agronomic features.

MATERIALS AND METHODS

The Spanish bunch groundnut genotype GG-35 was developed by hybridization followed by pedigree method of selection. It is a derivative of TG 37A x JVB 2113. From the segregating populations, a Spanish bunch type was isolated and evaluated for its yield performance. The genotype was tested in station trial at Junagadh during *kharif*, 2015. Later, it was evaluated under multi location trials at eleven locations in Gujarat state during *kharif*, 2015 to *kharif*, 2019. It was screened for reaction to pests (thrips and jassids) and diseases (tikka, rust, stem rot and collar rot) under field conditions. The yield data was analyzed by randomized block design as suggested by Panse and Sukhatme (1965).

RESULTS AND DISCUSION

GG 35 had proven its superiority in the all the years. The mean pod yield of GG 35 was 3177 kg/ha as compared to the checks *viz*., GG 7 (2452 kg/ha), GJG 9 (2471 kg/ha) and TG 37A (2758 kg/ha), which was 29.54%, 28.59% and 15.17% higher than the checks *viz*., GG 7, GJG 9 and TG 37A, respectively (Table 1). Ancillary observations of economic attributes of GG 35 along with the checks are presented in Table 3. Average kernel yield of GG 35 was 2267 kg/ha, which was 13.00%, 12.95% and 11.90% higher over the check varieties *viz*., GG 7 (1743 kg/ha), GJG 9 (1750 kg/ha) and TG-37A (1904 kg/ha), respectively (Table 2). GG 35 exhibited higher kernel and oil yields. The average shelling out-turn of the testing genotype was at par with all the check varieties; GG 7, GJG 9 and TG 37A.

The testing variety GG 35 was screened for pests and diseases during *kharif*, 2016 to *kharif*, 2019. The thrips population was not observed in test entry as well as check varieties. The reactions against tikka, rust, stem rot and collar rot; the genotype was comparable to the check varieties under field conditions. However, in GG 35 damage due to leaf defoliators was found lower as compared to the check varieties.

By virtue of all the superior performance for high pod yield, kernel yield, oil yield, with better quality characteristics, the newly developed variety GG 35 has been released by 16th Combined Joint AGRESCO Sub-Committee Meeting held on 8th -9th July, 2020. (Anonymous, 2021) for general cultivation in the rainfed groundnut growing areas of Gujarat state.

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Table 1 Yield performance of groundnut variety GG 35 in the state trials

Season/Year	Name of Trial	No. of Locations	Pod yield (kg/ha)			
			GG 35	GG 7(C)	GJG 9(C)	TG 37A(C)
Kharif-2015	PET-SB	1	2919	2508	2486	2467
Kharif-2016	SSVT- SB	4	3457	2576	2748	3009
Kharif-2017	LSVT- SB	7	2979	2350	2370	2631
Kharif-2018	LSVT- SB	10	2908	2407	2317	2371
Kharif-2019	LSVT- SB	9	3354	2521	2594	3208
Overall Mean		(31)	3177	2452	2471	2758
Overall % increase over the checks			-	29.54	28.59	15.17

Table 2 Ancillary observations of economic attributes of variety GJG-9 along with checks

Character	Variety			
	GG 35	GG 7(C)	GJG 9(C)	TG 37A(C)
Pod yield (kg/ha)	3177	2452	2471	2758
Kernel yield (kg/ha)	2267	1743	1750	1904
Oil yield (kg/ha)	1130	851	854	942
Haulm yield (kg/ha)	2665	4119	3839	2795
Shelling out-turn (%)	71.36	71.12	70.83	69.02
Oil content (%)	49.84	48.81	48.79	49.46
100-pod wt. (g)	101.93	125.57	114.76	98.21
100-kernel wt. (g)	42.79	46.81	42.56	42.35
Maturity days	105	106	106	105

Mapping soil property variability in oil palm (*Elaeis guineensis* jacq.) plantations of Krishna basin of Andhra Pradesh through geospatial technologies

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ABSTRACT

Sixty seven soil samples were collected from oil palm growing regions of NTR District of Andhra Pradesh and were analysed for different soil properties. The data was subjected to descriptive analysis to find out the variability and then to geostatistical analysis to design best fit models having minimal error for developing prediction maps. Highest variation was observed in exch. Mg and the lowest in pH. The mean values of soil pH, EC (dS/m), OC (g/kg), Olsen-P (mg/kg), NH4OAc-K (mg/kg), Exch. Ca (mg/kg), Exch. Mg (mg/kg), $CaCl_2$-S (mg/kg) and HWB (mg/kg) were 7.32 ± 0.08, 0.25 ± 0.02, 0.87 ± 0.03, 101.47 ± 6.95, 566.14 ± 42.97, 4.72 ± 0.24, 2.46 ± 0.27, 60.86 ± 2.6 and 5.98 ± 0.25 respectively in the surface layer (0-20 cm) of the soil. Geostatistical analysis revealed wider spatial variability in surface soil properties and they had circular, spherical, stable and exponential best fit semi variogram models for evaluating dependency. The wide spatial variability of soil properties warrants site specific nutrient management for higher oil palm production. Nutrient distribution maps could be developed through kriging interpolation to interpolate the nutrient levels in unsampled areas.

Keywords: Andhra Pradesh, Geospatial technologies, Krishna basin, Mapping, Oil palm, Soil analysis

Oil palm is a heavy feeder of water and nutrients. Response to recommendations based on soil and leaf sample analysis was found variable between different sites and also even within the same site in terms of FFB production. This shows that the variability at micro level is not detectable with classical soil sampling procedures. Goh et al. (2003) reported that optimum economic and sustainable oil palm yields can only be achieved with judicious use of fertilizers. Spatial dependencies of soil properties can be used to support spatial sampling for detailed soil mapping and thereby the management practices such as fertilizer application, irrigation and tillage operations can be finetuned within the field scale to maximize the crop production, while minimizing the detrimental effects on the environment (Nayanaka *et al.*, 2010). Therefore, understanding the spatial variability patterns and interpolating the nutrient levels in unsampled areas can make it possible to apply the nutrients at precise levels at point blank accuracy. Geostatistics offers a set of tools to illustrate spatial variability in a variety of natural phenomena, as well as the spatial characteristics of soil attributes. So, the present study was aimed at arriving the spatial structure including dependency and variability of georeferenced variables and development of prediction maps for nutrient management

MATERIALS AND METHODS

Soil samples were collected from 67 locations and a total of 201 soil samples i.e. 67 from 0-20 cm (surface), 67 from 20-40 cm (sub surface) and 67 from 40-60 cm (deep layer) depths were collected using hand auger at random points inside 3-m radius from the palm to assess soil properties. The latitude, longitude, and elevation at each sampling point were recorded using a hand held global positioning system (GPS) (Oregon 550, Garmin Ltd, Kansas, USA). Data on plantation age and average fresh fruit bunch yield also recorded. Data were subjected to descriptive analysis. Arc Map 10.3 was used to analyse the spatial structure of surface soil properties and to define the semivariograms. From semivariograms, differences in nugget/sill ratio and range were examined. All semivariograms in isotropic form were fit using spherical, circular, exponential, and Gaussian models. Kriging interpolation was applied to the best fit model. Ordinary kriging was chosen to create the spatial distribution maps of soil properties.

RESULTS AND DISCUSSION

Descriptive statistics: Descriptive analysis of soil properties indicates that the minimum, maximum, SD, CV, skewness and kurtosis values of pH, EC, OC, NH_4OAc-K, Olsen–P, Exch. Ca and Mg and $CaCl_2$-S and HWB ranged widely.

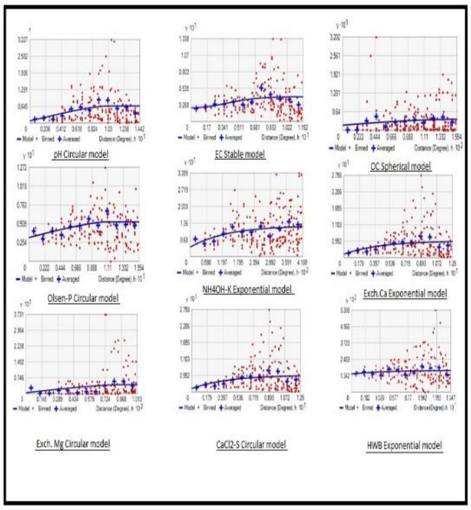

Fig1. Semi variograms of different soil properties in their best fit models

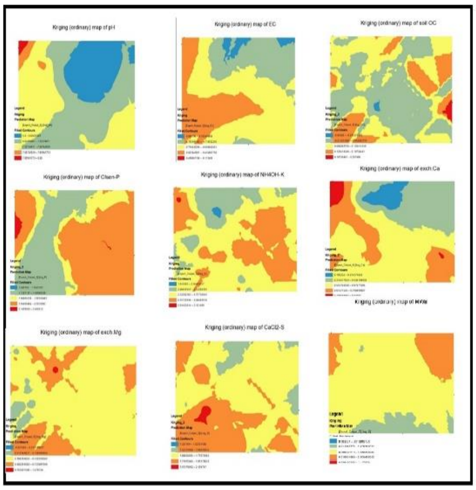

Fig 2 Prediction maps (ordinary kriging) of soil properties

Spatial analysis: From semi variograms, differences in nugget/sill ratio and range were examined for soil properties.

All semi variograms in anisotropic form were fit using stable, circular, spherical and exponential models (Fig. 1). Spatial dependence of surface soil properties ranged between weak to strong. Among them, pH, exchageable Ca and exchangeable Mg had shown strong spatial dependence because of low N:S (Nugget/Sill) ratio (<0.25). Moderate spatial dependence was noticed in EC, soil OC, Olsen-P, NH4OH-K and CaCl2-S. Only HWB recorded to have low spatial dependence. Strong spatial dependence is ascribed to the intrinsic factors like rock from which the soil is formed, minerology, slope etc. Whereas, weak spatial dependence could be attributed to the extrinsic factors mostly anthropogenic ones which influence the soil properties like management practices, fertilizer application, irrigation, ploughing, crop rotation etc. Moderate spatial dependence could be due to both extrinsic and intrinsic factors combined together. It was found that circular model was suitable for pH, Olsen-P, exch. Mg and $CaCl_2$-S. Similarly, stable model was the best fit for EC, spherical for soil OC and exponential model for NH_4OH-K, exch. Ca and HWB. The range in our investigation varied between 944 m to 14985 m. higher ranges were observed for HWB, exch. Ca, Olsen-P and pH. Very low ranges were found for exch. Mg, soil OC, $CaCl_2$-S and NH_4OH-K. The reasons for differences in range of different soil properties and also differences in spatial dependence could be attributed to the factors acting on the soil under a given situation. Interpolation maps developed through ordinary krigging (Fig. 3) could be utilized for point specific nutrient management which not only helps in saving on fertilizer costs, but also helps in avoiding excessive use of fertilizers which may cause deficiencies of some other nutrients and also soil and water pollution. To help in boosting oil palm production through most efficient nutrient management strategies.

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Genetic variability and heritability studies in sunflower inbred lines

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ABSTRACT

The experiment was conducted at Oilseeds Research Centre, Dr. PDKV, Akola during Kharif 2020-2021, to study the Genetic Variability studies in Sunflower Inbred Lines. The experiment consisted of 24 sunflower inbred lines were evaluated with three checks (DRSF 108, DRSF 113 and Phule Bhaskar) respectively and was laid out in Randomized Block Design. The study illustrated, the existence of wide ranges of variations for most of the characters among the sunflower inbred lines. Analysis of variation indicated that the mean squares of the genotypes were highly significant for all the characters taken under study. The range of variation, as well as genotypic and phenotypic coefficient of variations were high for seed yield/plant, plant height and test weight indicating the scope of improvement through simple selection procedure for obtaining high yield. Broad-sense heritability estimate was maximum for plant height (98.5), while that for seed yield g/plant (97.4) and head diameter (95.6). Hence, higher heritability estimates for these traits indicated that environmental factors did not greatly affect phenotypic variation of these characters.

Keywords: Genetic, Heritability, Inbred lines, Sunflower,Variability

Sunflower (*Helianthus annuus L.*) is an important oilseed crop, which belongs to the genus ‘Helianthus’ of the family Asteraceae. It is widely adopted and accepted for its high quality and nutritional edible oil. Due to its high economic importance, the developments of effective hybrids are required with superior yield and quality traits. According to Oilseeds Scenario (2019), IIOR, Hyderabad sunflower contributed area (27.37 m ha) and production (56.07 m.t.) of oilseeds in the world and India placed 17th position in area and 21st position in production respectively. In India sunflower occupies 224.36 ‘000’ ha area, 229.6 ‘000’tonnes production and 1023 kg /ha productivity. However according to Fourth Advance estimates of Maharashtra State for the year 2021-2022 in Maharashtra sunflower occupies 266 ‘00’ ha area, 141 ‘00’tonnes production and 532 kg /ha productivity.

Variability present in a gene pool of a crop species is important to plant breeder for breeding programme. Classification of germplasm based on agronomic characters plays an important role in plant breeding to select valuable genetic resources to be utilized later in different breeding programmes. The coefficients of variation expressed at phenotypic and genotypic levels are used to compare the variability observed among different characters. A wide range of variation has been reported for seed yield, seed number and other important components of yield (Virupakshappa and Sindagi, 1988). The heritability estimates aid in determining the relative amount of heritable portion in variation and thus help plant breeder in selecting the elite inbreds from a diverse population. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone. The success of any breeding programme depends upon the extent of genetic variability in base population and it is essential to subject a population for selection for achieve improvement in a particular trait. The present study was undertaken to assess the genetic variability, heritability and genetic advance in 24 inbred lines.

METHODS AND DATA SOURCES

The experiment consisted of 24 sunflower inbred lines were evaluated with three checks (DRSF 108, DRSF 113 and Phule Bhaskar) respectively and was laid out in Randomized Block Design. At maturity five plants from each accession were selected randomly for recording of data on yield and its related characters viz. days to 50% flowering, duration of reproductive phase (days), days to maturity, plant height (cm), head diameter (cm), seed yield (g) and100-seed weight (g).

RESULTS AND DISCUSSION

Among inbred lines (Table 1) mean seed yield ranged from 6-42 g/plant , however EC 601635 (42 g/plant), GMU 770 (41 g/ plant), GMU 494 (38 g/plant) and GMU 249 (35 g/plant) recorded significantly superior and highest seed yield over the three checks Phule Bhaskar (28 g/plant), DRSF 113 (27 g/plant) and DRSF 108 (25 g/plant) respectively. Days to 50% flowering mean ranges from 46-60 days and mean range of days to maturity ranges from 74-91 days, Plant height mean ranges from 78.0 cm (TSG 207) - 154.6 cm (check Phule Bhaskar). Head diameter mean ranges from 9.8 cm (TSG 331) -15.9 cm (check Phule Bhaskar). 100 seed weight mean ranges from 3.5 g (GMU 852) - 6.0 g (DRSF 113).

The success of any breeding programme depends upon the extent of genetic variability in base population and it is essential to subject a population for selection for achieve improvement in a particular trait. The mean squares from analysis of variance for different characters are presented in Table 2. Analysis of variation indicated that the mean squares of the genotypes were highly significant for all the characters taken under study. The range of variation, as well as genotypic and phenotypic coefficient of variations were high for seed yield/plant, plant height and test weight indicating the scope of improvement through simple selection procedure for obtaining high yield.

The magnitude of PCV values for all the traits was marginally higher than the corresponding GCV values. Phenotypic coefficients of variability ranged from 4.78 to 43.56 %, and the highest PCV was noticed for seed yield/plant and the lowest for Days to maturity. The highest genotypic coefficient of variability was recorded for seed yield/plant (42.99), whereas the lowest GCV was recorded for Days to maturity (4.34). Broad-sense heritability estimates were maximum for plant height (98.5), whereas they were moderate for 100 seed weight (49.5) Genetic advance asper cent of mean (GAM) was highest for seed yield/plant (87.41%) followed by plant height (39.7%), and the other traits showed a moderate-to-low genetic advance. The GCV and PCV were high for seed yield, which indicated the presence of additive genes for this character (Patil *et al.*, 1996, Sujatha *et al.*, 2002 and Virupakshappa and Sindagi, 1987). The genotypic coefficient of variation is not always true to reflect the amount of actual variation which is heritable.

The heritable variation cannot be estimated through genetic coefficient of variation (Burton, 1952). Also the genotypic coefficient of variation along with heritability would give the reliable information on the magnitude of genetic advance to be expected from selection. The heritability in broad sense is described as the ratio of genotypic variance to the total variance in the non-segregating populations (Hanson *et al.,* 1956). Further, it indicates whether there is sufficient genetic variation present in a population which will respond to selection pressure (Milatovic *et al.*,2010) Selection of the genotype based on specific character with high broad-sense heritability will lead to faster and increased gains in the offspring than selecting for specific character with low heritability (Browning *et al.,* 1994).

Broad-sense heritability estimate was maximum for plant height (98.5), while that for seed yield g/plant (97.4) and head diameter (95.6). Hence, higher heritability estimates for these traits indicated that environmental factors did not greatly affect phenotypic variation of these characters.

The present study exhibited diversity among the genotypes for seed yield and almost all yield component characters which may favour the selection and its further utilization in recombination breeding programmes. While selecting appropriate sunflower germplasm, the breeder looks for genetically diverse and superior genotypes which could be utilized in population and heterosis breeding. The genetically diverse sunflower germplasm identified could be utilized in development of diverse inbreds which may be utilized in heterosis breeding. Promising trait specific superior sunflower germplasm accessions identified will serve as donors for the development of trait specific heterotic gene pools which can be further exploited in sunflower improvement.

Table 1: Range of seed yield and related characters of sunflower inbred lines

Sr. No.	Characters	Genotype	Range of characters
1	Seed Yield g plant-[1]	TSG 17	6
		EC 601635	42
2	Days to 50% flowering	TSG 197	46
		DRSF 113 (C)	60
3	Days to maturity	TSG 197	74
		DRSF 113 (C)	91
4	Plant height (cm)	TSG 207	78.0
		PhuleBhaskar (C)	154.6
5	Head diameter (cm)	TSG 331	9.8
		PhuleBhaskar (C)	15.9
6	100 seed wt (g)	GMU 852	3.5
		DRSF 113 (C)	6.0

Table:2- Genetic variability, genetic parameters, heritability and genetic advance in percent of mean for six quantitative traits in 27 sunflower inbred lines

SN	Characters	Mean sum of squares	σ2 g	σ2 p	Coefficient of variation GCV	PCV	h^2 (b. s.)	GA asper cent of mean
1	Seed Yield g plant-[1]	200.31	98.84	101.47	42.99	43.56	97.40	87.41
2	Seed Yield kg/ha	18.23	8.71	9.51	5.40	5.65	91.60	10.66
3	Days to Maturity	27.96	12.61	15.34	4.34	4.78	82.20	8.10
4	Plant Height cm	922.40	457.77	464.63	19.44	19.59	98.50	39.76
5	Head Diameter	7.29	3.56	3.732	15.07	15.42	95.60	30.36
6	100-Seed Wt.(g)	0.97	0.32	0.65	11.65	16.55	49.50	16.89

σ2g – Genotypic variance, σ2p-Phenotypic variance, GCV –Genotypic Coefficient of variation, PCV- Phenotypic Coefficient of variation,h^2(b. s.)-Heretability in broad sense, GA-Genetic advance.

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Safflower heterosis for yield and its contributed characters

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ABSTRACT

Twenty two hybrids were tested using line x tester design involving two cytoplasmic male sterile lines during *rabi* 2018, using Randomized block design with three replications. Twenty two along with three checks 'A-1, PBNS-12, PKV Pink' were evaluated at the field of Oilseeds Research Unit, Dr. PDKV, Akola during rabi 2019-2020 to estimate extent of heterosis in safflower genotypes.Among all the crosses, AKS CMS 2A x GMU 1183 (46.15 % and 44.30%) exhibited highly significant and positive average heterosis for number of seeds/plant over mid and better parent. crosses, AKS CMS 2A x GMU 184 (49.26% and 34.44%) exhibited highly significant and positive average heterosis for 100 seed weight, whereas, cross AKS CMS 2A x GMU 5149 (15.28% and 9.32%) exhibited highly significant and positive average heterosis for volume weight. The highest heterosis and heterobeltiosis in desirable direction were recorded for seed yield/plant in AKS CMS 2A x GMU 1654 (246.96%) and the cross AKS CMS 3A x GMU 1183 (206.75%) showed highest and significantly positive standard heterosis over the checks i.e. PKV PINK, AKS 207 and PBNS-12.

Keywords: Heterosis and Heterobeltiosis, Safflower

Safflower (*Carthamus tinctorius* L.) belongs to Asteraceae family commonly known as “kusum” and has 2n = 24 chromosomes. Safflower (*Carthamus tinctorius*. L.) is one of the important *rabi* oilseed crops of India, Several reports from the USA and other parts of the world have demonstrated existence of significant heterosis for yield and total oil output in the crop. Despite numerous problems encountered currently in thelarge scale production of hybrid seeds in safflower owing to non-availability of simple, efficient and inexpensive mechanisms of cross pollination, such information obtained from large number of crosses involving diverse parental types would be very useful inidentifying superior cross combinations and framing our future breeding strategies in acrop which has been found to offer great promise for semi-arid tracts in the country. This study state that the present status and future prospects of heterosis breeding of safflower in India. In safflower, genetic as well as cytoplasmic male sterility systems are harnessed for the development of hybrid cultivars.

MATERIAL AND METHODS

The experimental material consisted of Twenty two hybrids were tested using line x tester design involving two cytoplasmic male sterile lines (viz., AKS CMS 2 A and AKS CMS 3A) and eleven fertility restorer lines (viz., GMU 1654, GMU 7363, GMU 880, GMU 1894, GMU 7593, GMU 1731, GMU 7573, GMU 6891, GMU 1183, GMU 184 and GMU 5149) during rabi 2018, using Randomized block design with three replications. Twenty two along with three checks 'A-1, PBNS-12, PKV Pink' were evaluated at the field of Oilseeds Research Centre, Dr. PDKV, Akola during rabi 2019-2020 to estimate extent of heterosis in safflower genotypes. All recommended cultural practices were followed to raise a good crop. The observations were recorded on five randomly selected plants for ten quantitative traits viz., days to 50% flowering, days to maturity, plant height (cm), number of branches/plant, number of capitula/plant, number of seeds/capitulum, volume weight (g/100ml), 100 seed weight (g), and seed yield/plant (g). Heterosis was calculated over mid parent, better parent and standard check for seed yield, its components.

RESULTS AND DISCUSSION

The analysis of variance for various characters under study is presented in Table 1. The variation among treatments was highly significant for all of the characters. The mean sum of square due to parents (testers), Male (testers) x Female (lines), crosses and parents vs crosses were also highly significant for all the characters studied except number of branches/plant and number of capitula/plant. This indicated presence of substantial genetic variability for the characters studied.

The variances due to testers were highly significant for all the traits except 50% flowering, 100 seed weight and volume weight. The variances due to crosses were highly significant for all the traits under study except number of branches/plant and number of capitula/plant which indicated the presence of significant differences between males and females.

The estimates of heterosis over mid parent (MP) and better parent (BP) for different characters in safflower are presented in Table 2. Heterosis was measured asper cent increase or decrease over mid parent (relative heterosis) and over better parent (heterobeltiosis). For calculation of relative heterosis and heterobeltiosis for days to 50per cent flowering, plant height, number of seeds/capitulum and days to maturity, parents with less values were considered as better parent and crosses with lower values were considered as heterotic crosses. The magnitude of heterotic effects observed in different characters varied from cross to cross. Positive heterosis is desirable for all the characters studied except days to 50% flowering and days to maturity where negative heterosis is desirable. Heterosis for days to 50 per cent flowering the highest, significant and negative heterosis over mid parent was observed in cross AKS CMS 3A x GMU 1183 (-6.07 %) and over and better parent was AKS CMS 2A x GMU 7593 (-10.20 %). Whereas, in case of days to maturity, the highest, significant and negative heterosis over mid parent and better parent was observed in cross AKS CMS 3A x GMU 6891and AKS CMS 3A x GMU 5149(-5.93 % & -7.86 %, respectively).

The highest magnitude of heterosis over mid parent and better parent was for plant height at harvest was observed in cross AKS CMS 3A x GMU 1183 (32.63 % and 30.16) respectively. In case of number of primary branches showed heterosis over mid parent and better parent was cross CMS 2A x GMU 1654 (40.35 and 37.93%) respectively. Number of capsules/plant the cross CMS 2A x GMU 1183 (40.0%) andCMS 3A x GMU 1655 (33.33%) showed highest and positive heterosis over mid parent and better parent.Similar results were also reported by Narkhede et al (1986 and 1987) and Deokar *et al* (1992) for both the traits in safflower. These cross combinations can be used in further breeding programme to enhance yield potential through plant height, number of primary branches and number of capsules/plant.Among all the crosses, AKS CMS 2A x GMU 1183 (46.15 % and 44.30%) exhibited highly significant and positive average heterosis for number of seeds/plant over mid and better parent. crosses, AKS CMS 2A x GMU 184(49.26% and 34.44%) exhibited highly significant and positive average heterosis for 100 seed weight, whereas, cross AKS CMS 2A x GMU 5149 (15.28% and 9.32%) exhibited highly significant and positive average heterosis for volume weight. These results are in line of results obtained by Deedawat *et al* (2016) in safflower.

The highest heterosis and heterobeltiosis in desirable direction were recorded for seed yield/plant in AKS CMS 2A x GMU 1654 (246.96. %) and the cross AKS CMS 3A x GMU 1183 (206.75%) showed highest and significantly positive standard heterosis over the checks i.e. PKV PINK, AKS 207 and PBNS-12. The relative heterosis, heterobeltiosis and standard heterosis for above characters in safflower was also reported by several workers in safflower Narkhede *et al* (1986 and 1987) and Deedawat *et al* (2016). Among twenty two hybrids, AKS CMS 2A x GMU 1654 (86.6 g plant-1), AKS CMS 3A x GMU 1654 (82.5 g plant-1), AKS 3A x 1183 (59.1 g plant-1), AKS 2A x 1183 (49.5 g plant-1), AKS CMS 2A x GMU 880 (29.7 g plant-1) and AKS CMS 3A x GMU 1894 (28.7 g plant-1) recorded highest mean seed yield than best check AKS 207 (26.7 g plant-1). However genotype GMU 1183 (49.5 and 59.1 g plant-1) recorded highest yield to both CMS lines.

Hence, above crosses have good genetic potential due to good magnitude of useful heterosis in desirable direction for most of traits that can be utilized in further breeding programme for exploiting hybrid vigour.

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Table 1: Analysis of variance for combining ability

Sources of variation	DF	Seed yield (g plant-1)	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches/plant	No. of capitula/plant	No. of seeds/ capitulum	100 seed wt. (g)	Volume wt. (g/100 ml)
Replicates	2	5.000	45.288 **	7.106	680.387 **	2.015	4.227	9.652	0.239	0.203
Crosses	21	1281.407 **	58.188 **	65.085 **	127.037 **	6.220	114.855 **	129.666 **	1.731 ***	17.838 **
Females (lines)	1	0.055	30.682	0.242	8.626	2.561	4.379	5.470	0.680	12.393
Males (testers)	10	2647.880 **	86.812	113.212 *	241.871 **	10.179 *	223.445 **	214.615 *	2.471	18.132
Females vs Males	10	43.069 **	32.315 **	23.442 **	24.043 *	2.627	17.312	57.136 **	1.096 **	18.089 **
Error	42	2.303	2.955	4.074	10.118	3.523	11.180	5.826	0.091	1.386
Total	65	415.635	22.102	23.879	68.515	4.348	44.461	45.954	0.626	6.665

* Significant at 5% level of significance; ** Significant at 1% level of significance

Table 2 Heterosis (%) over mid-parent (MP) and better-parent (BP) for different characters

Crosses	No. of branches/plant		No. of capitula/plant		No. of seeds/ capitulum		100 seed wt. (g)		Volume wt. (g/100 ml)	
	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)
AKS CMS 2A x GMU 1654	40.35 **	37.93 *	32.94 **	25.56 **	40.24 **	35.29 **	8.94	7.20	-0.53	-6.18 **
AKS CMS 2A x GMU 7363	1.69	0.00	0.00	-8.75	-5.66	-6.25	36.24 **	14.69 **	-0.41	-6.74 **
AKS CMS 2A x GMU 880	0.00	-3.23	-11.63	-17.39 *	9.32	7.32	15.44 **	3.97	5.70 **	-2.17
AKS CMS 2A x GMU 1894	-3.23	-9.09	-14.11	-15.66	-5.41	-11.39	18.37 **	16.94 **	1.18	-4.23 *
AKS CMS 2A x GMU 7593	-1.69	-3.33	-16.46 *	-17.50	10.98	2.13	3.64	1.59	7.50 **	0.87
AKS CMS 2A x GMU 1731	-11.86	-13.33	-19.48 *	-22.50 *	-38.37 **	-43.01 **	38.89 **	33.59 **	1.91	-3.35
AKS CMS 2A x GMU 7573	4.92	0.00	5.04	-8.75	1.30	-1.27	-6.49	-22.99 **	8.00 **	3.67 *
AKS CMS 2A x GMU 6891	3.45	3.45	4.90	-6.25	-14.89 *	-24.05 **	-24.67 **	-36.87 **	0.59	-5.13 **
AKS CMS 2A x GMU 1183	26.67 *	22.58	35.77 **	16.25	46.15 **	44.30 **	27.35 **	23.14 **	7.43 **	3.46
AKS CMS 2A x GMU 184	-7.14	-10.34	-35.37 **	-36.90 **	-26.51 **	-29.89 **	49.26 **	34.44 **	5.83 **	-0.92
AKS CMS 2A x GMU 5149	13.33	9.68	-16.46 *	-17.50	12.16	5.06	25.90 **	21.54 **	15.28 **	9.32 **
AKS CMS 3A x GMU 1655	20.63	8.57	38.73 **	33.33 **	14.79 *	14.12 *	24.82 **	14.77 **	-3.73 *	-5.19 **
AKS CMS 3A x GMU 7363	-16.92	-22.86	-19.46 *	-27.71 **	-1.22	-3.57	0.61	-7.34	7.20 **	4.78 **
AKS CMS 3A x GMU 880	-6.06	-11.43	-10.86	-15.22	-36.14 **	-36.90 **	-2.00	-2.65	1.70	-1.80
AKS CMS 3A x GMU 1894	0.00	-2.86	6.02	6.02	9.80	0.00	26.74 **	16.11 **	3.40 *	2.22
AKS CMS 3A x GMU 7593	-26.15 *	-31.43 *	-32.92 **	-34.94 **	-3.37	-8.51	20.00 **	10.74 *	3.98 *	1.86
AKS CMS 3A x GMU 1731	-7.69	-14.29	-22.29 **	-26.51 **	-6.21	-10.75	27.14 **	19.46 **	0.17	-0.78
AKS CMS 3A x GMU 7573	-25.37 *	-28.57 *	-16.90	-28.92 **	24.53 **	17.86 **	2.98	-7.49 *	7.85 **	7.51 **
AKS CMS 3A x GMU 6891	0.00	-8.57	2.74	-9.64	-8.22	-20.24 **	-20.12 **	-26.82 **	-0.31	-1.82
AKS CMS 3A x GMU 1183	6.06	0.00	40.00 **	18.07 *	45.34 **	39.29 **	11.45 *	-2.01	-0.89	-1.54
AKS CMS 3A x GMU 184	-9.68	-20.00	-32.93 **	-33.33 **	-39.18 **	-40.23 **	19.33 **	18.54 **	1.17	-1.14
AKS CMS 3A x GMU 5149	-15.15	-20.00	-32.92 **	-34.94 **	21.57 **	10.71	6.81	0.00	-1.01	-1.95
RANGE	-20.0 to 40.35	-31.43 to 37.93	-35.37 to 40.0	-36.90 to 33.33	-39.18 to 46.15	-43.01 to 44.30	-24.67 to 49.26	-36.87 to 34.44	-3.73 to 15.28	-6.74 to 9.32
SE(D)±	1.2868	1.4859	2.0168	2.3288	1.5812	1.8258	0.1927	0.2225	0.8942	1.0325
CD 5%	2.5969	2.9986	4.0702	4.6998	3.1911	3.6847	0.3888	0.4490	1.8046	2.0838
CD 1%	3.4719	4.0090	5.4416	6.2834	4.2663	4.9263	0.5198	0.6002	2.4126	2.7859

* Significant at 5% level of significance; ** Significant at 1% level of significance

Genetic variability studies of yield, its attributing traits and oil content in RHA lines of sunflower (*Helianthus annuus* L.)

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ABSTRACT

Sunflower inbred lines (RHA) derived from different sources with Rf gene were evaluated during 2018-2020.Genetic variability, phenotypic and genotypic coefficients of variation, heritability and genetic advance were assessed for seven traits related to seed yield, its attributing traits and oil content in 50 RHA lines of sunflower. The analysis of variance revealed highly significant differences for all the characters among the RHA lines. The magnitude of differences between PCV and GCV was relatively low for all the traits, indicating less environmental influence. The estimates of GCV and PCV were high for seed yield/plant. High heritability in broad sense estimates (>90%) were recorded for all the traits under study indicating, the predominance of additive gene action and selection of RHA lines based on these characters would be more valid and selected RHA lines are likely produce high yielding hybrids. Effective for target plant selection in early generation.

Keywords: GCV, PCV, Heritability and GAM, Oil content, RHA lines, Seed yield

Sunflower (*Helianthus annuus* L.) is an important oilseed crop, and is widely adopted and accepted for its high quality and nutritional edible oil. Due to its high economic importance, the development of effective hybrids with superior yield and quality traits is an important requirement. Presence of genetic variability is a prerequisite before initiating any breeding programme. Information on variability and heritability is useful to formulate selection criteria for improvement of seed yield and its component traits. Heritability estimates along with genetic advance is a more reliable measure in predicting the expected performance. Hence, variability present in a gene pool of a crop species is important to plant breeder any breeding programme (Mangin *et al*. 2017).

MATERIAL AND METHODS

A field experiment was conducted with 50 Restorer *Helianthus annus* (RHA) lines of sunflower, in randomized complete block design with two replications during *rabi* 2018, 2019 and 2020 at the Zonal Agriculture Research Station, GKVK, Bangalore, Karnataka. Five random plants from each restorer line in each replication were used to record observations on seed and oil yield and attributing traits. The mean of the 50 RHA lines was analyzed statistically for genetic variability by the method outlined by Ostle (1966). The analysis of variance for different characters was carried out in order to assess the genetic variability among genotypes.

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among RHA lines for all the characters under study indicating the presence of adequate variability among the RHA lines (Table 1). A wide range of variation was observed in the RHA lines of sunflower for yield, its attributing traits and also for oil content. However, widest range of variability was recorded for seed yield/plant (2.25-37.5g) (Table 2). The estimates of Phenotypic Coefficient of Variation were slightly higher than their corresponding Genotypic Coefficient of Variation (Fig 1). for all the traits under this study indicating the less influence of environment on the expression of these traits. The traits with almost equal value of PCV and GCV can be considered as stable (Dimitrijević*et al*., 2017).

High heritability in broad sense and genetic advance estimates were recorded for majority of the characters under study except for days to 50 % flowering and volume weight (g/100ml) (Table 2 and Fig. 2) indicating that these characters are under the control additive gene action and selection for improvement is rewarding in this set of RHA lines.

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Table 1: ANOVA for seed yield, oil content and attributing traits in 50 sunflower RHA lines

Source of variation	Mean Sum Squares (MSS)				
	Replications	Treatments	Error	CV	CD @ 5per cent
Degrees of freedom (df)	1	49	49	-	-
Days to 50 % Flowering	34.810	45.249**	1.218	0.158	0.202
Plant Height (cm)	0.771	845.895**	1.624	0.089	0.161
Head Diameter (cm)	0.260	11.001**	0.439	1.644	0.262
Seed Yield Plant^{-1} (g)	2.679	99.621**	1.040	0.494	0.103
Volume Weight (g/100ml)	5.852	40.014 **	1.597	0.120	0.104
100 Seed weight (g)	0.226	2.009**	0.408	0.629	0.054
Oil Content (%)	1.241	95.20**	1.313	0.173	0.124

****** Significant at 1% level; CV- Coefficient of variation; CD- Critical Difference

Table.2 Genetic variability in 50 sunflower RHA lines for seed yield, oil content and attributing traits

Character	Mean	Range		Coefficient of variation (%)		Heritability (%)	Genetic Advance as Mean (%)
		Low	High	Genotypic Coefficient of Variation	Phenotypic Coefficient of Variation		
Days to 50 % Flowering	63.09	53	74.5	7.43	7.64	94.75	14.91
Plant Height (cm)	89.34	36	146.9	22.95	23.03	99.61	47.27
Head Diameter (cm)	7.92	4.33	19.95	28.98	30.16	92.32	57.37
Seed Yield Plant^{-1}(g)	10.59	2.25	37.5	66.29	66.98	97.93	135.14
Volume Weight (g/100ml)	42.66	29.09	50.59	10.27	10.69	92.32	20.33
100 Seed weight (g)	4.37	3.12	7.055	20.43	25.10	66.23	34.25
Oil Content (%)	35.08	20.16	52.99	19.57	19.79	97.28	39.67

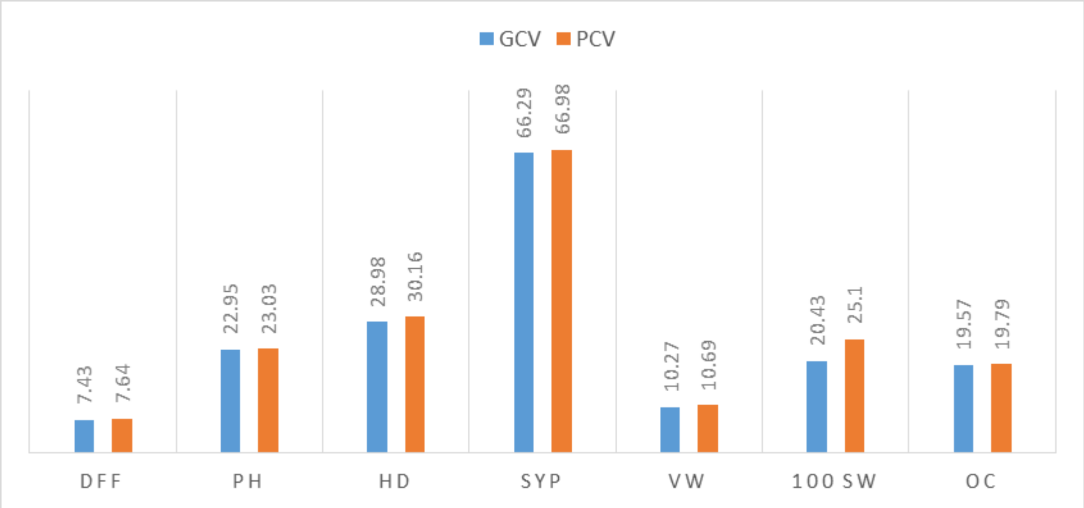

Fig.1: Graphical representation of Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV)

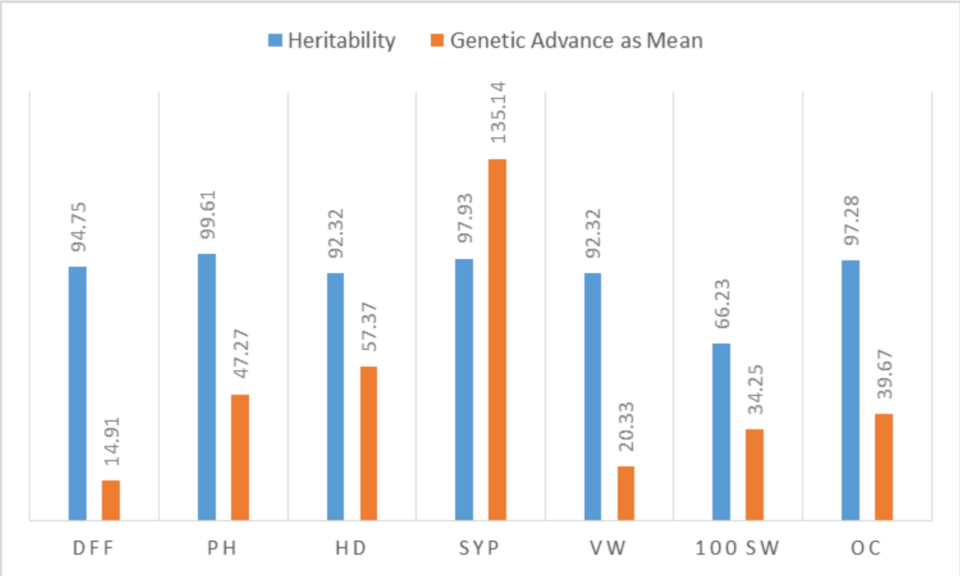

Fig.2: Graphical representation of heritability and genetic advance as mean (%)

Heterosis and combining ability studies in Sesame

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ABSTRACT

The present investigation on heterosis and combining ability using line × tester analysis at NRS, NAU, Vanarasi Gujarat indicated that there is sufficient amount of variation present in the tested material for seed yield and its components. Non-additive genetic variances were important in the inheritance of all the traits. The preponderance of non-additive genetic variance was observed in the inheritance of days to 50 % flowering, days to maturity, plant height, effective branches/plant, capsules/plant, capsule length, seeds/capsule, 1000-seed weight, harvest index, seed yield/plant and oil content which suggested that heterosis breeding would be more suitable for the improvement of these traits in sesame. Further the crosses which exhibited high seed and oil yield along with high heterosis and heterobeltiosis should be exploited through pedigree method to obtain desirable transgressive segregants with high seed yield along with high oil content.

Keywords: Combining ability, GCA, Heterosis, SCA, Sesame

Sesame (*Sesamum indicum* L.) is probably the most ancient oilseed known and used by man and known as the "Queen of oil seeds" because of its excellent qualities of the seed, oil and meal. It is basically considered as a crop of tropical and sub-tropical regions but, it has also spread to the temperate parts of the world. Sesame is self pollinated crop with an average cross pollination to the extent of 4 to 5 %. Most of the varieties evolved and released for cultivation are selections from locals or closely related populations under low levels of management. This is the major cause attributed for low productivity potential of cultivars grown in India which indicates the need to enhance the productivity of this crop by developing high yielding genotypes, hence the present investigation was undertaken with an objective to study heterosis and heterobeltiosis for yield and its attributes, combining ability of parents and gene action for the yield and its various attributes for developing varieties with high seed and oil yield.

MATERIALS AND METHODS

The experimental material used in the present study consisted of 44 genotypes comprising of 32 hybrids developed from four lines and eight testers. The crosses were effected during *rabi*-summer 2020 at Niger Research Station, Navsari Agricultural University, Vanarasi through line × tester mating design. The complete sets of 44 genotypes were evaluated in a Randomized Block Design with three replications, evaluated at Niger Research Station, NAU, Vanarasi during *rabi*-summer 2021. Five randomly competitive plants from each entry excluding border plants in each replication were selected for recording the observations on different characters and their averages values were taken for statistical analysis. The analysis of variance was performed to test the significance of difference among the genotypes for all the characters based on statistical model as suggested by Panse and Sukhatme. The estimation of heterosis and heterobeltiosis was based on the formula suggested by Fonesca and Patterson, whereas, the analysis of variance for combining ability was performed according to the model given by Kempthorne.

RESULTS AND DISCUSSION

The results revealed that the mean sum of squares due to genotypes was found highly significant for all the characters which indicated that sufficient amount of genetic variability was present in the experimental material for all the characters under study. In general, the magnitude of heterosis was higher for seed yield/plant, capsules/plant, days to 50% flowering, days to maturity, harvest index and oil content, whereas it was moderate for plant height, capsule length, seeds/capsule and effective branches/plant and low for 1000-seed weight. Significant estimates of positive heterosis and heterobeltiosis were observed in 17 and 7 cross combinations, respectively for seed yield/plant. The range of heterosis and heterobeltiosis for seed yield were from -44.87 to 67.08 and -52.99 to 39.43 respectively for seed yield/plant. The highest and positive heterosis and heterobeltiosis for seed yield was recorded in the cross JLS-706 × ASRT-15 (67.08%) and JLS-706 × ASRT-15 (39.43 %). These crosses also recorded significant heterosis and heterobeltiosis for days to 50% flowering, plant height, capsules/plant, harvest index, seed yield/plant and oil content. Analysis of variance for combining ability revealed that the mean sum of squares due to lines were significant for all characters except days to maturity and 1000-seed. Whereas, mean sum of square due to tester and line × tester were significant for all the character. The results indicated the non-additive genetic variances in the expression of these characters. Similar results have been repoted by Reddy*et al*. (2015) and Ismail *et al.* (2020).

The estimates of genetic variance indicated that the magnitude of variance due to GCA (σ^2gca) were lower than those due to SCA (σ^2sca), for the all characters indicating the preponderance of non-additive gene action. The line JLS-706 had given a desired GCA effect for four characters *viz*., days to 50 % flowering, capsule length, harvest index and seed yield/plant. Apart from this, DS-18-46 had desired GCA effects for three characters capsules/plant, harvest index and seed yield/plant. Among the tester, AT-287 had given desired GCA effects for days to 50 % flowering, plant height, capsules/plant and 1000-seed weight. The ASRT-12 had given desired GCA effects for three different characters *viz.*, capsule length, harvest index and seed yield/plant. For days to maturity, days to 50 % flowering and harvest index the tester ASRT-10 was found to be good general combiner. A tester, ASRT-8 was found to be good general combiner for two character i.e., effective branches/plant and seeds/capsule. While the ASRT-15 had given desired GCA effects for two characters *viz*., plant height and oil content.

The estimates of SCA effects of crosses indicated that 8 out of 32 crosses had reported significant and positive SCA effects for seed yield/plant. Among them the highest SCA effects were manifested by the cross were PURVA-1 × AT-307 followed by PURVA-1 × AT-331 and DS-18-46 × AT-287. The cross DS-18-46 × AT-287 was also found good specific combination for days to 50 % flowering, days to maturity, plant height, effective branches/plant, capsules/plant, seeds/capsule, harvest index, seed yield/pant and oil content. Likewise, the cross PURVA-1 × AT-307 exhibited significant SCA effect for days to maturity, capsules/plant, seeds/capsule, harvest index and seed yield/plant (Table 1). Similar findings were reported by Sikarwar *et al*. (2021) and Ghule *et al*. (2022).

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Table 1 Specific combining ability (SCA) effect of hybrids for different characters in sesame

Crosses	DFF	DM	PH (cm)	EB/ plant	Capsules/ plant	CL (cm)	Seeds/ capsules	TW (g)	HI (%)	Seed yield/ plant	Oil content (%)
JLS-706 × ASRT-12	1.37	-2.14	2.17	-0.43 *	-16.4 **	0.42 **	-0.16	-0.23	-6.40 **	-1.44 *	-3.77 **
JLS-706 × ASRT-10	-1.12	-5.80 **	-6.94	0.19	2.76	0.08	6.57 *	0.189	5.01 **	1.14	-0.81
JLS-706 × AT-331	-1.93	3.45	-6.30	-0.352	-12.92 **	-0.33 **	-11.98 **	-0.44 **	-4.72 **	-4.22 **	4.28 **
JLS-706 × AT-307	2.49 *	-3.30	13.27 **	0.04	-6.53	-0.09	-0.23	0.30 *	1.99 *	0.63	-1.42
JLS-706 × AT-287	1.10	0.45	-13.01 **	-0.27	-7.70	0.01	0.90	0.36 *	-2.71 **	-0.60	-3.48 **
JLS-706 × ASRT-15	2.30	1.87	16.56 **	0.10	16.45 **	-0.10	-3.99	0.01	9.29 **	2.45 **	2.711 *
JLS-706 × ASRT-9	-4.10 **	2.53	-1.94	-0.26	0.65	-0.01	4.70	-0.06	-5.74 **	-0.42	-1.63
JLS-706 × ASRT-8	-0.12	2.95	-3.82	0.98 **	23.73 **	0.02	4.20	-0.11	3.27 **	2.46 **	4.13 **
DS-18-46 × ASRT-12	1.75	3.62	-11.29 *	0.25	14.73 **	0.05	-2.29	0.29	5.45 **	1.63 *	-0.73
DS-18-46 × ASRT-10	-2.35	0.62	9.44 *	-0.81**	-6.30	-0.23	-3.22	0.21	-2.42 *	0.16	-0.57
DS-18-46 × AT-331	-3.16 *	1.20	0.14	0.006	17.21 **	0.15	4.64	-0.01	1.32	1.12	-1.32
DS-18-46 × AT-307	0.59	1.45	-7.17	-0.59 **	-18.38 **	-0.04	-8.20 **	-0.69 **	-6.35 **	-4.02 **	-1.03
DS-18-46 × AT-287	0.88	-1.47	4.53	0.58 **	7.25	0.04	6.79 *	-0.26	9.33 **	2.58 **	4.49 **
DS-18-46 × ASRT-15	-2.49 *	-0.39	-12.31 **	0.63 **	-7.19	-0.43 **	2.35	0.09	-11.12 **	-2.71 **	-1.07
DS-18-46 × ASRT-9	1.11	-1.72	3.72	0.13	-4.38	0.28 *	-2.02	0.14	1.94	0.59	2.16
DS-18-46 × ASRT-8	3.68 **	-3.30	12.96 **	-0.19	-2.93	0.19	1.94	0.23	1.84	0.64	-1.92
TKG-523 × ASRT-12	-0.88	2.74	1.57	-0.09	12.41 **	-0.11	7.09 *	-0.19	4.09 **	0.63	-0.55
TKG-523 × ASRT-10	1.53	3.07	-13.08 **	0.56 **	15.52 **	0.15	-1.56	0.19	5.25 **	2.16 **	0.37
TKG-523 × AT-331	4.60 **	-7.67 **	2.81	0.39	-5.81	0.01	2.18	0.03	-3.47 **	-0.19	1.85
TKG-523 × AT-307	-3.74 **	6.24 **	1.09	0.35	10.24 *	0.09	2.02	0.12	-2.41 *	-0.01	1.14
TKG-523 × AT-287	-1.51	-4.34 *	8.10	-0.30	2.51	-0.03	1.41	-0.14	-1.90	-0.64	-0.84
TKG-523 × ASRT-15	1.42	-1.59	-5.87	-0.65 **	1.75	0.37 **	3.18	-0.04	5.59 **	2.42 **	-1.59
TKG-523 × ASRT-9	1.68	1.41	8.29	-0.08	-16.69 **	-0.22	-3.21	0.16	-0.48	-1.17	-0.14
TKG-523 ×ASRT-8	-3.10 *	0.16	-2.91	-0.17	-19.94 **	-0.26 *	-11.13 **	-0.11	-6.65 **	-3.21 **	-0.24
PURVA-1 × ASRT-12	-2.24	-4.21 *	7.56	0.27	-10.68 *	-0.35 **	-4.63	0.14	-3.14 **	-0.82	5.06 **
PURVA-1 × ASRT-10	1.95	2.12	10.57 *	0.06	-11.98 **	-0.005	-1.78	-0.58 **	-7.84 **	-3.48 **	1.01
PURVA-1 × AT-331	0.49	3.03	3.36	-0.04	1.5	0.16	5.15	0.42 **	6.87 **	3.29 **	-4.82 **
PURVA-1 × AT-307	0.66	-4.38 *	-7.19	0.19	14.68 **	0.04	6.41 *	0.26	6.77 **	3.41**	1.30
PURVA-1 × AT-287	-0.47	5.36 **	0.38	-0.002	-2.06	-0.02	-9.12 **	0.04	-4.71 **	-1.32 *	-0.16
PURVA-1 × ASRT-15	-1.23	0.12	1.62	-0.08	-11.02 *	0.16	-1.55	-0.05	-3.75 **	-2.17 **	-0.04
PURVA-1 × ASRT-9	1.31	-2.22	-10.07 *	0.215	20.42 **	-0.04	0.53	-0.23	4.28 **	1.00	-0.38
PURVA-1 × ASRT-8	-0.46	0.20	-6.23	-0.610 **	-0.864	0.04	4.99	0.001	1.53	0.1	-1.95
SE(S_{ij})	1.19	1.87	4.60	0.20	4.42	0.11	2.78	0.14	0.98	0.65	1.13

* and ** indicates significance at 5% and 1% levels of probability, respectively

Agronomic interventions for productive and profitable sunflower (*Helianthus annuus* L.) in saline soils

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ABSTRACT

Experiment was conducted at ARS, Gangavati Karnataka to know the feasibility of sunflower production and its profitability in saline soils by adoption of different management practices. Significantly higher sunflower yield was recorded by soaking seeds with $CaCl_2$@1% then sowing at half way on the ridge with application of FYM @ 5 t /ha. It also recorded higher head diameter, filling percentage, 100 seed weight. Whereas seeds soaked either with $CaCl_2$ @ 1% was found effective over dry seeding or hardening in water. Residual soil chemical properties including soil pH, EC, OC, N, P_2O_5, K_2O and Ca showedthat these were no much influence of method of sowing, FYM application and seed treatment.

Keywords: Management, Saline soil, Sunflower

In Tungabhadra (TBP) Irrigation command in Karnataka 0.96 lakhs hectares of land are affected by salt. Salinity is a major abiotic stress that affects sunflower growth and development, thus resulting in significant yield loss. It is the fifth most widely grown edible oil crop in the India. It is a crop with moderate salt-tolerance; salinity stress is still a major constraint in a region of inadequate rainfall failing to leach salt from the root zone and high evapo-transpiration (ET) often exceeding rainfall. The ability of a crop to survive and grow under saline conditions depends on its salt tolerance, or modified management strategies (Liu *et al.*, 2010). Sunflower degree of response to level of salinity was varied by organic acid and soluble sugars and inorganic K^+ and Na^+ contents. Further nutrient use efficiency under salinity also depends on rate of N and S application to alleviate salinity (Ma et al., 2022). Thus, high germination ability of crops in saline soil is necessary for later growth and development. It has been reported that salt stress can lead to a significant reduction in germination rate, as it reduces the ability of plants to uptake water from the soil, result in the growth inhibition and yield loss. Study was conducted in saline soils with an objective to evaluate sunflower productivity and profitability in a modified method of planting coupled with FYM application and seed soaking with chemicals.

METHODOLOGY

Experiment was conducted at ARS, Gangavati during 2017, 2018 and 2010 in a fixed plot to know the feasibility of sunflower production in saline soils by adoption of different management practices. During 2019, the trial was vitiated due to heavy rains at early vegetative stage subsequently poor crop establishment. Experiment was conducted in a saline soil with EC 5.2- 5.8 dS/m and soil pH 8.5-9.1 and average OC of 0.356. Previous crop in all the years was fallow. It was laid out in split-plot design with two replications in a 5.4 m x 4.8 m plot size. Main plot treatments were planting on flatbed and half way on the ridge and furrows combined with or without FYM application @ 5 t /ha (MF). Sub plot treatment consists of seed soaking with NaCl, KNO_3, $CaCl_2$ compared with dry seeding and soaking in water (S) (Table 1). Experiment was sown in *Kharif* first week of August. Seeds were hand dibbled in all the treatments. Sunflower hybrid RSFH-1887 was selected for the study sown at 60 cm x 30 cm. Recommended rate of fertilizer for the region was 90: 90: 60 kg NPK /ha. Soil chemical properties were measured before and after the experiment. Irrigation water was applied during dry spells from TBP canal, tested its salt content (EC) at 20 days interval. All canopy characters at regular intervals, yield attributes and seed oil content were estimated at maturity. Rest of the production practices were followed as per the University recommendation for the region. Data were analyzed as/the split plot design at probability level 0.05.

Table 1. Yield components of sunflower as influenced by method of sowing, FYM application and chemical seed soaking (Average of 3 years)

Treatments	Plant height (cm) at maturity	Head diameter (cm)	Seed Filling percentage	100 seed weight (g)	Seed yield (kg/ha)	Oil yield (kg/ha)
Year						
2017	161.2	16.08	79.65	5.42	1695	731.2
2018	162.7	16.43	80.77	6.48	1908	713.9
2020	174.7	16.20	75.94	4.90	1863	611.7
CD@5%	10.26	NS	NS	0.75	NS	NS
Method of sowing and FYM levels (MF)						
M_1F_0: Flatbed sowing	154.8	15.59	70.41	5.18	1438	542.6
M_1F_5: Flat bed sowing with FYM@5 t /ha	149.9	16.77	85.59	5.72	1953	744.9
M_2F_0: Sowing half way on the ridge	176.8	15.35	75.05	5.60	1778	676.3
M_2F_5: Sowing half way on the ridge with FYM @ 5 t/ha	183.1	17.22	84.10	5.89	2119	778.5
C.D.@5%	3.10	0.59	1.39	0.30	126	42.2
Seed treatment (S)						
S_1: Dry seeding	160.2	15.65	78.46	5.50	1521	577.5
S_2: Seed hardening in water	161.6	16.17	79.54	5..49	1671	627.3
S_3: Seed soaking with NaCl@1% for 6h	170.5	16.00	79.54	5.59	1933	728.6
S_4: Seed soaking with $CaCl_2$@1% for 6h	1708	17.07	76.85	5.66	2083	780.8
S_5: Seed soaking withKNO_3@1% for 6h	167.8	16.29	79.54	5.75	1902	713.7
C.D.@5%	2.76	0.36	1.41	NS	110	46.1
Interaction (MF x S)						
CD@5%	5.52	0.73	2.81	NS	220.3	92.2

RESULTS

Results over three years showed that significantly higher sunflower yield was recorded by sowing seeds at half way on the ridge with application of FYM @ 5 t /ha (M_2F_5) it was followed by sowing half way on the ridge with application of fertilizers alone (M_1F_5) (Table 1). It was also recorded higher head diameter, filling percentage, 100-seed weight, greater oil even though seed oil content was found non-significant. There was no significant difference in growth and yield of sunflower between the years of experimentation. Whereas seeds soaked either with $CaCl_2$ @ 1% or NaCl@ 1% for 6h (S_4) was found effective over dry seeding (S_1) or seed hardening in water (S_2). Soil chemical properties *viz.*, soil pH, EC, OC, N, P_2O_5, K_2O and Ca analyzed after crop harvest these were not influenced by method of sowing, FYM application and seed treatment. Results confirmed that production of sunflower was possible in a saline soil (EC>4.0 dS/m) by adoption of seed soaking 6h with CaCl2@1% along with planting seeds half way of the ridge with application of FYM@ 5 t /ha.

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Assessment of genetic diversity and population structure of groundnut cultivars using morphological characters

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ABSTRACT

Forty six germplasm of groundnut (*Arachis hypogaea* L.) evaluated under *kharif* season have been classified using Principal component analysis (PCA) based on correlation matrix yielding eigen values and eigen vectors. Multivariate analysis of phenotypic characters extracted eight principal components (PC) using the mean performance of the genotypes and showed that the first three principal components contributed 61.75% of observed variability amongst the 46 genotypes with the eigen value >1 and PC1 accounted for 25.60% of the total morphological variation for the traits. The information given in this paper will be valuable in the efficient management and utilization of the groundnut genetic resources.

Keywords: Groundnut germplasm, Mean performance, Morphological traits, Principal component analysis

Groundnut (*Arachis hypogaea* L.,), the king of oil seeds is one of the important legume crops cultivated predominantly under rain-fed conditions in the tropical and semi-arid tropical countries including India, where it provides a major source of oil, carbohydrates and proteins. Groundnut kernels are rich sources of oil, protein, carbohydrate, minerals (e.g., P, Ca, Mg, and K), and vitamins (E, K, B). Local demand for groundnut is increasing due to the emerging groundnut processing factories. Principal component analysis is a variability estimation method that reduces data dimensionality by performing covariance analysis between factors. Improving the genetic potential of groundnut for qualitative and quantitative traits is one of the major objectives in most groundnut breeding programs (Upadhyaya *et al*. 2005). PCA determines the net effect of each variable on the total variance of the data set and then extracts the maximum variance possible from the given material. The current study explains the PCA as variability estimation through classification of forty six accessions of groundnut. Sustainable peanut development programs need to find out and incorporate genes from germplasm with high genetic variability for desired characters.

MATERIALS AND METHODS

Forty six groundnut genotypes including 21 released varieties and 25 germplasm accessions were raised in randomized block design with two replications during *kharif* 2022.The morpho-metrical observations were recorded on five randomly selected plants in each genotype in each replication for the characters *viz*., days to 50% flowering (DFF), plant height (PH), number of branches/plant (NB), number of matured pods/plant (NP), number of peg/plant (NPeg), pod yield/plant (SPY), 100-kernel weight (100Kwt) and yield kg/ha (Y).Principal component analysis (PCA) was computed from correlation matrices using SAS Procedure PRINCOMP in order to assess the patterns of phenotypic trait variation considering all variables simultaneously.

RESULTS AND DISCUSSION

On perusal of the mean data of eight traits of 46 genotypes, K6 has taken the longest days (52 days) for days to 50 % flowering and Dharani had short duration (40 days) of 50 % flowering. The overall mean for days to 50 % flowering of all the accessions was 47 days. The germplasm Tag 24 showed minimum number of branches/plant and maximum branches/plant recorded by the genotype GG 33 (17.7) with the mean value of 9.03. The entry ALR 3 recorded maximum single plant yield (27.48g) with the mean of 16.38. It depicts a huge variation within the germplasm (Janila et al., 2013).The analysis of variance for RBD was performed and there exists significant difference among the 46 genotypes with respect to eight traits.

The principal component analysis of forty six accessions based on correlation matrix yielded the Eigen values and eight Eigen vectors. The Eigen values and associated cumulative percentage of variation explained by Eigen vectors have been presented in table 1 which shows the cattle scree graph for variation explained by various principal components. The eigen value of first principal component accounted for 25.60% of total variation presented in the original data followed by second to eighth principal components which accounted for 21.28, 14.87, 10.50, 9.75, 8.39, 6.75 and 2.85 per cent respectively. The first four principal components accounted for 72.25% of total variation whereas, the percentage of variation explained for five to eight PCs was small (<10.00). Based on biplot, number of pegs/plant contributes more in PC1 and in PC2 Days to 50% flowering and 100 kernel weight contribute more and the plant height and number of branches /plant has positive correlation.

Scree plot explained the percentage of variance associated with each principal component obtained by drawing a graph between Eigen values and principal component numbers. PC1 showed 25.60% variability with Eigen value 2.05, which then declined gradually. Haizheng Xiong et al (2016) also got highest variability in PC1 with Eigen value more than 1.0. Semi curve line was obtained after four PC tended to become straight with little variance observed in each PC. So, selection of lines from PC1 will be useful (Fig. 1). The first three components in the PCA analysis with Eigen values >1 contributed 61.75per cent of the variability among genotypes evaluated for different agro-morphological traits. This is in accordance with the reports of Umadevi et al (2020) in grain amaranth who considered genetic variability as essential in crop breeding.

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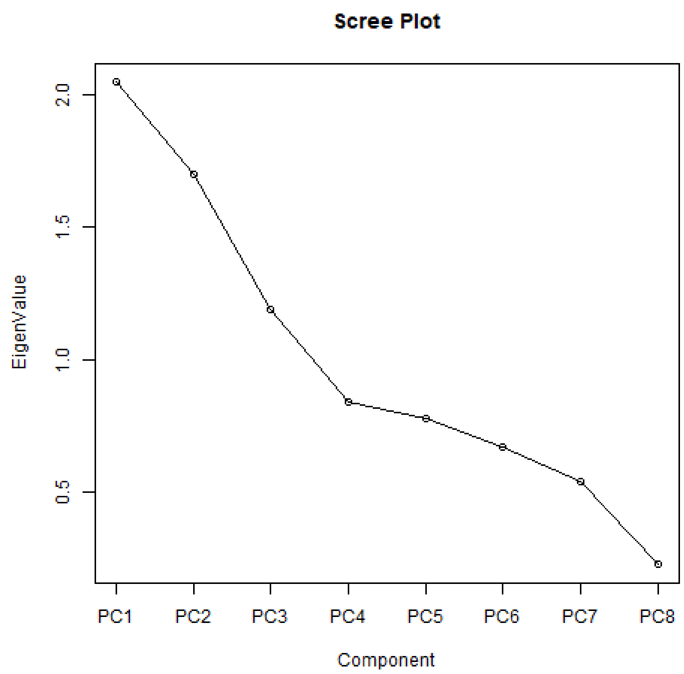
Table 1. Principal component analysis of the different morphological traits

Particulars	**Eigen vectors**							
	PC1	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**
Variability percentage	25.60	21.28	14.87	10.50	9.75	8.39	6.75	2.85
Cumulative percentage	25.60	46.88	61.75	72.26	80.00	90.40	97.15	100.00
Eigen values	2.05	1.70	1.19	0.84	0.78	0.67	0.54	0.23
Characters	**Co-efficient of variates**							
Days to 50% flowering	-0.0517	0.5733	-0.2248	0.0514	0.3579	0.2829	0.6355	-0.0587
Plant height	0.1873	0.1878	0.6179	-0.5524	0.215	-0.3897	0.1727	0.1214
No. of branches/plant	0.4271	0.3488	0.155	0.4491	0.305	0.0905	-0.4343	0.4246
No. of pods/plant	0.4367	-0.3664	0.2049	-0.0909	0.3427	0.5128	-0.021	-0.4939
No. of pegs/plant	0.5239	0.1652	-0.1228	0.3024	-0.2559	-0.516	0.1546	-0.4858
Single plant yield	0.5249	-0.2074	-0.1738	-0.1824	-0.4122	0.2285	0.3611	0.5153
100 kernel weight	0.0996	0.536	-0.1505	-0.4795	-0.3638	0.2861	-0.4328	-0.2208
yield (kg/ha)	0.1708	-0.15	-0.6586	-0.3571	0.4975	-0.3108	-0.1889	0.0853



Detection of petal colour QTLs in RILs of safflower

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ABSTRACT

The present study aimed to determine the QTL monitoring petal colour in F_9 and F_{10} RILs derived from CO-1/EC-523368-2 safflower. Yellow, red and orange colours were observed in the population. QTL analysis determined five and three QTLs in F_9 and F_{10} RILs respectively with 25.1 % as the highest phenotypic variance explained.

Keywords: Petal colour, QTL, RILs, Safflower

Safflower (*Carthamus tinctorius* L.) is one of the important oilseeds in India and belongs to the family Compositae. It was previously grown for its flowers, which were used to colour and flavour foods, make dyes, and in medicines because of its two natural pigments, carthamin and carthamidin. The crop's petal colours include yellow, orange, red and white. The petal colour in safflower changes from the initial blooming to maturity stage. The occurrence of different petal colours in safflower is due to five genes according to Narkhede and Deokar. However, Golkar *et al.* (2010) mentioned R, O, C and Y genes were also responsible. Their combinations yield yellow, orange, red, and grayish colours (Leus, 2016). Pearl *et al.* (2014) determined single recessive gene controlling petal colour variation and a large QTL with PVE of 63.4%.

MATERIALS AND METHODS

In the present study, petal colour at initial blooming and final maturity stages was observed in F_9 and F_{10} RILs developed from the cross between CO-1 and EC-523368-2. QTL mapping was done using software QTLIciMapping version 4.0.6.0 (Wang *et al*., 2015).

RESULTS AND DISCUSSION

The petal colours observed in the population were yellow, orange and red (Figure 1). In the population, one-fourth of the RILs were observed with red colour petals, similar to Pearl *et al*. (2014), indicating the variation may be due to recessive gene.The QTL analysis was done using previously constructed linkage map by Jegadeeswaran *et al*. (2021) with F_6 RILs derived from a cross between CO-1 and EC-523368-2. The analysis detected five QTLs (initial and final stages) in F_9 RILs and three QTLs (initial and final stages) in F_{10} RILs. A QTL for initial petal colour observed on LG-2 was consistent over generations with marker interval SafM-461 – SafM-91 and, LOD 5.1 and 3.7 in F_9 and F_{10} RILs respectively (QTL peaks are presented in figures 2 & 3). In both generations, initial petal colour was controlled by the desirable allele from CO-1 while final petal colour by EC-523368-2. The QTLs (Table 1) detected were inconsistent over generations which requires further evaluation. The genetics of petal colour may improve the usage of medicinal properties of safflower in pharmaceutical industries.

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Yellow colour **Orange colour** **Red colour**

Figure 1. Different petal colours observed in RIL population

Table 1. List of QTLs detected over generations in RIL population

Trait	LG	Marker interval	LOD	PVE (%)	Additive effect
$F_{6:9}$ RILs					
PC-I	2	SAFM-461 – SAFM-91	5.1	17.2	+0.18
PC-I	11	SAFM-283 – CT448	5.4	25.1	+0.21
PC-F	2	SAFM-461 – SAFM-91	3.6	9.6	-0.22
PC-F	11	CtDES-448 – NGSaf_33	3.5	10.0	-0.24
PC-F	11	CtDES-158 – SAFM-200	3.2	12.0	-0.25
$F_{6:10}$ RILs					
PC-I	2	SAFM-461 – SAFM-91	3.7	15.4	+0.16
PC-I	11	CtDES-229 – SAFM-59	4.7	15.8	+0.17
PC-F	11	CtDES-229 – SAFM-59	4.2	16.6	-0.28

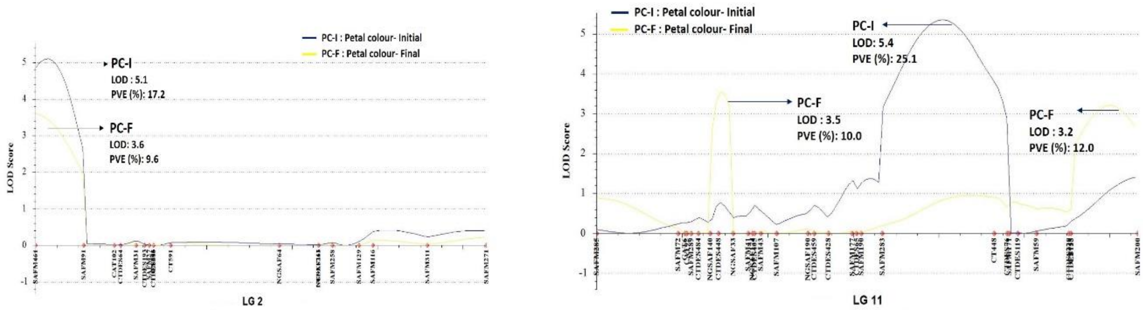

Figure 2. QTL peaks for petal colour in F_9 RILs positioning in LG-2 and LG-11

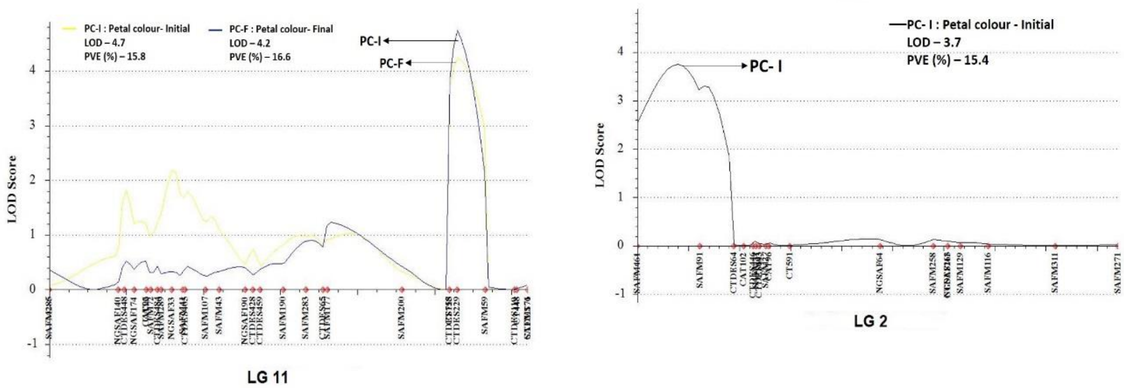

Figure 3. QTL peaks for petal colour in F_{10} RILs positioning in LG-2 and LG-11

Evaluation of chlorpyrifos 50% + cypermethrin 5% EC against lepidopteran defoliators *Helicoverpa armigera* L. and *Spodoptera litura* L. on soybean

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ABSTRACT

Field experiments on evaluation of chlorpyrifos 50% + cypermethrin 5% EC against lepidopteran defoliators *H. armigera* L.and *S. litura* L.on soybeanwas carried out at Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh during *kharif* 2018 and 2019. All the treatments were significantly superior over untreated check. The pooled results of 5 and 10 days after spray indicated that lowest number of larvae/plant was recorded in the treatment of chlorpyrifos 50% + cypermethrin 5% EC 625 + 62.5 a.i./ha which was statistically at par chlorpyrifos 50% + cypermethrin 5% EC500+50 a.i./ha. Looking to the yield both treatments recorded 1818 and 1735 kg/ha, respectively.

Keywords: *Helicoverpa armigera*, *Spodoptera litura* and Chemical control, Soybean

Soybean, *Glycine max* (L.) Merill ranks first in the world for production of edible oil. India ranks third in world in respect of area and fifth in terms of production. It is a versatile food plant that, used in its various forms, is capable of supplying most nutrients. It is a crop capable of reducing protein malnutrition. The low productivity of soybean is attributed to abiotic and biotic stress like drought and insect pests attack, respectively. In India, soybean is reported to be attacked by 273 species of insects, 1 mite, 2 millipedes, 10 vertebrates and 1 snail and in India, 20 insect species have been recorded as major pests of soybean crop (Singh and Singh, 1990). Among the different defoliators of soybean *S. litura*, *H. armigera* are considered as major insect pest. The present investigation was therefore, undertaken to evaluate the different concentration of ready mix insecticides chlorpyrifos 50% + cypermethrin 5% EC against *S. litura* and *H. armigera* on soybean under field conditions.

MATERIAL AND METHODS

With a view to find out the efficacy of different concentration of ready mix insecticides chlorpyrifos 50% + cypermethrin 5% EC against defoliators in soybean; a field experiment was conducted at MORS, JAU, Junagadh during consecutive two year *i.e. kharif* 2018 and 2019 in randomized block design with three replication. First spray was done at initiation of pest infestation in all the experimental plots and subsequent spray was given at fifteen days intervals. Observations on incidence of *H. armigera* and *S. litura* were recorded at 24 hours before spray, 5 and 10 days after each spray on randomly selected five plants/plot and subjected for square root transformation and statistical analysis.

RESULTS AND DISCUSSION

The defoliators *H. armigera* and *S. litura* population was found non-significant before spray but after first and second spray, it was found significantly differ in all the treatments over control (Table 1). Pooled data after five days of spray (*kharif* 2018 & 2019) indicate that the lowest population of for *H. armigera* and *S. litura* were recorded in the treatment of chlorpyrifos 50% + cypermethrin 5% EC 625 + 62.5 a.i./ha (0.72 & 0.70 larvae/plant) which was at par with chlorpyrifos 50% + cypermethrin 5% EC500 + 50 a.i./ha (0.85 & 0.82 larvae/plant). More or less similar trend was observed after 10 days of first & second spray. Looking to the yield maximum yield were recorded in the treatment of chlorpyrifos 50% + cypermethrin 5% EC 625+62.5 a.i./ha (1818 kg/ha) which was statistically at par with chlorpyrifos 50% + cypermethrin 5% EC 500+50 a.i./ha (1735 kg/ha) and spinetoram 11.7% SC 54% a.i./ha (1705 kg/ha). Shivaleela and Chowdary (2020) revealed that chlorpyriphos 50% + cypermethrin 5% EC @ 1000+100 g. a.i/ha were found most effective against *Spodoptera exigua* and diamondback moth on cabbage crop. Sharma *et al.* (2012) reported that three sprays of chlorpyriphos + cypermethrin @ 0.01 percent a.i. at 15 days intervals resulted in minimum shoot infestation damage of 2.15% and 12.95 % fruit damage against *L. orbonalis* in eggplant crop.

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Table 1: Effect of different concentration of chlorpyrifos 50% + cypermethrin 5% EC against defoliators on soybean

Treat	No. of larvae HL / plant					No. of larvae SL / plant					Yield (Kg/ha)
	After 1st spray			After 2nd spray		After 1st spray			After 2nd spray		
	Before 24 hr.	5 DAS	10 DAS	5 DAS	10 DAS	Before 24 hr.	5 DAS	10 DAS	5 DAS	10 DAS	
T1	1.51 (1.78)	1.30* (1.19)	1.13 (0.78)	1.16 (0.85)	1.06 (0.63)	1.56 (1.94)	1.35 (1.32)	1.22 (0.98)	1.16 (0.85)	1.06 (0.62)	1569
T2	1.53 (1.85)	1.16 (0.85)	0.94 (0.37)	0.87 (0.25)	0.78 (0.10)	1.60 (2.05)	1.16 (0.82)	1.04 (0.59)	0.98 (0.46)	0.93 (0.36)	1735
T3	1.54 (1.86)	1.10 (0.72)	0.87 (0.25)	0.87 (0.26)	0.75 (0.07)	1.60 (2.06)	1.10 (0.70)	0.97 (0.44)	0.87 (0.26)	0.79 (0.13)	1818
T4	1.58 (1.99)	1.30 (1.19)	1.16 (0.85)	1.19 (0.92)	1.08 (0.66)	1.58 (1.99)	1.38 (1.39)	1.25 (1.05)	1.22 (0.98)	1.12 (0.76)	1521
T5	1.42 (1.52)	1.35 (1.32)	1.21 (0.97)	1.25 (1.05)	1.15 (0.83)	1.41 (1.48)	1.40 (1.46)	1.30 (1.19)	1.30 (1.19)	1.15 (0.83)	1427
T6	1.43 (1.55)	1.30 (1.19)	1.13 (0.78)	1.22 (0.98)	1.12 (0.75)	1.46 (1.64)	1.27 (1.12)	1.27 (1.11)	1.18 (0.89)	1.08 (0.66)	1705
Control	1.52 (1.80)	1.53 (1.83)	1.40 (1.45)	1.34 (1.29)	1.31 (1.22)	1.52 (1.80)	1.55 (1.89)	1.50 (1.75)	1.42 (1.51)	1.36 (1.35)	1135
SEm ±	0.06	0.04	0.05	0.05	0.05	0.06	0.05	0.05	0.04	0.04	69.99
C.D. at 5%	NS	0.13	0.15	0.14	0.14	NS	0.14	0.16	0.12	0.11	204.28
C.V. %	9.53	8.23	11.60	10.45	11.36	9.63	8.80	10.72	8.96	8.45	11.00

* Square root ($\sqrt{x + 0.5}$) transformed value, (The data in parenthesis are retransformed value) , DAS = Days After Spray, Chlor. = Chlorpyrifos Cyper.= Cypermethrin, HL = *H. armigera*, SL = *S. littura* , a.i. = Active ingredients

T1 = Chlorpyrifos 50% + Cypermethrin 5% EC 375+37.5 a.i./ha
T2 = Chlorpyrifos 50% + Cypermethrin 5% EC 500+50 a.i./ha
T3 = Chlorpyrifos 50% + Cypermethrin 5% EC 625+62.5 a.i./ha
T4 = Chlorpyrifos 50% EC 600 a.i./ha
T5 = Cypermethrin 10% EC 60 a.i./ha
T6 = Spinetoram 11.7% SC 54 a.i./ha

Identification of bio-intensive pest management (BIPM) approaches in sesame for organically managed system

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ABSTRACT

The result revealed that all the bio-intensive treatments recorded significantly higher population of natural enemies as compared to control. Among the treatments, the lowest larval population of *Antigastra* (0.20 and 1.00 larvae/plant at 7 and 14 days after first spraying respectively) was recorded from the treatment T_7 (Farmer Practices) followed by (0.33 and 1.13 larvae/plant after 7 and 14 days after first spraying respectively) treatment T_3. The highest seed yield (907 kg/ha) was recorded from the treatment T_6 followed by (903 kg/ha) $T_{5,}$ while the highest BC ratio (5.9) was received from the treatment T_7 followed by (4.4) T_2 and T_3.

Keywords: Bio intensive approaches, Insect management, Sesame

Sesame is grown mainly for its seeds that contain approximately 52 to 57% oil and 25% protein. The presence of some antioxidants (sesamin, sesamolin and sesamol) makes the oil to be one of the most stable vegetable oils in the world**.** The growing domestic demand for edible oil, coupled with the emergence of sesame as a potential export crop, provides good opportunity for farmers to take up the cultivation of this crop and be assured of good market value (Panday et al 2017). The yield potential of sesame has not been fully realized due to number of biotic and abiotic factors. Among them, the attack of insect pests is the major limiting factor in achieving higher productivity (Ahirwar *et al.* 2010). Therefore, the present work is envisaged to study the identification of bio-intensive pest management (BIPM) approaches in sesame for organically managed system.

MATERIALS AND METHODS

A field experiment was conducted at the experimental farm of Project Co-ordinating Unit Sesame and Niger (ICAR), College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh, to evaluate the different biointensive pest management approaches for organically managed system in sesame during *kharif*, 2021. The experiment was designed in RCBD (Randomized Complete Block Design) had eight treatments including control with three replications. The data on population of sesame leaf webber and capsule borer was recorded from randomly selected five plants in each treatment. The larval population of *Antigastra* was recorded one day before and 7^{th} and 14^{th} day after each spray. Based data of marketable yield, B:C ratio for different treatments were worked out.

RESULTS AND DISCUSSION

The result revealed that all the bio-intensive treatments recorded significantly higher population of lady bird beetle, spider and honeybee as compared to control. Among the treatments, the lowest larval population of *Antigastra* (0.20 and 1.00 larvae/plant at 7 and 14 days after first spraying respectively) was recorded from the treatment T_7 (Farmer Practices) followed by (0.33 and 1.13 larvae/plant after 7 and 14 days after first spraying respectively) treatment T_3. (RDF (N) 75% through FYM +25% through neem cake + seed treatment with *Trichoderma sp* @ 10 g/kg of seed – furrow application of enriched *Trichoderma sp* (2.5 kg *Trichoderma sp* + 100 kg vermicompost) @ 250 kg/ha + release of *T. chilonis* 5 cc egg cards/ha, (six times) at 10 days intervals + border crop with maize + installation of one sticky trap/plot + foliar spray of neem oil @ 10 ml/l at 30 and 45 das). The lowest plant damage (11.42%) due to *Antigastra* was recorded from treatment T_2 (RDF (N) 75% through vermin compost +25% through neem cake + seed treatment with with *P. fluorescens* @ 10 g/kg of seed – furrow application of enriched *P. fluorescens* (2.5 kg *P. fluorescens* + 100kg vermin compost) @ 250 kg/ha) @ 250 kg/ha + release of *T. chilonis* 5 cc egg cards/ha, (six times) at 10 days intervals +border crop with maize + installation of one sticky trap/plot +foliar spray of NSKE 5% at 30 and 45 das) while lowest flower (6.20%) and capsule damage (3.72%) was recorded from the treatment T_7. The highest seed yield (907 kg/ha) was recorded from the treatment T_6 (RDF (N) 75% through vermin compost +25% through Neem cake +Seed treatment with with *P. fluorescens* @ 10 g/kg of seed – furrow application of enriched *P. fluorescens* (2.5 kg *P. fluorescens* + 100kg vermin compost) @ 250 kg/ha) @ 250 kg/ha + release of *T. chilonis* 5 cc egg cards/ha, (six times) at 10 days intervals + border crop with maize + installation of one sticky trap/plot +foliar spray of *Bacillus thuringiensis* var. kurstaki @ 1.0 kg/ha at 30 and 45 das) followed by (903 kg/ha) T_5 while the highest BC ratio (5.9) was received from the treatment T_7 followed by (4.4) T_2 and T_3.

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Large scale germplasm diversity study to identify the diverse trait-specific accessions for obtaining high heterotic hybrids in sunflower

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ABSTRACT

The present study was conducted to assess the large scale diversity present among the 2146 sunflower germplasm accessions along with three checks and focuses on the identification of the diverse trait-specific working accessions for the development of the new inbreds which could be utilized in the development of the high heterotic hybrids in sunflower. The cluster means for eight characters of 2149 accessions were obtained, and a large range of mean values among the 14 clusters was recorded for different traits. For a given character based on cluster mean values, we can select highly divergent genotypes from the respective clusters for the development of new inbreds.

Keywords: Germplasm diversity, Sunflower, Trait-specific accessions

In India, sunflower breeding objective is to develop hybrids or varieties with high yield, oil content and oil quality along with disease resistance (Dudhe *et al.*, 2009; Ramesh *et al.,* 2013). To achieve this objective, the breeder has to identify genetically diverse parents with maximum variability for combining desirable characters. Diversity of sunflower germplasm is usually studied to determine the crop variability and to evaluate the existing germplasm for breeding programme or to detect needed variability for morphological and agronomic traits. Therefore, knowledge of the exiting genetic diversity in the germplasm is essential for undertaking recombination breeding. Our studies examined diversity among the large scale sunflower germplasm maintained at IIOR, Hyderabad.

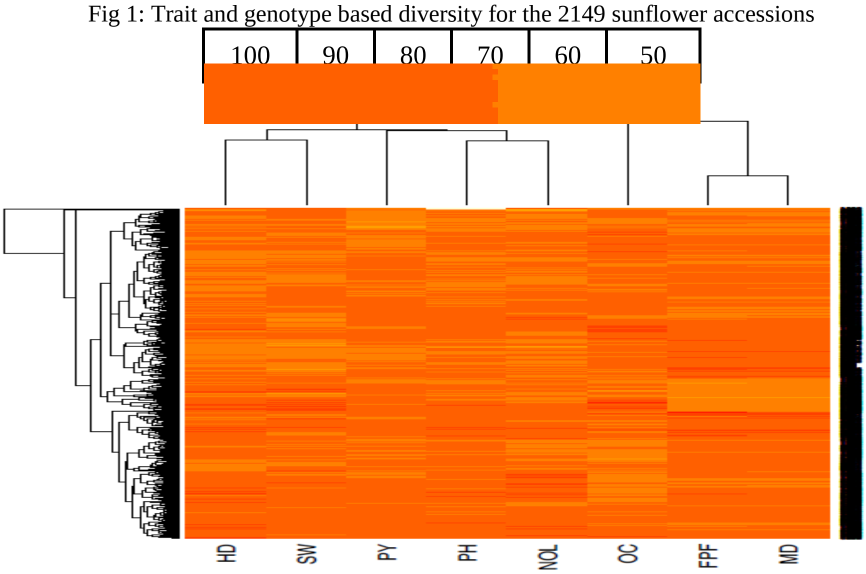
MATERIALS AND METHODS

The present study was conducted during 2011–2012 and 2012–2013 cropping seasons to accesses the large scale diversity present among the 2146 sunflower accessions along with three checks, *viz.,* DRSF-113, DRSF108 and Bhanu. The experiments were carried out at the ICAR-IIOR during late *kharif* in augmented block design for both the years. The number of replications of checks used were 2 and each accession was grown in a single row of 4 m length with a spacing of 60 cm x 30 cm. Observations were recorded from five randomly selected plants in each accession for eight quantitative characters such as days to 50% flowering (DF), days to maturity (MD), plant height (PH), head diameter (HD), 100-seed weight (SW), number of leafs/plant at maturity (NOL) and seed yield/plant (Y/P). R software version 4.2.2 was used for the cluster and diversity analysis.

RESULTS AND DISCUSSION

The 2149 genotypes grown in two seasons were subjected to hierarchical clustering (HCA). Trait and genotype based diversity for the 2149 accessions is presented in the fig 1. All the genotypes were grouped into 14 clusters comprising of different number of genotypes. Cluster VI recorded the highest mean values for plant height (201.5), whereas the lowest cluster mean was recorded for 100-seed weight in cluster IX (3.7). The genotypes with the highest value for seed yield were recorded in cluster IV (24.2) and the lowest in cluster I (6.6). Clusters XII and VI exhibited the highest cluster mean values for days to maturity, i.e. 94 and 93 days, respectively, indicating the inclusion of late maturing accessions. Genotypes in cluster VI recorded the highest value for oil content (36.0), while the least was recorded by genotypes in the cluster II (33.0). The genotypes were grouped into 14 clusters, out of which the Ist cluster was the largest having 580 genotypes. Similarly, cluster II is comprised of 529 genotypes, cluster IV with 416 genotypes and cluster III with 299 accessions, indicating genetic similarity among the genotypes. Clusters XII and XIV are solitary clusters containing one genotype each. Clusters V, VI, VII, VIII, IX, X, XI and XIII grouped 91, 160, 3, 48, 5, 2, 12 and 2 genotypes, respectively. It is suggested that 416 accessions grouped under cluster IV can be considered as the genotypes with high yielding ability along with high oil content and medium maturity. These genotypes can serve as the genetic base for development of high yielding and high oil content varieties to develop inbred lines which can be subsequently utilized in the crossing programme. If the breeding objective is to increase seed weight, the genotypes grouped under clusters III and VI can serve as a base material to initiate the breeding. Genotypes that are grouped under cluster VI can serve as donors for high oil content. It has been observed that the most productive hybrids may come from high yielding parents with high genetic diversity. Based on cluster mean values for a given character, we can select highly divergent genotypes from the respective clusters to be used in crossing work. Unique clusters which were having only a single genotype were reported with specific trait and genotype by Dudhe *et al.*, 2010.

Fig 1: Trait and genotype based diversity for the 2149 sunflower accessions



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Knowledge level of sunflower farmers under public and private extension systems

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ABSTRACT

A test was constructed to measure the farmers' knowledge level on sunflower cultivation and administrated to 183 and 167 farmers under public and private extension systems, respectively. The farmers were selected from Chikballapur, Kadapa, Nizamabad and Raigarh districts of Karnataka, Andhra Pradesh, Telangana and Chhattisgarh states. The item analysis indicated significant differences in knowledge level of farmers on best season to grow sunflower crop, most suitable period of sowing sunflower crop during *Rabi*, suitable sunflower hybrids, application of fertilizers and bee keeping increases yield in sunflower under public and private extension systems.

Keywords: Extension, Farmers' knowledge, Sunflower practices

Sunflower oil is quite popular as healthy cooking oil because of its nutritional benefits. In India, it is cultivated over an area of 2.90 lakh ha with a production of 2.36 lakh t and productivity of 0.9 t/ha (Directorate of Economics and Statistics, 2020-21). The production of sunflower crop is low in India and the major reasons being rainfed cultivation, small operational land holdings, losses due to pests and diseases, and low knowledge level and low adoption of improved technologies by farmers. Knowledge plays an important role in adoption of improved technologies and popularization of the crop. Farmers access knowledge on sunflower cultivation through various sources. These sources were categorized into public and private extension systems and a knowledge test was administered to farmers covered by the two systems to understand their level of knowledge on different aspects of sunflower production technology.

METHODOLOGY

A knowledge test was developed based on the guidelines of Sureshverma *et al*, 2018 and administered to farmers covered by public (183 nos.) and private (167 nos.) extension systems in Chikballapur, Kadapa, Nizamabad and Raigarh districts of Karnataka, Andhra Pradesh, Telangana and Chhattisgarh states, respectively. The data were analyzed using frequency, percentage and Z-test.

RESULTS AND DISCUSSION

It was observed that farmers' under public extension had more knowledge on sunflower production technology compared to farmers' under private extension system. There were significant differences ($p<0.01$) in knowledge level between farmers of public and private extension systems on most suitable period of sowing sunflower, suitable hybrids, application of boron and bee keeping, best season to grow sunflower crop ($p<0.05$), application of fertilizers ($p<0.05$), management of pests and diseases ($p<0.05$). The knowledge level of farmer under public and private extension systems were similar with respect to suitable soils for cultivation of sunflower, seed treatment and time of harvesting. Similar results were done by Kumar *et al.*, (2016) and Sureshverma *et al.*, (2018).

Farmers availing the public extension services had higher levels of knowledge compared to private extension services mainly due to lower involvement of private sector in extension services related to sunflower as the sunflower farmers were not ready to pay for the services. The services offered by the private extension were limited to sale of hybrid seed and the plant protection chemicals. Very limited activities related to capacity building of farmers were undertaken by the private extension system. Further, based on the study it is suggested to have a pluralistic extension services for the benefit of farmers. The private extension system can take care of supply of quality seed and other critical inputs and the public extension system can concentrate on capacity building of farmers in improving the knowledge level and enhancing the adoption of improved technologies.

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Table1: Knowledge level of Public and private extension system farmers

Items	Public F (%) n=183	Private F (%) n=167	Z-value
What type of soil is suitable for sunflower cultivation	139 (75.9)	123 (73.6)	0.49 NS
What is the best season to grow sunflower crop	142 (77.6)	115 (68.9)	1.84*
What is the most suitable period for sowing sunflower crop in *Rabi*?	149 (81.4)	117 (70.0)	2.48**
Can you name any hybrid of sunflower ____________	132 (72.1)	101 (60.5)	2.2**
Do you know about seed treatment? If, yes give the details. Name and Quantity (g/kg)	139 (75.9)	119 (71.3)	0.99 NS
Do you know about chemicals for seed treatment?	137 (74.9)	121 (72.5	0.51 NS
Do you know the seed rate of sunflower/acre?	137 (74.9)	124 (74.3)	0.13 NS
What is the critical period of weed competition in sunflower? Days	136 (74.3)	118 (70.6)	0.76 NS
What is the recommended dose of NPK for sunflower under rainfed conditions? Rainfed- N: kgs/acre, P : kgs/acre, K:kgs/acre	141 (77.0)	106 (63.5)	2.78*
What is the recommended dose of NPK for sunflower under irrigated conditions? Irrigated- N: gs/acre, P :kgs/acre, Kkgs/acre	139 (75.9)	125 (74.9)	0.24 NS
Do you know application of Boron improves seed yield and seed weight?	141 (77.0)	109 (65.3)	2.44**
List out any three important pests which cause major damage to crop and mention their control measures Pest Name Controlling Measures	145 (79.2)	116 (69.5)	2.09*
List any three important diseases which cause major damage to crop and mention their control measures Disease Name Controlling Measures	134 (73.2)	108 (64.7)	1.73*
Do you know that honeybee hives in sunflower crop increases production?	152 (83.0)	114 (68.3)	3.24**
Can you mention the correct stage of harvesting sunflower crop?	155 (84.7)	131 (78.4)	1.5 NS

* = Significant at 0.01 level of probability; ** = Significant at 0.05 level of probability and NS = Non-significant

Competitive interspersed staminate flowers in females: A problem in hybrid seed production of castor

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ABSTRACT

The *in vitro* pollen germination study was carried out by using pollens of six genotypes which included two popular hybrids, two female and two male parents viz, DCH-177, ICH-66, DPC-9, SKP-84, DCS-9 and ICS-164 to know the competitiveness of interspersed staminate flowers (ISF). The standardized medium containing 15% sucrose, 0.01% H_3BO_3, 0.3% $Ca(NO_3).4H_2O$, 0.0214% Mg $(SO_4)7H_2O$ and 0.01% KNO_3 were used in the study. The results revealed that highest % of pollen germination observed with ISF pollens of female parents (DPC- 9: 57.35% and SKP- 84: 44.51%) in both the hybrids compared to their respective male parents (DCS-9: 47.24% and ICS-164: 27.27%). It indicated the importance of rouging of ISFs in order to maintain the high genetic purity in castor hybrid and parental seed production.

Keywords: Castor, Hybrid seed production, Interspersed staminate flowers (ISF)

Castor (*Ricinus communis* L.) is a non-edible oilseed crop extensively cultivated for bio-based raw material for wide industrial applications. Despite belonging to monotypic genus, castor shows high sexual polymorphism and highly unstable pistillateness. The reversed pistillate lines serves as a source of pollen during the hybrid seed production which affect the genetic purity (85%) for certification. In order to maintain the high genetic purity as well as to reduce the cost of rouging operations, we need to understand the competitive nature and fitness of pollen produced by ISFs of pistillate lines over the male flowers of monoecious lines.

MATERIALS AND METHODS

The *in vitro* pollen germination study carried out by using pollens of six genotypes which includes two popular hybrids, two female and two male parents viz, DCH-177, ICH-66, DPC-9, SKP-84, DCS-9 and ICS-164 to quantify fitness of the pollen grains produced by ISF over monoecious flowers using standardized medium containing 15% sucrose, 0.01% H_3BO_3, 0.3% Ca $(NO_3).4H_2O$, 0.0214% Mg $(SO_4)7H_2O$ and 0.01% KNO_3. Pollen grains were tested for germination and tube growth in cavity slides in the laboratory. The number of pollens germinated was counted at five random fields in each cavity of slide for total ten cavities after one hour of incubation and the pollen tube length was measured for hundred randomly selected pollen in stereo binocular microscope. The pollen with the pollen tube length more or equal to pollen diameter itself was considered as germinated.

RESULTS AND DISCUSSION

The castor genotypes exhibited significant differences in pollen germination and pollen tube length. Among the hybrids, pollen germination rate was highest for ICH-66 (73.30). Among the parental lines, the pollen germination % was more in ISFs of pistillate lines (DPC-9:57.35 and SKP-84:44.51) compared to pollen of male lines (DCS-9:47.24 and ICS-164:27.27) indicating the more competitiveness of ISF pollen. Similar kind of study carried out by Salvatierra *et al.* (2016) and reported that pollen from male flowers, from both ambisexual and male plants, germinated 75% in summer, while germination decreased to 56% in spring.

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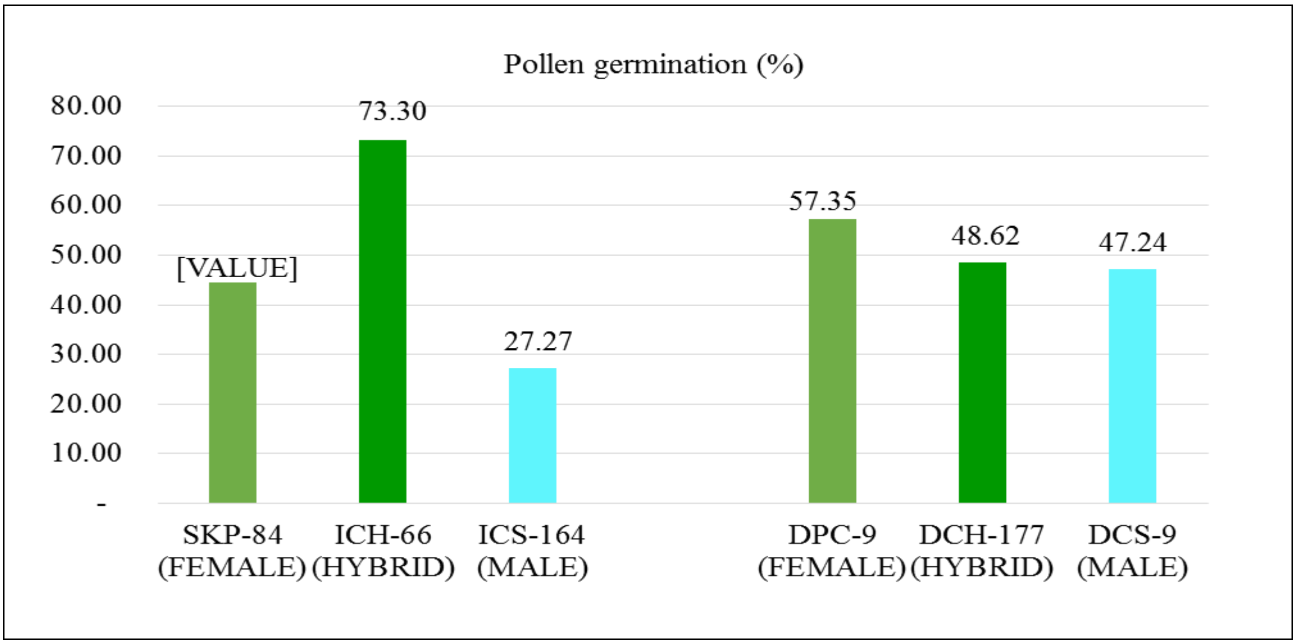

Fig 1.Pollen germination % ofcastorhybrids andtheirparental lines

Molecular characterization supports that the surviving population of Linseed leaf blight in Chhattisgarh is *Alternaria lini*

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ABSTRACT

Naturally infected linseed leaves expressing leaf blight symptoms were collected from different linseed growing regions of Chhattisgarh. Eight isolates of *Alternaria* spp. (ALN-1, ALN-2, ALN-3, ALN-4, ALN-5, ALN-6, ALN-7 and ALN-8) were derived from naturally infected leaves. Isolates varied in their colony morphology and conidial size (L:-4.30-16.37µm; W:-3.80-5.18 µm; beak length ranged from 1.47 µm to 4.20 µm) but they all resembled peculiar characteristics of *Alternaria lini*. Sequence analysis of the ITS region confirmed the species identity of *Alternaria* spp as *Alternaria lini*.

Keywords: *Alternaria lini*, Linseed, Leaf blight, Morpho taxonomy

Linseed (family Linaceae) is an important oilseed crop grown for seed, oil and its fibre. Linseed is widely adapted to temperate to varied climates of the world. Major biotic stresses causing significant losses in linseed are *Fusarium* wilt, powdery mildew, rust and collar rot and *Alternaria* leaf blight. Two different species *Alternaria lini* (Dey) and *Alternaria linicola* (Groves and Skolko) are reported to cause leaf blight in linseed thus affecting quality and quantity of the crop produce (Dey, 1933). Through morphological and molecular characterization we tried to address the issue that whether leaf blight of linseed in Chhattisgarh is caused by a single species of *Alternaria* or both the species of *Alternaria* (*Alternaria lini* and *Alternaria linicola*).

MATERIALS AND METHODS

Naturally leaf blight infected samples were collected from different locations (Raipur, Mungeli, Bilaspur, Korba, Jashpur, Jagdalpur and Ambikapur) of Chhattisgarh, India, during the *Rabi* 2020-21. For micrometry and morphotaxonomy studies spores were derived from the infected leaf samples by incubating them in moist chambers. Single spore isolaton technique of Kotasthane and Agrawal, 2010 was followed to derive the associated *Alternaria* spp from the naturally infected leaf samples. Spores were placed on 4% water agar, the plates were then incubated at 27°C for 4-6 h. Germinating spores were lifted by removing the agar disc along with the germinated spore using a sterilized inoculation needle and aseptically transferred to the potato dextrose agar slants and incubated at 27°C. Pure cultures were preserved at 4°C in the refrigerator for further cultural studies. To confirm the species identity of associated Alternaria spp. genomic DNA of isolated pathogens were subjected to PCR amplification of ITS region was performed using universal primers ITS 4 forward and ITS 5 reverse (ITS 4-5’- TCCTCCGCTTATGATATGC-3’ ITS 5-5’ GGAAGTAAAAGTCGTAACAAGG-3’). Sequencing of the amplified product was then outsourced.

RESULTS AND DISCUSSION

Maximum radial growth on PDA after one week of incubation at 25±1°C was recorded in ALN-6 (88 mm) and least was recorded in ALN-5 (77 mm). The colony colourof the isolates in potato dextrose agar media ranged from light grey (ALN-4, 5) to dark grey (ALN-1, 2, 3, 6, 7 & 8).Colony texture was smooth in all the isolates (except ALN 4 and 5 with rough texture). White colony margin was found in all the isolates except ALN-1, 6, 8, where the colony margin was grey. Pigmentation was black in all the isolates. Average spore size ranged from 4.30µm - 16.37 µm x 3.80 µm -5.18 µm. Maximum number of horizontal septation was recorded in ALN-8 isolate (6-8) and the least was found in ALN 1 isolate (2-4). Conidial beak length ranged from 1.47 µm to 4.20 µm.Shape of the conidia observed to be obclavate in all the isolates. Blast analysis of query sequences of isolates of *Alternaria* spp. # 34 A2 (AL2) and # 36 A3 (AL3), # 32 A1 (AL1) and # 40 A4 (AL4) sequence resolved phylogenetic affinities with the sister clad containing species of Alternaria OK447929 *Alternaria lini* isolate FCBP1529, KF293969.1 *Alternaria lini* strain A09_2801509. Thus, confirming that the isolates collected from diverse location of Chhattisgarh were *Alternaria lini.*

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Table: - Variation in *Alternaria* isolates based on spore morphology in linseed

Isolate code	Conidia						Beak length (µm)
	Size (µm)				Septation		
	Length	Mean	Width	Mean	Horizontal	Vertical	
	Dark brown conidia						
ALN-1	7.0-20.0	11.20	3.0-5.0	3.80	2.0-4.0	1-2	1.47
ALN-2	15.0-20.0	16.37	4.0-5.0	4.65	4.0-6.0	1-3	3.25
	Light brown conidia						
ALN-3	10.0-20.0	13.00	4.0-5.0	4.30	3.0-6.0	1-2	2.76
ALN-6	12.0-20.0	4.33	4.0-5.0	4.33	4.0-6.0	1-2	2.08
ALN-7	9.0-15.0	4.46	4.0-5.0	4.46	3.0-5.0	1-2	1.60
ALN-8	7.0-20.0	4.30	4.0-5.0	4.30	6.0-8.0	1-2	4.20
ALN-4	13.0-18.0	14.50	4.0-10.0	5.18	3.0-5.0	1-3	3.45
ALN-5	12.0-20.0	4.75	4.0-5.0	4.75	3.0-5.0	1-2	3.37

Heterosis for seed yield and yield contributing traits in Sunflower (*Helianthus annuus* L.)

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ABSTRACT

The present investigation on "Heterosis studies for seed yield and yield contributing traits in Sunflower (*Helianthus annuus* L.). four CMS & eight restorer lines were crossed in L x T design to produce 32 hybrids during *kharif*- 2021these 32 hybrids along with two checks were evaluated for days to 50 % flowering, day to maturity, plant height, head diameter, seed filling percentage, 100 seed weight, volume weight, hull content, seed yield/plant and oil content. The range of heterosis over best check LSFH-171 was from (-52.81)per cent CMS-47A x IR-1-1 to (30.67)per cent CMS-234A x MRHA-2. whereas for another check LSFH-35 was from (-50.88)per cent CMS-47A x IR-1-1 to (36.02)per cent CMS-234A x MRHA-2 for seed yield/plant. Among the hybrids CMS-234A X MRHA-2, CMS-249A X R/HA-1, CMS-47A X MRHA-2, CMS-234A X R/HA-1 and CMS-10A X MRHA-2 was most promising for seed yield /plant (g) on the basis of*per se* performance, highest significant standard heterosis for seed yield and yield contributing traits.

Keywords: Contributing traits, Heterosis, Seed yield, Sunflower

Sunflower is one of the most important oilseed crops in India and ranks fifth after soybean, mustard, groundnut and sesame as edible oil source. BSH-1 was the first sunflower hybrid created by 'Heterosis breeding' and released in India in 1980. Sunflowers were grown on 2.26 lakh hectares in India in 2020-21, with a total production of 2.28 lakh tonnes. The average yield is 1011 kg/ha. Sunflower is grown on 0.28 lakh hectares in Maharashtra, with a yield of 0.13 lakh tonnes and a productivity of 466 kg/ha. Karnataka, Maharashtra, Odisha, Andhra Pradesh and Tamil Nadu are the important sunflower growing states. It is rich source of edible oil (40 to 50%) and is considered as good quality oil from health point of view, due to high concentration of polyunsaturated fatty acids (55 to 60% linoleic acid, 25 to 30% oleic acid). A land mark in sunflower breeding was due to discovery of cytoplasmic male sterility by Leclereq (1969) and restorer genes in wild type sunflower cultivar (Kinman,1970). In sunflower, the cytoplasmic male sterility (CMS) system, which involves the use of CMS line (A), maintainer line (B) and fertility restorer line (R) has allowed breeders to exploit heterosis and heterosis breeding.

MATERIALS AND METHODS

The present study on heterosis in sunflower (*Helianthus annuus* L.) were conducted during *rabi*- 2021-22 at Oilseeds Research Station, Latur. The crossing programme carried out in line x tester design during *Kharif*-2021. The experimental material for study included 4 CMS lines (CMS-10A, CMS-47A, CMS-234A, CMS-249A) and 8 restorer lines (IR-1-1, R/HA-1, MRHA-2, 12R-1, ID-51-32, EC-279309-1, EC-502036, EC-625730) to produce 32 hybrids along with 2 checks (LSFH-171 and LSFH-35) were evaluated in RBD design. The morphological observations on ten quantitative characters were recorded. The heterosis of these 32 hybrids were evaluated and compared with checks.

RESULTS AND DISCUSSION

The negative heterosis was considered desirable for days to 50 % flowering, days to maturity, plant height and hull content. While positive heterosis is desirable for rest of the triats in sunflower. Sunflower is highly cross pollinated in nature it provides tremendous scope for commercial exploitation of heterosis breeding by using cyto-restorer system. The standard heterosis of the newly developed hybrids is of prime importance for its adoption by farmers. The magnitude of heterosis over the check LSFH-171 and LSFH-35 for most of the characters in the present study were highly appreciable.

Among the hybrids. CMS-47A x ID-51-32 (-2.42, -4.72**) and CMS-47A x EC-279309-1 (-2.42, -4.72**) showed significant heterosis for days to 50 % flowering. For days to maturity, CMS-10A x EC-502036 (-2.69*, -4.23**) and CMS-47A x EC-279309-1 (-2.15, -3.70**) showed significant heterosis in the desired direction. The crosses CMS-10A x ID-51-32 (-5.87**, -6.14**) and CMS-10A x 12R-1(-5.28**, -5.56**) recorded desirable significant negative heterosis over both the checks for plant height.

For head diameter, CMS-234A x MRHA-2 (9.94, 14.33), CMS-249A x R/HA-1 (8.97, 13.33), CMS-47A x MRHA-2 (7.69, 12.00) showed the non-significant positive heterosis over both the checks. For seed filling percent these four hybrids showed significant standard heterosis over both checks. For 100-seed weight these four hybrids showed high heterotic effect over both checks while three crosses showed significant heterosis for volume weight over both the checks. Among the hybrids only one hybrid CMS-47A x MRHA-2 (-1.05) showed non-significant negative heterosis for hull content over check LSFH-171.

For oil content, all the hybrids showed significant positive heterosis over check LSFH-171, while five crosses recorded significant positive heterosis over check LSFH-35. The hybrids CMS-234A x MRHA-2 (30.67**, 36.02**), CMS-249A x R/HA-1 (23.60**, 28.65**), CMS-47A x MRHA-2 (23.15**, 28.19**), CMS-234A x R/HA-1 (22.25**, 27.25**) CMS-10A x MRHA-2 (17.98**, 22.81**) recorded positive highly significant heterosis over both the check LSFH-171 and LSFH-35 for seed yield/plant. Similar results for heterosis were found earlier by Chandra *et al.* (2014), Yamgar *et al*. (2015), Sapkale *et al.* (2016) and Ailwar *et al.* (2020).

The hybrid CMS-234A x MRHA-2 can be exploited commercially based on highest significant standard heterosis for seed yield/plant (g) and oil content (%).

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Effect of paddy straw incorporation and nitrogen levels on oil yield, seed yield and B: C ratio of mustard (*Brassica juncea* L.)

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ABSTRACT

Incorporation of paddy straw along with of 20% excess nitrogen (T_6) over recommended dose (60:40:40) to mustard significantly increased the seed and oil yield and higher B: C ratio compared to residue burning (T_1) and residue removal (T_2) treatments.

Keywords:B: C ratio, Mustard, Seed yield , Residue burning, Residue incorporation

Crop residues have a lot of potential for improving soil health, boosting crop yield, and finding practical solutions to the waste disposal issue. Crop residues like, paddy straw may be directly incorporated into farmland, but because of its high C:N ratio and the presence of polymers like cellulose and lignin, it may act as a natural barrier for biological decomposition and it reduces nutrient availability due to immobilization (Udayasoorian *et al.*, 1997). Therefore, besides the straw incorporation addition of excess nitrogen to the field together could enhance the productivity of the following crop (Wang *et al*., 2021).

METHODOLOGY

A field experiment was conducted during *rabi*, 2021-22 at RARS (Regional Agricultural Research Station), Northern Telangana Zone, Jagtial, Telangana State, India to study the effect of paddy straw incorporation on seed yield, oil yield and B: C ratio of mustard. The experiment was laid in randomized block design with six treatments and four replications. Oil yield was computed by multiplying oil content with seed yield produced per hectare and expressed as kg /ha. Net returns/rupee invested (B:C ratio) was calculated by dividing net returns with operational cost.

RESULTS AND DISCUSSION

Significantly higher grain yield of 1194 kg /ha was recorded when the crop residue was incorporated with the application of 20 % excess nitrogen over RDN (T_6) and it was statistically not different with the grain yield of 1172 kg /ha recorded when the residue was incorporated with 10 % excess N over RDN (T_5). Incorporation of straw that results in increase in the levels of nutrients in the soil solution (Bakht *et al.,* 2009). It was found that the residue incorporation along with 20per cent excess nitrogen over RDN (T_6) recorded the highest oil yield of 458 kg /ha. Lowest oil yield was obtained in the residue burning treatment (T_1) with mean of 344 kg /ha. Incorporation of paddy straw in to soil and application of 20 per cent excess nitrogen over RDN (T_6) resulted B: C ratio (2.23) due to higher net returns and gross returns.

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Effect of paddy straw incorporation and nitrogen levels on seed yield (kg /ha), oil yield (kg /ha) and B: C ratio of mustard crop

Treatments	Seed yield (kg /ha)	Oil yield (Kg /ha)	B : C
T_1- Residue burning + 100 % N (2 splits *i.e.*(50%Basal + 50% at flowering)	854	344	1.70
T_2- Removal of straw +100% N (2 splits *i.e.* 50% Basal+ 50% at flowering)	989	393	1.93
T_3- Residue incorporation +100% RDN (2 splits *i.e.* 50% Basal + 50% at flowering)	1058	414	1.98
T_4- Residue incorporation +100% RDN (3 splits *i.e.* 20% at basal + 30% at 15 DAS + 50% at flowering)	1080	421	2.02
T_5- Residue incorporation +110% RDN (3 splits *i.e.* 10% at basal + 50% at 15 DAS + 50% at flowering)	1172	453	2.19
T_6- Residue incorporation +120% RDN (3 splits *i.e.* 20% at basal + 50% at 15 DAS + 50% at flowering)	1194	458	2.23
SEm ±	37.4	14.3	0.07
CD (P=0.05)	113	43.1	0.21
CV %	7.10	6.89	6.99

Heterosis studies for seed yield and yield contributing traits in sesame (*Sesamum indicum* L.)

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ABSTRACT

The highest magnitude of significantly positive heterosis over mid parent to the extent of 77.91 per cent and over standard check JLT-408 to the extent of 34.63 per cent was recorded by the cross RT-351 X TMV-4 and the cross RT-346 X PKDS-11 showed heterosis (57.01 %) over better parent for seed yield/plant. The crosses RT-351 X TMV-4 and RT-346 X THILARANI were identified as the best cross combinations for further exploitation.

Keywords: Analysis, Heterosis, Line x tester, Sesame

Sesame (*Sesamum indicum* L.) known as *gingelly, til, benniseed, simsim,* of family *Pedaliaceae*. Sesame is a self-pollinated crop, having (2n = 26) chromosome number. It requires average temperature of 25-27^{o}C for rapid germination, initial growth and flowering. Sesame is called the 'Queen' of oil seeds in view of its oil (38-54%) and protein (18-25%) are of very high quality. Brown or black seeded are valued more for oil (for medicinal purpose) extraction whereas white seeded are rich in iron.

MATERIALS AND METHODS

The experimental material consisted of 4 lines (AKT-101, RT-351, JLT-07, RT-346) and 7 testers (GT-10, KRISHNA, TMV-4, PKDS-11, THILARANI, VRI-2, CO-1) and 28 F_1 hybrids developed in line x tester mating design including 2 checks (Phule Til-1 and JLT-408). The experiment was conducted by using randomized block design with two replications. A total of 41 treatments, comprising 4 females, 7 males, 28 F_1`s and 2 check hybrids were randomized separately in each replication. Each treatment comprised of two rows of 3 m length, row spaced at 45 cm apart and with plant-to-plant distance of 20 cm. Sowing was done by dibbling one to two seeds at/hill. The recommended dose of fertilizers was applied and other cultural operations were followed. Observations were recorded on Seed yield/plant (gm), Oil content (%), 1000 seed weight (gm), Days to maturity, Length of capsule (cm), Number of seeds/capsule, Number of capsules/plant, Plant height (cm), Number of branches/plant, Days to 50 per cent flowering. Statistical analysis was done as per Rai (1979).

RESULT AND DISCUSSION

Based on mean performance female parent AKT-101 and RT-346 and male parent GT-10 and KRISHNA and hybrids RT-351 X TMV-4, RT-346 XTHILARANI, RT-346 X PKDS-11, JLT-07 X CO-01 were found best for seed yield and yield components. The magnitude of heterosis and heterobeltiosis for all the characters in the present study was highly appreciable. Among all the characters the magnitude of midparents and better parent heterosis was for seed yield/plant to the extent of (77.91 % and 53.99 %) respectively for the cross RT-351 X TMV-4 which was followed by the characters number of seed/capsule (52.95 % and 50.65 %) in the cross AKT-101 X KRISHNA, number of capsule/plant (52.91 % and 47.75 %) in the cross RT-351 X CO-01, number of branches/plant (49.40 % and 29.17 %) in the cross RT-351 X VRI-2, number of seed/capsule (22.33 % and 16.67 %) in the cross RT-351 X GT-10. After comparison of heterotic crosses and their *per se* performance for various characters, two crosses *viz.*, RT-351 x TMV-4 and RT-346 x THIALARANI were identified as most potential crosses for exploitation of their hybrid vigour commercially.

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Unravelling the potential of effective seed bacterial endophyte in groundnut for stem rot disease (*Sclerotium rolfsii*) management

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ABSTRACT

Groundnut (*Arachis hypogaea* L.) is known as “King of oilseeds” which is grown extensively in both Kharif and Rabi/Summer seasons.Several among the several pathogens, Stem rot caused by *Sclerotium rolfsii* Sacc. causes the yield loss up to 80 per cent during favourable conditions. Hence, an attempt has been made to isolate bacterial endophytes for biocontrol management from peanut seeds as an alternative approach. Sixteen isolates (EGN1- EGN16) isolated from peanut were tested against *Sclerotium rolfsii* under *in vitro*. Further, the effective isolates were further analyzed for the presence of thermo stable compounds, profiling of secondary metabolites through GC-MS analysis, growth promotion test (rhizo scanner) and pot culture experiment. The results showed that talc formulation of effective isolate EGN 1 (*Pseudomonas* sp.) significantly increased the vigour index (4902.81), germination rate (91.3per cent), root length (28.1 cm) and shoot length (25.6 cm) along with the simultaneous reduction in disease incidence of 5.54 %.

Keywords: Antagonistic activity, Stem rot, Seed bacterial endophytes, Thermostable and pot culture study

Groundnut is grown over an area of 24.7 million hectares with a total production of 33 million tonnes in the whole world. In India, Gujarat is the largest producer contributing 25 per cent of the total production followed by Tamil Nadu (22.48 per cent). Several factors are responsible for low productivity, among them *Sclerotium rolfsii* Sacc. This pathogen is soilborne and produces enormous Sclerotia (resting structure). As an alternative to judicious use of fungicides, eco-friendly disease management strategies has to be evolved especially the use of seed endophytes. Seed endophytes may come from different plant organs, being transferred to seeds via vascular connections, resulting in colonization of embryo and endosperm. The purpose of this study is to isolate and characterize endophyte that naturally colonize the seeds of peanut varieties and its effect on soil borne pathogen.

MATERIALS AND METHODS

***In vitro* antagonsitic activity:** In the dual culture assay, 9 mm diameter of the pathogen disc from virulent/active culture was taken and placed at a distance of 1 cm from the end of periphery of the Petri plate whereas the antagonistic bacteria from 24 - 48 hrs old culture was streaked at a distance of 1cm on the other end of the periphery. Then, the plates were incubated for one week at 28 ± 2°C and three replicates were maintained along with control plate. The Percent Inhibition (PI) over control was also calculated.

Production of thermo stable antifungal compounds: A loopful of 72 h culture was transferred to 250 mL Erlenmeyer flasks containing 100 mL PD broth, followed by incubation at 150 rpm for 72 h. From that, 10 mL aliquots of each isolate were transferred to Erlenmeyer flasks containing 90 mL PDA medium. After sterilization, 9-mm culture disk of *Sclerotium rolfsii* was transferred to the center of each plate and incubated at 25 ± 1 °C. From two perpendicular directions, mycelial growth of *Sclerotium rolfsii* was measured.

Rhizo scanner and Pot culture study: The plantlets which were grown in germination paper at 10th day of incubation were further subjected for rhizo scanner analysis (the instrument which is available at DARS, Chettinad, TNAU, Coimbatore). For evaluating the effectiveness of bacteria, surface sterilized seeds were treated with talc formulation of seed bacterial endophytes (10g / kg). Two seeds/each hill were sown in each pot. Six treatments were fixed with four replications and the percent disease incidence (PDI) were calculated.

RESULTS AND DISCUSSION

Seed bacterial endophytes EGN 1 and EGN4 showed highest inhibition of 47.77 per cent and 60.0 per cent respectively. EGN 1 showed 13.84 per cent inhibition of mycelial growth and EGN 4 exhibited 6 per cent mycelial inhibition when compared to control. It showed that the isolate EGN 1 and EGN 4 had the presence of thermo stable compounds even after subjecting to high temperature.The compounds which were identified through GC MS analysis in EGN 1 was octadecanal, pyrrol, hexadecanoic acid, oleic acid, cis-vacenic acid, harmine, triphenyl phosphine and pyrrolo compounds. Similarly, Nisa *et al.*, (2022) identified 12 compounds by GC–MS analysis from crude extract of endophytic Bacillus strain LBL6 isolated from Berberis lycum (medicinal plant) namely Piperidinone, N-(4-Bromo-N-Butyl)- Phytol, Tricosanal , Octadecanal, 2-bromo- β-sitosterol acetate, Cholest 5-en-3-ol- 3 beta acetate etc.

In the rhizoscanner study, total root length, root tips, segment and forks were higher in EGN 1 (3370 mm, 425 root tips, 501 forks) than the control (1129 mm, 184 root tips, and 463 forks).The total root architecture of the plantlets could be measured (Fig. 1.). The results of the pot culture studies showed that seed treatment with EGN 1 (*Pseudomonas* sp.) at 10g / kg of seeds significantly increased the vigour index (4902.81). It also increased the germination rate (91.3per cent), length of the root (28.1 cm) and shoot length (25.6 cm) along with that simultaneous reduction in disease incidence to 5.54 % was also observed (Table. 1). Dhar Purkayastha *et al.* (2018) treated the talc formulation of the *Serratia marcescens* (ETR17) in tea seedlings. Higher growth response of 50% was recorded under both sterile and non-sterile conditions and it also increased the shoot length by 6.0 cm and root length by 4.7 cm respectively under sterile conditions.

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S. No	**Isolates**	**Root length (cm)**	**Shoot length (cm)**	**PDI**
1	EGN 1	28.1	25.6	5.54
2	EGN 4	20.5	23.0	16.66
3	TNAU-Pf 1	29.6	28.5	11.11
4	Control	10.1	13.6	94.44

Table. 1. Effect of talc-based formulation on plant growth promotion in pot culture studies

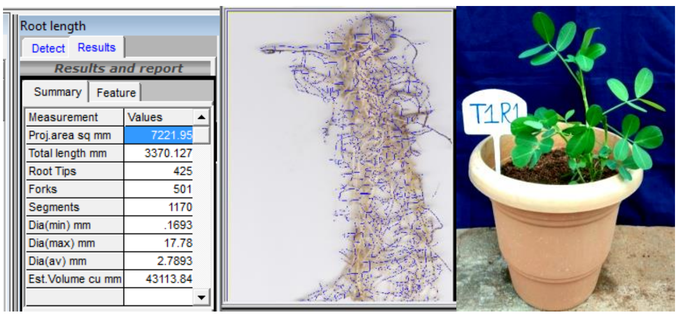

Fig. 1. Analysis of root architecture using Rhizoscanner study

Studies on sex expression of novel pistillate lines and their suitability for hybrid development in castor *(Ricinus communis* L.*)*

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ABSTRACT

Studies on sex expression of new pistillate lines and their suitability for hybrid development in castor was carried out by involving five new pistillate lines developed by ICAR-IIOR, Hyderabad along with three checks. Pistillate lines IPC-42, IPC-44 and IPC-46 observed very low number of interspersed staminate flowers (ISFs) i.e., 3.67, 5.33 and 2.33 respectively compared to checks M-574 (13.67), SKP-84 (8.33) and DPC-9 (17.33). Pistillate lines IPC-46 and IPC-44 expressed ISFs only in the quaternary order whereas they showed complete pistillateness in all other order of spikes even in the sixth order of spikes (S1T1Q1P1H1). Even under higher temperature (33.1^{0}C) and high diurnal range of temperature (13.4^{0}C) these lines expressed complete pistillateness. Hence, these female lines can be directly utilized in future breeding programme to develop high yielding potential hybrids.

Keywords: Castor, Female lines, Hybrids, Pistillate, Sex expression

Castor (*Ricinus communis* L.) is an industrially important non-edible oil seed crop being used as lubricant because of its high viscosity. Despite belonging to monotypic genus, castor shows high sexual polymorphism and highly unstable pistillateness. The reversed pistillate lines serves as a source of pollen during the hybrid seed production which affect the minimum standards of genetic purity (85%) for certification. The changes in sex expression influenced by environment is the major bottleneck in hybrid seed production. Therefore, stability of pistillateness across a wide range of temperature regimes is a prerequisite for economic hybrid seed production.

MATERIALS AND METHODS

The present study was laid out in RCBD design with three replications during kharif 2021 at AICRP(Castor) UAS, Bangalore involving five new pistillate lines IPC-39, IPC-41, IPC-42, IPC-44, IPC-46 developed by ICAR-IIOR, Hyderabad along with three checks M-574, SKP- 84 and DPC-9 for their pistillate expression to find the stable pistillateness which could be utilized for desired hybrid development.

RESULTS AND DISCUSSION

In the present study, IPC-42(3.67), IPC-44(5.33) and IPC-46(2.33) lines expressed very low number of interspersed staminate flowers (ISFs) compared to checks M-574 (13.67), SKP-84 (8.33) and DPC-9 (17.33). Pistillate lines IPC-46 and IPC-44 expressed ISFs only in the quaternary order whereas they showed complete pistillateness up to sixth order of spikes (S1T1Q1P1H1). Even under higher temperature (33.1^{0}C) and high diurnal range of temperature (13.4^{0}C) these lines expressed complete pistillateness. Hence, these female lines can be directly utilized in future breeding programme to develop high yielding potential hybrids. Shifriss (1960) and Zimmerman (1966) also reported that sex expression in castor is highly influenced by environmental characters like high day temperature, fertility and age of the plant.

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Identification of resistance germplasm in sesame against root & stem rot (*Macrophomina phaseolina*) of Sesame

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ABSTRACT

3700 accessions of sesame germplasm were sown during *kharif* 2021 with susceptible and resistant checks in augmented plot design in 3 meter length row in sick plot (artificial inoculum) condition. Out of these accessions, only 53 accessions were resistant against root and stem rot of sesame and disease incidence was less than 10%.

Keywords: *Sesame, Macrophomina*

Sesame (*Sesamum indicum* L.) is one of the world's oldest oilseed crops and has been cultivated in Asia since ancient times and largely produced for its oil and is also used as a flavoring agent. The seeds of sesame contains 40 to 63 percent oil, which contains significant amount of oleic and linoleic acids. Sesame phyllody is the most destructive disease in India. Among the fungal diseases, *Macrophomina* root & stem rot *Alternaria* leaf blights, *Phytophthora* leaf spot, *Cercospora* leaf spot, Powdery Mildew are important diseases of sesame. *Macrophomina phaseolina* earlier reported by Aly *et al.* (2001),Rajpurohit T S (2004). & Gupta *et al*., (2018). The Distributed worldwide and *M. phaseolina* attacks crop plants at different stages of plant growth and causes complex disease syndromes like root rot, seedling blight, charcoal rot, ashy stem blight, wilt, collar rot, dry rot, pod rot and seed rot in several crops. *Macrophomina phaseolina* is infecting the sesame plant in any stage of growth when temperature varies from 28^0C to 32^0C. The stem rupturing upward and becomes blackish in colour. The roots will become brittle and black colour dots appear on stem. Present investigation was undertaken for identification of resistant germplasm in sesame against root & stem rot (*Macrophomina phaseolina*).

MATERIAL AND METHODS

A field experiment was conducted at Project coordinated unit, Sesame and Niger field under Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, during *Kharif* 2021. 3700 accessions were sown in augmented plot design with resistance and susceptible check after every 12^{th} for Screening of these accessions against root and Stem rot of sesame. The inoculum of the test pathogen *M. phaseolina* maintained on agar slants was further multiplied on sorghum grains. One hundred grams of sorghum seeds were washed thoroughly in tap water and soaked overnight in 250 ml of the conical flask. Then the grains of sorghum were kept to remove the excess amount of water at room temperature for 4-6 hours. The flask filled with the sorghum grains were autoclaved for 20 minutes at 121.6^0C and 1.05 kg/cm^2. After cooling the flask at room temperature, they were shaken well to separate the sterilized grains and were inoculated with 2-3 discs of 4 days old culture of *M. phaseolina* and incubated at 28 ± 1^0C in a BOD incubator. After two weeks, the inoculum was ready to mix with sterilized soil and further use. The percent disease incidence was observed at-pre emergence, post emergence, root and stem rot disease incidence. The incidence of charcoal root rot was recorded by counting the number of infected and healthy plants in a random quadrate from each plant

RESULTS AND DISCUSSION

Managing root & stem rot in sesame through an integrated approach has been suggested and us of resistant variety is one of the economic methods. Under the field condition maximum number of germplasms should be screened against root & stem rot of sesame and found susceptible 3700 accessions lines were evaluated against the root & stem rot disease under sick field conditions. Among the accessions, 53 lines were found resistant, and disease incidence less than 10%. The resistant lines could be used further in the breeding programs.

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Identification of resistance germplasm in sesame (*Sesamum indicum*) against phyllody disease

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ABSTRACT

Sesame phyllody is an important disease caused by a phytoplasma and is transmitted by a leaf hopper called *Orosius albinctus*. The affected plants become stunted and floral parts are modified in to leafy structures bearing no fruits and seeds causing yield loss up to 33.9 per cent. 3700 accessions of sesame germplasm were screened for resistance against phyllody disease during *kharif* 2021 under natural field condition. Results showed that most of the accessions were susceptible to phyllody and only 61 showed some resistance and disease reaction was below 10%.

Keywords: Germplasm, Phyllody, Screening, Sesame

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop. It plays an important role in the oilseed economy of the world. The export of sesame is increasing day to day and having bright future for its export potential. The crop is affected by many pests and diseases. One of the important pests is leafhopper *Orosius albiacinctus*.which transmits phyllody diseases cause by phytoplasms. The yield loss due to phyllody in India is estimated to be about 39-74%. The poor crop management and exposure of the crop to the multiple biotic and a biotic stress. Phyllody disease of sesame is caused by a Plemorphic mycoplasma-like organism (Phytoplasma) and transmitted by leaf hopper (Vasudeva and Sahambi, 1955). The affected plants become stunted and the floral parts being modified in to leafy structure which results in non bearing of fruits and seeds causing yield loss up to 33.9 per cent (Abraham *et al*., 1977). Hence the proposed work was planned to screen the large germplasm collection against phyllody disease in sesame.

MATERIALS AND METHOD

A field experiment was conducted to identify resistant germplasm against phyllody at Research Farm of Project Co-ordinating Unit, Sesame and Niger, JNKVV, Jabalpur (M.P.) during the year *kharif* 2021. 3700 accessions were sown in augmented plot design with resistance and susceptible check after every 12th row. The incidence of Phyllody was recorded individually by counting the number of infected and healthy plants at random by quadrate selection in each row and percent disease incidence was calculated. Observations on disease incidence, test weight and yield gm/plant was recorded. The economic device was also calculated.

RESULTS AND DISCUSSION

Among the 3700 accessions of sesame, most of the line was susceptible and only 63 accessions were found resistance against phyllody& disease reaction is below less than 10%. It is concluded that only 63 accessions with lower phyllody disease reaction could offer some solution to programs aimed at phyllody resistance breeding.

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Ultra-dry storage extends the viability of groundnut (*Arachis hypogaea* L.) seeds

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ABSTRACT

In general, the groundnut seed possess short viability. Therefore, an experiment was conducted to extend the storability of seeds by ultra-dry moisture content. The results showed that the groundnut kernels dried to 5% moisture content, vacuum packed in aluminium foil pouch and stored at -20^{0}C, -5^{0}C and 5^{0}C maintained the germination above Indian Minimum Seed Certification Standards (>70%) with maximum seedling vigour for the period upto 20 months.

Keywords: Germination, Grounnut seeds, Longevity, Storage conditions

The longevity of seed depends on the amount of water it contains and on the temperature under which it is stored. In general, the lower the moisture content, the longer the longevity. However, the seed storage behaviour varies from species to species. Generally, seed longevity is reduced by approximately half for every one per cent increase in seed moisture content or 5^{0}C increase in temperature and the effects are additive. Thus, seeds stored at 10 per cent moisture content and 30^{0}C will last only one quarter as long as seeds stored at 9 per cent moisture content and 25^{0}C. This principle implies that, seed storage life can be enhanced considerably by lowering both moisture and temperature. However, moisture content is the key factor that can be lowered for successful seed storage.

Ultra-dry storage, also called low moisture content storage, is a technique for decreasing seed moisture content to below 5-6 per cent using different methods and then stored hermetically at ambient, but preferably cooler temperatures. Some studies have confirmed that low moisture content storage can not only be used to maintain the quality of seeds, but also improve their storability. The ability of seeds to withstand severe desiccation depends on the drying rate, which has been shown to affect seed survival after drying. In sorghum, optimum seed moisture content for storage was 7.5%, whereas the moisture content, below which seed survival was negatively affected at 5% (Babiker *at al*., 2012). Groundnut seeds dried up to 4% moisture content using sorption type drier with secondary refrigeration (15°C and 15% RH) retained viability considerably for longer periods (Sastry *et al*., 2007). The ability of seeds to bear desiccation could be associated with their ability to scavenge ROS in order to avoid deleterious events such as lipid peroxidation.

Thus, groundnut, possesses very poor seed storability and can be stored for the period of upto 6-8 months. This creates the problems in seed supply and field stand. Therefore, the present study was conducted to extend the storability of the seeds by ultra-dry method for long-term storage.

MATERIALS AND METHODS

The study was conducted using freshly harvested groundnut variety CO 6 seeds with ultra-dry moisture content at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. Initially, the pods were decorticated and the kernels were dried to different moisture contents *viz*., 3.5, 5.0 and 6.0 % using zeolite beads. Then, the kernels were vacuum packed in aluminium foil pouches. The seeds were stored at four different temperatures *viz*., -20, -5, 5^0C and ambient condition. The seeds were evaluated for its viability, vigour and biochemical constituents at bimonthly intervals.

RESULTS AND DISCUSSION

The results showed that the groundnut kernels stored with different moisture contents and temperatures have significantly influenced by its germination and vigour. Generally, the seeds recorded decline in germination during storage irrespective of the treatments. However, kernels with 5 percent seed moisture content, vacuum packed and stored at -20^0C, -5^0C and 5^0C maintained the germination above Indian Minimum Seed Certification Standards (>70%) for a period upto 20 months when compared with other treatments (Fig. 1). However, the kernels with 6 percent moisture content and stored under ambient condition showed a rapid reduction in germination and recorded 68 percent in four months storage. Nevertheless, the kernels dried with 3.5 percent moisture content also did not withstand the moisture loss and recorded reduction in germination below IMSCS even at six months period. The potential benefit of ultra-drying to seed longevity must be weighed against the potential risk of damaging seeds by extreme drying (Kong and Zhang, 1998). Buitink *et al*. (2000) opined that too low temperatures combined with too low moisture contents make a "sub-optimal" combination which reduces seed longevity. Similarly, the seedling vigour was also higher in the kernels stored at -20^0C, -5^0C and 5^0C with 5% seed moisture content.

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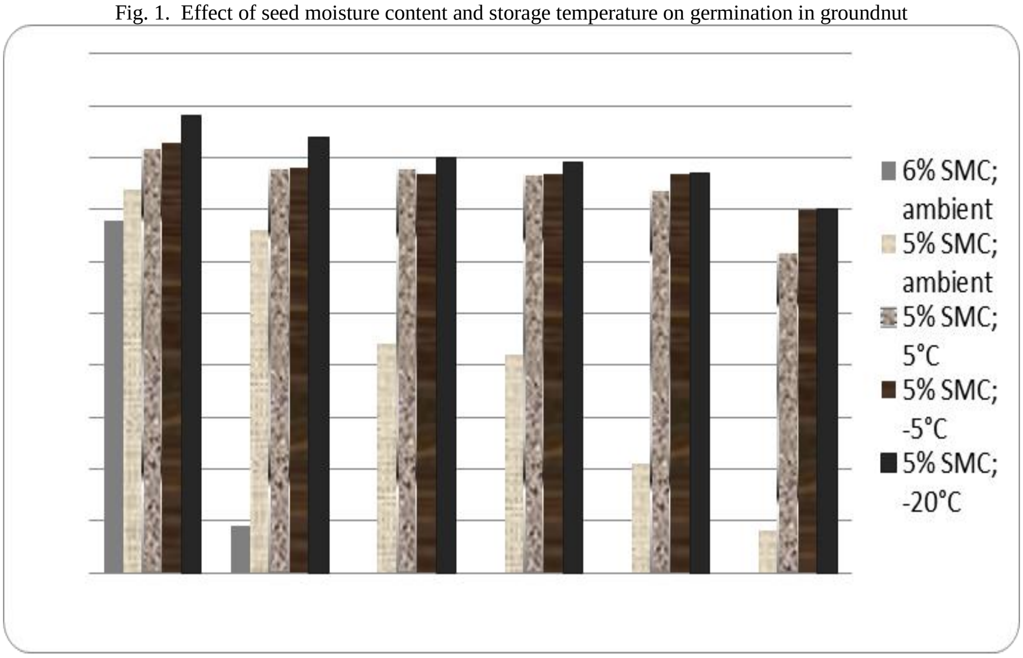
Fig. 1. Effect of seed moisture content and storage temperature on germination in groundnut



White rust: Plant-microbe interaction and plant breeding perspective on Indian mustard

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ABSTRACT

White rust is an important disease of Indian mustard which results in appreciable yield losses. A monogenic dominant gene has been responsible for resistance against this pathogen in *B. juncea*. In the pathogen, avirulence has been observed to be dominant, governed by a single gene. R gene (resistance gene) present in resistant lines of *B. juncea,* encodes CC-NB-LRR (coiled coil nucleotide binding leucine rich repeat) protein whereas, susceptible lines have truncated LRR domain of the same protein. Resistant and moderately resistant lines have higher amount of chlorophyll, sugars and total phenols than susceptible cultivars, throughout crop growth. Increased accumulation of phytoalexins such as spirobrassinin, cyclobrassinin and rutalexin have been observed in resistant lines compared to, susceptible ones upon infection by fungi. Molecular markers tagged to R gene are being used in resistance breeding programmes. Scientists have developed intron polymorphism (IP) markers namely;At5g41560, At5g41940 and At2g36360 for positive selection of white rust resistance and, simple sequence repeat (SSR) marker, At2g34700, for negative selection of resistance in different rust resistant sources. The major issue in use of these markers is their transferability as they do not show association with R gene in different set of crosses.

Keywords: Avirulence gene, Brassica, Molecular markers, Resistance gene, White rust

White rust caused by *Albugo candida* is an important disease of Indian mustard accounting upto 90% yield losses in years with severe disease intensity. An eco-friendly and economically sustainable approach would be to breed white rust resistant varieties.

MATERIALS AND METHODS

A number of white rust resistant exotic lines show resistance to white rust. Genes present on different chromosomes have been mapped in Donskaja and Heera (Panjabi-Massand *et al*, 2010). BioYSR, an indigenous resistant line has shown allelism to both the known resistant genes in Heera and Donskaja (Singh *et al*., 2020). These genotypes have been used for trait introgression in leading varieties.

RESULTS AND DISCUSSION

Marker assisted selection has proven to be successful in identifying white rust resistant lines in segregating generations by several workers. However, not all reported markers are observed to be linked to resistance in different crosses. A white rust resistant variety having high yield derived from marker assisted selection is yet to be released. Thus, more concerted efforts are needed to overcome challenges posed by white rust.

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Prebreeding and genetic enhancement of cultivated sunflower (*Helianthus annuus* L.) using diploid wild *Helianthus* species in India

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ABSTRACT

Pre-breeding activities using promising diploid wild *Helianthus* like *Helianthus annuus* (wild), *H. argophyllus*, *H. praecox*, *H. debilis* and *H. petiolaris* and popular cultivar (ARM-243B) have been initiated at ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad to increase the frequency of desirable genes, wider adaptability and a broad genetic base. Wider variability was observed for yield and yield contributing traits besides disease reactions within and between species. Evaluation of a few populations for biotic stresses and yield related traits resulted in the identification of desirable introgression lines. The highest seed yield (42.5 g/plant) was reported in combinations with *H. annuus* (wild), *H. petiolaris* (40.2 g/plant) and *H. debilis* (39.8 g/plant). Interspecific derivatives derived from *H. praecox* were found resistant to powdery mildew. Interspecific derivatives of *H. argophyllus*, namely PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014, and PB-1019 were resistant to leafhoppers, while PB-1003, PB-1005, and PB-1007 exhibited resistant reactions to downy mildew under sick plot conditions. *H. debilis* derivatives *viz.,* PB-120, PB-127, PB-128, PB-129 and PB-130 recorded >40% oil content. The pre-breeding lines derived from these interspecific cross combinations serve as an invaluable reservoir of genes for carrying out basic studies on the key traits as well as the exploitation of agronomically desirable traits in the AICRP sunflower breeding programmes.

Keywords: Biotic and abiotic stresses, Gene introgression, Prebreeding, Wild *Helianthus* species.

The main issue in sunflower is the limited genetic base of cultivated sunflowers.Gentzbittel *et al.* (1994) reported a lower available genetic variability in cultivated sunflower inbreds using RFLP markers than in other crops, suggesting that efforts to introgress new genes from wild sunflower species. The production and productivity of sunflower crop are adversely affected by different biotic and abiotic stresses, and lack of high levels of resistance or tolerance to biotic (SND, Leaf curl virus, *Alternariaster* and powdery mildew) and abiotic (drought and salinity) stresses are not available in the cultivated sunflower. In contrast, wild species contain a large number of useful genes and have the potential to survive in harsh climatic conditions. The present study aimed to identify agronomically superior interspecific derivatives coupled with resistance/tolerance to biotic and abiotic stresses.

MATERIALS AND METHODS

In this study, agronomically superior maintainer line, ARM-243B was crossed with 5 diploid annual wild *Helianthus* species *viz.,Helianthus annuus* (wild), silver leaf sunflower *H. argophyllus*, *H. praecox*, *H. debilis* and *H. petilaris* and advanced interspecific derivatives were developed through limited conventional backcrossing (BC_2) as well as through selfing. Stable advanced interspecific derivatives thus obtained were evaluated for yield and yield related traits in an augmented design. A few derivatives were screened along with susceptible check (NDCMS-2A) against leafhoppers following the infester row method in a RBD with two replications and downy mildew under sick plot at Latur centre. For powdery mildew, materials were screened under field conditions with susceptible (CMS-2023A) and resistant (PM-81) checks. A few of the advanced interspecific derivatives were screened against *Alternariaster* leaf blight under polyhouse conditions in an augmented design with a resistant (/HA24B) and susceptible check (TSG-208).

RESULTS AND DISCUSSION

In the present study, a limited number of advanced (BC_2F_6) stable interspecific derivatives were characterized and evaluated for yield and yield contributing traits and screened against major biotic stresses. Four lines *viz.,*PB-151, PB-153, PB-158 and PB-147 derived from *H. annuus* (wild) exhibited high seed yield (>40.0 g/plant). Five interspecific derivatives *viz.,* PB-120 (44.3%), PB-127 (41.0%), PB-128 (42.7%), PB-129 (43.0%) and PB-130 (42.7%) recorded high (>40%) oil content. Seven interspecific derivatives *viz.*, PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014 and PB-1019 derived from *H. argophyllus* were resistant to leafhoppers based on two years of screening, while PB-1003, PB-1005 and PB-1007 showed resistant reaction to downy mildew under sick plot at Latur centre. *Alternariaster* leaf blight is a major disease during rainfed (*kharif*) condition in India. Getting highly resistant material for Alternariaster is a major task due to the polygenic nature of inheritance. In this study we have identified moderately resistant/tolerant interspecific derivatives *viz.,* PB-889, PB-898, PB-904 and PB-905 derived from *H. debilis*. Santha Lakshmi Prasad *et al.* (2017) reported that prebred lines derived from crosses of cultivated sunflower with wild *H. annuus* followed by trispecific crosses of cultivated sunflower with *H. argophyllus*, wild *H. annuus* and cultivated sunflower with *H. argophyllus* showed less leaf blight disease under field conditions.

From the present investigaction it could be concluded that Interspecific derivatives which showed resistant/tolerant reaction to leafhoppers, downy mildew, and Alternariaster leaf blight coupled with high seed yield as well as high oil content may be utilized in heterosis breeding as well as in resistance breeding in sunflower.

Table 1. Identified trait specific interspecific derivatives

Trait	Interspecific derivatives	Derived from
High seed yield (>35.0 g/plant)	PB-151, PB-153, PB-158 and PB-147	*H. annuus* (wild), *H. petiolaris, H. debilis*
High oil content (>40%)	PB-120, PB-127, PB-128, PB-129 and PB-130	*H. debilis*
Resistant to leafhoppers	PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014 and PB-1019	*H. argophyllus*
Resistant to downy mildew	PB-1001, PB-1003 and PB-1005	*H. argophyllus*
Resistant to powdery mildew	PB-1100, PB-1114, PB-1115, PB-1118, PB-1126, and PB-1129	*H. praecox*
Moderately resistant/tolerant to *Alternariaster* leaf blight	PB-889, PB-898, PB-904 and PB-905	*H. debilis*

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Economic benefit of complete mechanization of groundnut cultivation

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ABSTRACT

Groundnut (*Arachis hypogea* L.) is the one of the most important oilseed crops in Telangana usually grown during *rabi* season. The study of the area and productivity of groundnut in Telangana over the years indicated that despite the increase in the productivity of groundnut, the area under groundnut is considerably going down due to various production constraints particularly mechanization. In an attempt to understand the effect of mechanization this study was taken up during *rabi,* 2015. The results of revealed that mechanization has reduced the cost of cultivation of groundnut/acre by Rs. 4100/-/acre (20.6%) as compared with the farmer's method of cultivation. Thus 20.6 % decrease in the cost of cultivation will proportionately increase the net profits and the Benefit cost ratio of groundnut cultivation.

Keywords: Economic benefit, Groundnut, Complete mechanization

Groundnut (*Arachis hypogea* L.) is the second most important oilseed crop in Telangana after Soybean with an area and productivity of 1, 26, 512 ha and 2,491 kg/ha respectively in 2018-19 (Telangana open data portal, 2022). Groundnut is grown widely in South Telangana Zone during *rabi* season. Despite continuous increase in the productivity of groundnut, the area under groundnut crop is decreasing in India. The main reason for the decrease in the area of groundnut cultivation might be due to the various production constraints and challenges in the groundnut crop cultivation. The challenges of groundnut cultivation include the high cost of cultivation for the activities like sowing, harvesting, threshing and scarcity of labour. Similar production constraints were reported by Sunandini and Devi (2020). In view of this, to address the mechanization impact on the groundnut profitability the present study was planned and executed in farmer's field (10 farmers) during *rabi*, 2015 with an objective of estimating and comparing the economic benefit of seed to seed mechanization of groundnut cultivation with the existing farmers' practice.

MATERIALS AND METHODS

Randomly 10 groundnut growing farmers were selected in Nagarkurnool District of Telangana and the demonstration and training was given in using the machinery in various cultivation practices in groundnut *viz.,* sowing with seed drill, intercultivation, pod harvesting with digger cum shaker and threshing with dry pod thresher. Further, the data on the cost of cultivation was collected from the farmers in the form of a questionnaire.

RESULTS AND DISCUSSION

The data was tabulated and the analysis of the data (Table 1) revealed that the cost of cultivation of groundnut/acre was decreased by Rs. 4100/-/acre (20.6%) as compared with the farmer's method of cultivation. Similar findings were reported by Govindaraj and Mishra (2010).This decrease in the cost of cultivation will proportionately increase the net profits and the benefit cost ratio of groundnut cultivation.

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Table 1: Cost of cultivation of groundnut under farmers practice and complete mechanization method

Particulars	Farmer's practice (Manually operated) (Rs./acre)	Complete mechanization method Rs./acre)
Cost of Seed	6000	6000
Sowing	1600 (Gorru)	1500 (Seed cum ferti drill)
Herbicide spraying	1300 (Sprayer)	1300 (Sprayer)
Pesticide spraying	2400 (Sprayer)	2400 (Sprayer)
Intercultivation & weeding	3200 (Manual)	1500 (intercultivator)
Digging of pods	2000 (Manual)	1500 (Digger cum shaker)
Threshing	2400 (Manual)	600 (Dry pod thresher)
Drying, bagging, transport	1000 (Manual)	1000 (Manual)
Total	19900/-	15800/-

Development of wilt resistant parental lines through mutagenesis in castor (*Ricinus communis* L.)

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ABSTRACT

The present study was taken up to diversify the pistillate and monoecious lines to be used in hybridization programme. Mutagenesis was carried out using the chemical mutagen ethyl methane sulfonate (EMS) to induce mutation in popular pistillate line DPC 9 and land race Rasipuram local. The segregating mutant population was evaluated for their wilt resistance by screening in wilt sick plot. Plant to progeny row was continued up to M_5 generation by selecting superior progenies in terms of yield and wilt resistance. Skewness and kurtosis indicated the presence of gene interactions for most of the traits studied. The pistillate progeny M5 29-11-5 (YRCP 2) and the monoecious progeny M4 106-2-3(YRCS 1904) were found to be the promising one and this could be further utilized as parents in hybrid development process.

Keywords: Castor, Chemical mutagenesis, Monoecious, Pistillate, Wilt resistance

Castor (*Ricinus communis* L.), a monotypic species in the Euphorbiaceae family with chromosome number 2n = 20 is a non-edible oil crop. Wilt caused by *Fusarium oxysporum*f.sp. *ricini* is one of the most devastating diseases that limit castor production in many castor growing countries, including India. The extent of seed yield loss ranges from 39 to 77% depending upon the crop stage (Raoof and NageshwarRao, 1999). Genetic diversification plays a key role in the success of any breeding programme.since castor is monotypic species, the diversity and variability is limited in primary gene pool. Hence,besides relying on conventional selection and hybridization, recourse to mutation breeding is being taken up. But in industrially valuable oilseed crop like castor very little researches had been undertaken using mutation breeding (Lavanya*et al.*, 2018). Considering these aspects the present study was undertaken to isolate superior mutant using chemical mutagen ethyl methane sulfonate (EMS) in pistillate and monoecious lines of castor thereby facilitating the development of superior wilt resistant castor hybrid.

MATERIALS AND METHODS

The experimental study was undertaken at Tapioca and Castor Research Station, Yethapur, Salem from 2013-2018. Lethal dose 50 (LD 50) was fixed by using the castor variety TMV 5 having abundant pollen production and leaf hopper resistance. DPC 9, a popular non revertant pistillate line with zero bloom and the land race Rasipuram Local were mutagenized using the chemical mutagen ethyl methane sulfonate (EMS). LD 50 value was fixed as 1.50 %. M_2 generation of Rasipuram Local and DPC 9 along with control was planted under wilt sick plot in non replicated rows by adopting the spacing of 90x90 cm.The wilt sick plots were maintained with a minimum inoculum load of $2\text{-}3\times10^3$ CFU/g of soil. The resistant plants were selected and selfed for raising next generation. Subsequently M_3, M_4 and M_5 generation were raised and evaluated. For making selection, the pistillate plants/progenies which were non-reverting up to 5^{th} order were selected and evaluated for early maturity, superior agronomic performance and wilt resistance.

In case of monoecious lines, progenies with early maturity, acute branching angle, high yield, possessing 2-3 whorls of male column with abundant pollen production and with no interspersed staminate flowers (ISF) were selected.

RESULTS AND DISCUSSION

The mutants obtained exhibited a wide range of morphological diversity *viz.*, higher number of branches, stable non reverting pistillate character, non spiny type and with wilt resistance .Wilt resistance studies revealed that the resistance is controlled by the single dominant gene, recessive gene, and digenic (R1 and R2) epistatic interactions (Reddy *et al.,* 2011, Shaw *et al.,*2016 and Anjani*et al.,* 2012). The population of M_2 generation consisted of around 2420 individual plants and among them 232 individual plants which were wilt resistant (screened in wilt sick plot) and agronomically superior were selected and the selfed seeds were harvested separately for raising M_3 generation. The M_3 generation was further evaluated and a total of 149 superior individual plants were selected, screened for soil borne Fusarium wilt resistance and selfed. Out of 149 progenies, 52 promising single plants which were wilt resistant were selected from relatively homogenous progenies that have nearly stabilized rows with respect to morphology, pistillate character and quantitative characters. Plant to row progenies were continued upto M_5 generation. Out of the selected promosing lines, 32 pistillate and 20 monoecious progenies were advanced to the next generation M_5. Hence from a total of 149 plants, 52 superior progenies were chosen and their progeny performance was assessed.

The pistillate progeny M4 29-11 and the selfed progeny from this plant M5 29-11-5 recorded highest seed yield of 345 and 350 g/plant respectively. Seed yield of 341 g was recorded in the monoecious progeny M4 128-10 which also recorded the highest 100 seed weight. The pistillate progeny M5 29-11-5(YRCP 2) and the monoecious progeny M5 106-2-3(YRCS 1904) recorded the highest seed yield coupled with resistance to the major soil borne fusarium wilt disease. This could be further utilized in hybrid development work for evolving a high yielding wilt resistant hybrid/variety.

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Inheritance and molecular mapping of the genomic regions governing seed viability in soybean (*Glycine max*. L. Merr.)

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ABSTRACT

Loos of seed viability in soybean (*Glycine max* L. Merrill, 2n=40) during ambient storage from harvest to the next planting season is a significant barrier for the production of high-quality seeds. The present study includes the inheritance and molecular mapping of the loci linked to seed viability in soybean. For this, five high viable genotypes (>90% germination after one year of storage) viz. EC-1023, EC-105790, G2651, UPSL34, UPSL736 and three poorly viable genotype (<70% germination after one year of storage) viz. MACS-565, PK1243, VLS61 were hybridized in all possible combination. Obtained F_1 were advanced separately. Cross EC1023 x VLS61 and their derived $F_{2:3}$ seeds, were exposed to 72 hours of accelerated ageing (AA) at 41°C and 100% RH, followed by a germination. After AA test, germination % of EC1023 and VL5-61 were 40 and 14, respectively, whereas range of $F_{2:3}$ seeds were 4.16 to 71.42 %. The seed viability is governed by polygenes or quantitative trait loci (QTL), as evidenced by the continuous distribution of germination % of $F_{2:3}$ seeds. Parental polymorphism was studied with 506 SSR markers indicated it to 20.35% whereas distribution of the polymorphism was not uniform across the chromosomes; Chr. 15 had 46.15% polymorphism as against 15.78% on Chr. 3 and 4. Through inclusive composite interval mapping 8 QTL for seed viability on Chr. 6, 7, 8, 10, 13 and 17, respectively, were mapped. Two of the eight QTLs appear to be major QTLs, as their PVE percent is greater than 10% and other seems as minor ones. Previously reported markers linked to seed viability were also validated in the parental genotypes, with only Satt538 being able to differentiate the five good and three poor storing genotypes. The genetics of seed viability, as well as the QTLs and markers found in this study, will pave the way for molecular breeding to generate genotypes with improved seed viability.

In India soybean (*Glycine max* L. Merrill, 2n=40) is the *numero uno* oilseed crop with 40-45% quality protein, 18-20% health-friendly oil and countless other vital nutrients, which is grown for food, feed and industrial uses. However, loss of seed viability during ambient storage from harvest to the next planting season is a significant barrier for the production of high-quality seeds and subsequently leads to an increase in the seed rate and production costs, as extra seeds are needed for sowing. It is therefore important to understand genetic control of the trait for its effective improvement through breeding. In this study, an attempt was made to understand the genetics of seed viability and to map the associated genomic regions with SSR markers.

MATERIALS AND METHODS

Five high viable soybean genotypes EC1023, EC105790, G2651, UPSL34, and UPSL736 (>90% germination after one year of ambient storage) and three poor viable genotypes VLS61, PK1243, MACS56 (< 70% germination after one year of ambient storage) were hybridized in all possible combination. The F_1 seeds obtained from three crosses viz., EC1023 x VL561, UPSL736 x PK1243 and UPSL736 x MACS565 were advanced to the subsequent generations individually. A total of 119 $F_{2:3}$ seeds of the cross EC1023 x VL5-61 along with the parental genotypes were tested through accelerated ageing under the optimized conditions of 41^0C and ~100% RH for 72 hours followed by germination test. Molecular genotyping of the F_2 population was undertaken with 506 SSR markers and through inclusive composite interval mapping QTLs were mapped across the twenty chromosomes. The QTLs mapped in this study were validated in the RIL population.

RESULTS AND DISCUSSION

The germination of EC1023 and VLS61 after accelerated ageing was 40% and 14%, respectively, while that in the $F_{2:3}$ seeds ranged from 4.16% to 71.42% with an average of 17.31%. The continuous distribution of the germination (percentage) data of the $F_{2:3}$ seeds indicated that the seed viability is controlled by many genes or quantitative trait loci (QTL). Germination (percentage) was positively and significantly correlated with average seedling length (r=0.78) and seedling dry weight (r=0.83). Parental polymorphism studied with 506 SSR markers indicated the polymorphism between the parents to be 20.35%. The distribution of the polymorphism, however, was not uniform across the chromosomes; Chr. 15 had 46.15% polymorphism as against 15.78% on Chr. 3 and 4. Through inclusive composite interval mapping 8 QTL for seed viability on Chr. 6, 7, 8, 10, 13 and 17 were mapped. Two of the eight QTLs appeared to be major QTLs (PVE is greater than 10%) and others appeared as minor ones. The mapped QTLs were validated in 40 interspecific RILs with varying level of seed viability. The germination in ambient stored seeds found to be comparable with that of the accelerated ageing seeds. Previously reported markers linked to seed viability were also validated in the parental genotypes, with only Satt538 (Singh et al. 2008) being able to differentiate the five good and three poor storing genotypes. The SSR marker Satt538 could successfully (70%) separate the highly viable RILs from the poor-viable RILs.SSR markers Sat_316 and Sat_173 were 80-85% successful in separating the high and poor viable RILs. The genetics of seed viability, as well as the QTLs and markers found in this study, will pave the way for molecular breeding to generate genotypes with improved seed viability.

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Diversity analysis of linseed germplasm for quantitative traits

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ABSTRACT

132 linseed germplasm evaluated for ten morphological traits and fatty acid profiles indicated ample variability for the studied traits. BRLS 120 recorded high yield and 1000 grain weight along with high linolenic acid content. The genotypes grouped in to seven clusters indicating the diversity among the germplasm.

Keywords: Germplasm, Linseed, Morphological traits, Seed traits, Variability

Linseed or flax (*Linum usitatissimum* L., 2n= 30) is the only species of economic importance in this genus grown for its stem fibre, seed, oil and meal. Development of linseed genotypes with desirable combinations and trait manipulation utilizing recombinant breeding require potential, diverse and suitable parents for crossing. Characterization of linseed germplasm is essential to provide information on the traits assuring its maximum utilization by the final users.

MATERIAL AND METHODS

A set of 132 linseed germplasm including exotic and advanced breeding lines were evaluated at ICAR- Indian Institute of Oilseeds Research, Rajendranagar farm during *rabi* 2021-22 along with T 397 and LSL 93 as checks in an augmented design. All the agronomic measures were followed to maintain proper crop growth. Data on ten morphological traits and fatty acid profile were recorded. Major descriptive statistics such as mean range and standard deviation of quantitative traits of accessions were done. The diversity among the germplasm was calculated by wards method of clustering using Euclidean genetic distances derived from quantitative traits.

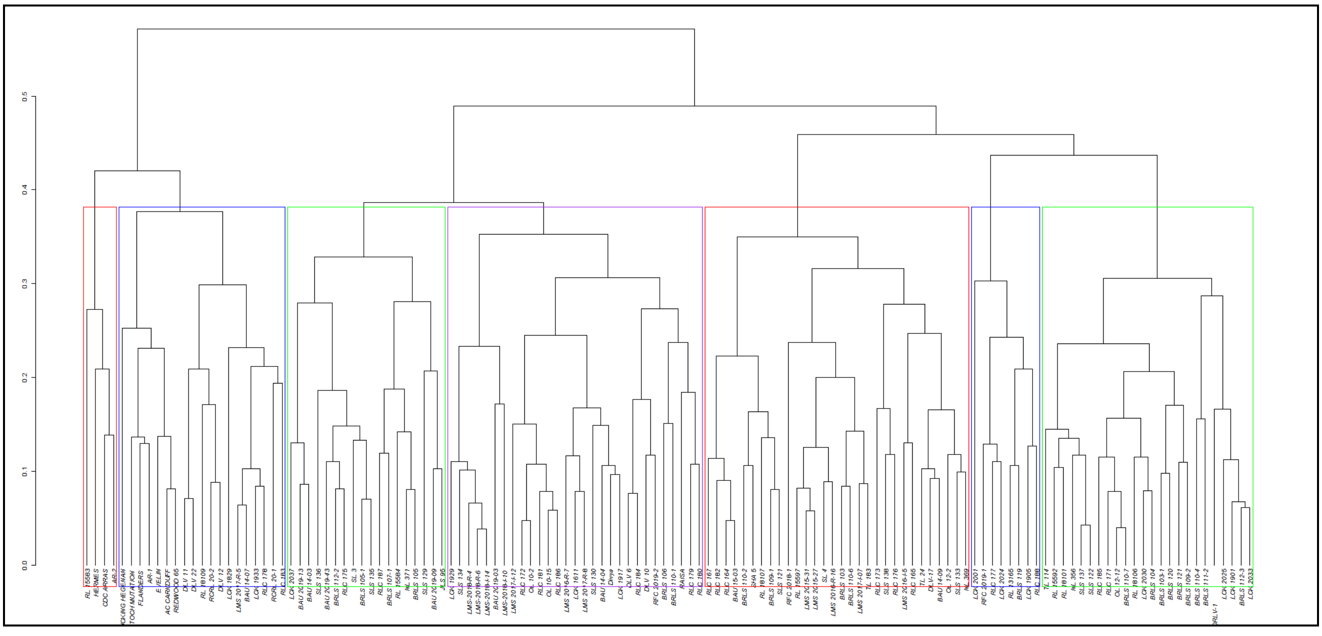
RESULTS AND DISCUSSION

The results of the data indicated that a good range of variability is available for the quantitative traits recorded specially for days to flowering, plant height, thousand grain weight and yield/plant**.** The highest yield was recorded by SLS 130 (9.5g/plant) followed by LMS 2016-I-5 (9.3g/plant). Highest Thousand grain weight was recorded by BRLS 110-4 (7.5g) followed by BRLS 120 (7.3g). The range for linolenic acid was found to be 22.1 to 51.2%. The range, SD and CV of each trait studied is tabulated (Table:1).The range of Euclidean distance among the genotypes is relatively wide. This result indicated that the amount of phenotypic variation among these genotypes is relatively high. The linseed germplasm was divided in to seven clusters and maximum genotypes got clustered in to 4th, 5th and 7th clusters (Fig:1). The exotic germplasm got grouped in to first two clusters along with indigenous advance breeding lines. The genotypes in each cluster are mostly related by geography or pedigree.

Table: 1 Descriptive statistics of ten quantitative traits in linseed Germplasm

Trait	Mean	SD	CV	Min	Max
Days to flower	51.9	5.5	9.8	39	70
Corolla size (cm)	2.2	0.2	0.1	1.4	2.6
Plant Height (cm)	60.8	11.0	10.1	40	94.5
Yield (g/plant)	4.0	1.8	3.1	1	9.5
TGW (g)	5.2	0.9	0.9	2.36	7.48
Palmitic acid (%)	6.3	0.5	0.3	4.68	7.9
Stearic acid (%)	6.9	1.2	1.4	3.94	9.88
Oleic acid (%)	32.4	3.6	13.1	22.63	40.58
Linoleic acid (%)	12.9	3.1	9.3	1.39	26.76
Linolenic acid (%)	41.4	4.9	10.5	22.1	51.25

Figure 1: Dendrogram using agglomerative clustering method



Postharvest losses and seed storage problems in major Sesame (*Sesamum indicum* L.) Growing states in India

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ABSTRACT

A survey was conducted on postharvest losses and seed storage problems in sesame under farmers, oil extraction mills, mandi (government-regulated grain selling and procurement market) and warehouse conditions in major sesame growing states like Gujarat, Rajasthan, Madya Pradesh, Uttar Pradesh and Tamil Nadu. It was observed a minimum of 10% to a maximum of 25% postharvest losses from harvesting to transportation of seeds to processing/washing plant for export purposes. These losses are mainly because of shattering while harvesting, spillage during transportation, improper handling in mandi and unscientific storage methods adopted by farmers and traders.

Keywords: Post harvest losses, Seed storage problems, Sesame, Survey

Sesame (*Sesamum indicum* L) is one of the important oilseed crops in the world. It is cultivated in India, under 1.72 million hectares with production and productivity of 0.81 million tonnes and 474 kg/ha respectively (Anonymous, 2022). Postharvest losses and seed storage problems in sesame are considered important reasons for the loss of produce and income to farmers as well as traders which ultimately affect the export of sesame from India to foreign countries. Post-harvest losses start from harvesting of sesame crop (shattering loss). It further continues during transportation and storage from farmer's level to traders and exporters. Awareness about the proper harvesting technology, transportation and storage methods of sesame seedsneed to be created among farmers and traders to harness the potential income from sesame crops.

MATERIAL AND METHODS

A survey was conducted on postharvest losses and seed storage problems in sesame under farmers, oil extraction mill, mandi and warehouse conditions at Bhind, Madhya Pradesh; Jhansi, Uttar Pradesh; Bhuj (Kutch), Gujarat; Pali, Rajasthan and Vriddhachalam, Tamil Nadu. 10 farmers (contact farmers of that location), 5 oil mills, 5 traders in Mandi and two warehouses in each location were selected as the contact points for conducting survey. RT-351, G-1, GJT-5, VRI-2, VRI-3, TVM-4 and TMV-7 are popular varieties under cultivation in surveyed area. 90% of the varieties under surveyed area were white seeded which were mainly cultivated for export purposes. Harvesting methods, shattering loss while harvesting, packing materials for storage and transportation, losses during transportation, handling losses in mandi, storage methods, storage period, insect pest during storage, losses due to storage pests and insect control during storage were surveyed in all the locations.

RESULTS AND DISCUSSION

All the farmers were following traditional methods for harvesting and threshing. They were experiencing a 5-20 % shattering loss. Timely harvesting, early morning harvesting and placing harvested produce immediately on the cloth in the field reduce the shattering loss from 20% to 5%. Only in Tamil Nadu, it was found that the nymphs and adults of the pod bug, *Elasmolomus sordidus* (Lygaeidae: Hemiptera) suck the sap from the young capsules and seeds on the threshing floor and damage the capsules. It results in appearance of black spots on the capsules, shrivelling of pods and reduction in seed weight and oil content. Farmers used to apply organophosphorous and synthetic pyrethroids insecticides on the threshing floor to manage the bug. If the bugs are not managed, it will cause total seed yield and quality loss in sesame. For packaging and transport, 90% of the farmers and 100% of the traders prefer gunny bags with a capacity of 85kg. This results seed loss of nearly 100g/bag during transportation and handling in mandi and warehouse conditions. Sesame seeds are mostly not stored by farmers, traders and oil mills. Traders in mandi occasionally store the seeds if price fluctuation is more at the time of procurement. While storage they experienced 10% weight loss over a 6-months storage period. If the storage period extends more than one year in the mandi warehouse, then there was a problem of insect pest and storage loss of 5% were experienced by traders. Immediately after procurement of seeds from mandi, traders transport seeds to processing/washing plants located in Gujarat and Mumbai from where the seeds will be exported to foreign countries. If the big players purchase seeds directly from mandi, they store the seeds in warehouse for 3 to 6 months. Fumigation by celphos @ 3 tablets or Quickphos @ one fumigant bag/m^2 is applied to control storage pests in mandi, oil mill (occasionally) and warehouse condition. When farmers store the seeds for consumption and sowing purposes (10-15kg), they dry the seeds every month and follow the traditional storage methods (storage with neem leaf, dry chilli, Nochi leaf and Adhatoda leaf in the mud pot or plastic jar) to control storage pest. Farmers and traders in mandi encountered red flour beetle (*Tribolium castaneum*), rice moth (*Corcyra cephalonica*) and khapra beetle (*Trogoderma granarium*) during seed storage. Sometimes farmers experienced up to 50% of storage loss because of improper storage pest management. From this survey, it could be concluded that shattering loss is the major and unavoidable loss experienced by farmers. Varieties with less shattering loss need to be promoted among farmers. Harvesting technology with less shattering loss need to be developed. Farmers and traders need to be educated about scientific packaging and storage methods.

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Screening of Niger (*Guizotia abyssinica*) germplasm against sucking pests

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ABSTRACT

Studies were carried out on screening of 114 germplasm of Niger along with two check varieties RCR 18 and DNS 4 during *kharif*, 2020 at College of Agriculture, Raichur against sucking pests. Screening of Niger germplasms for their resistance or susceptibility against sucking pests *viz*., whiteflies, aphids and jassids based on the infestation. Among them 40 germplasm scored one (R), 36 germplasm scored two (MR), 22 germplasm scored three (MS), 12 germplasm scored four (HS) and 6 germplasm scored five(S)

Keywords: -Germplasm, Niger, *Guizotia abyssinica*, Sucking pests

Niger (*Guiiotla abyssinica* l.) is an important oilseed crop of tropical and subtropical areas of the world. As it is a minor oilseed crop in India, little importance is given for its genetic improvement, biotic and abiotic stresses which limits the productivity. Among different insect pests affecting Niger cultivation, sucking pest's*viz.*, whiteflies, leaf hoppers and thrips causes significant economic damage. Therefore, identification of the resistant genotypes and cultivation of resistant genotypes along with integrated pest management practices helps to reduce the infestation by these insect pests.

MATERIALS AND METHODS

The field experiment was carried out at, Raichur during rabi-2020. Totally114 germplasm entries acquired from NBPGR, New Delhi, ARS, Igatpuri, UAS, Dharwad and some collections of UAS, Raichur along with two check varieties RCR 18 and DNS 4 were laid out in an augmented design with each genotype sown in single row. The genotypes were screened against sucking pests at vegetative growth stage based on the visual observation and were categorized into different groups *viz.*, Resistant (R), Moderately resistant (MR), Moderately susceptible (MS), Susceptible (S) and Highly susceptible (HS).

RESULTS AND DISCUSSION

Among all, forty germplasm lines showed resistance reaction and categorized as I. Similarly, thirty six germplasms were moderately resistant (MR) for the sucking pests. Whereas, twenty two germplasm lines scored three grade which were moderately susceptible (MS). Twelve genotypes were susceptible to all the sucking insect pests in Niger (S) and six germplasms were highly susceptible (HS) (Table 1). Similar studies were carried out by Darandale *et al* (2015).

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Table 1. Screening of germplasm lines for thrips, leafhoppers and whiteflies

Resistance Rating	Resistance Grade	Name of accessions
I	R	IC 15794, IC 15801, IC 16394, IC 16396, IC 16399, IC 16400, IC 42078, IC 42079, IC 42080, IC 42085, IC 42087, IC 42088, IC 16401, IC 19233, IC 19234, IC 19235, IC 19236, IC 19241, IC 19242, IC 25629, IC 26294, IC 26296, IC 26298, IC 26300, IC 33814, IC 33871, IC 49567, IC 49568, IC 53552, IC 53553, IC 53554, IC 53555, IC 53556, IC 53557, IGP-GP-48, IGP-GP-22, ICNR-02, ICNR-03, ICNR-04, DNS 17
II	MR	IC 1885, IC 15795, IC 15800, IC 15802, IC 16397, IC 499211, IC 499234, IC 499243, IC 42077, IC 42082, IC 42086, IC 19237, IC 19243, IC 19290, IC 28488, IC 33029, IC 33774, IC 33786, IC 33952, IC 53551, IC 53558, IC 53559, IC 53560, IC 53561, IC 53562, IGP-GP 33, IGP-GP 36, IGP-GP-39, IGP-GP-24, IGP-GP-45, IGP-GP-46, ICNR-05, ICNR-06, ICNR-07, DNS 4,RCR 18
III	MS	IC 1446, IC 15796, IC 16398, IC 499215, IC 499224, IC 499231, IC 42083, IC 16404, IC 19238, IC 19239, IC 19244, IC 19245, IC 33676, IC 33677, IC 33678, IC 33804, IC 33928, IC 34084, IC 49569, IC 53549, IGP-GP-35, ICNR-01,
IV	S	IC 856, IC 864, IC 15797, IC 15798, IC 15799, IC 499216, IC 499217, IC 42076, IC 42084, IC 16402, IC 53347, IC 53348,
V	HS	IC 34183, IC 34758, IC 42071, IC 42072, IC 42073, IC 42074

Effect of seed coating in a combination of biopolymer, fungicide and biocontrol agents on the vigour and stem rot incidence of groundnut under *in-vitro* condition

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ABSTRACT

The experiment was conducted with a combination of effective fungicide, potential biocontrol agents and seed coat biopolymer (chitosan) with different concentrations and their combinations along with untreated seeds as control, were used for coating groundnut seeds. The pathogen was inoculated on each treated and untreated seeds and the maximum germination of 94.0 % was recorded in T_5 treatment having double layer seed coat which showed higher vigour index I and II (3190 and 87.4) and minimum seedling mortality of 10.7 %. Whereas untreated seeds (T_1) showed low germination of 64.0 %, vigour index I and II (1709 and 44.6) with maximum seedling mortality of 75.2 %.

Keywords: Chitosan, Fungicide, Groundnut. Stem rot, *Trichoderma harzianum*,Th4d and *Bradyrhizobium* sp.

Groundnut is the second most important oilseed crop after soybean. India accounts for 27 % of global area and contributes to 19 % of world groundnut production. The crop is known to suffer from several fungal, bacterial and viral diseases. Among many soil borne fungal diseases, stem rot caused by *Sclerotium rolfsii* Sacc is an important soil borne pathogen in several groundnut growing areas and reduces yields to an extent up to 80 %). Since the pathogen is very difficult to manage with chemical fungicides alone due to its soil borne nature efforts were made to identify effective combination of biopolymer, fungicides and bioagents under *in vitro* conditions to develop management strategy against stem rot.

MATERIALS AND METHODS

The inoculum of *S. rolfsii* of groundnut was prepared by using seven days old culture of the pathogen grown on PDA medium by gently scraping the surface of the culture with needle and placed in sterilized distilled water. Before inoculation, the seeds were surface sterilized with 1 % sodium hypochlorite solution for 1 minute followed by three washings in sterile distilled water. Then seeds were coated as/treatment schedule. In each paper towel ten seeds of groundnut were placed separately and inoculated with 0.1 ml of mycelial suspension of *S. rolfsii* on groundnut seeds were placed on paper towels and rolled carefully without displacing the seeds from their position and kept in growth chamber at 25 ± 2ºC temperature with 90 % relative humidity. Data on seed germination, seedling vigour and seed rot and seedling infection were recorded at 15 days by adopting completely randomized design (CRD) replicated five times.

RESULTS AND DISCUSSION

The results on inoculation of mycelial suspension of *S. rolfsii* @ 0.1 ml in each treated and untreated groundnut seeds indicated that, the maximum germination of 94.0 % was recorded in T_5 treatment (chitosan 5 ml + fungicide 7.5 ml + Th4d 0.1 g) + (chitosan 5 ml + *Bradyrhizobium* sp. 0.5 g) which wasfollowed by T_7 treatment(chitosan 2.5 ml + fungicide 7.5ml + Th4d0.1 g) + (chitosan 2.5 ml + *Bradyrhizobium* sp. 0.5 g) with 92.0 % of germination. The treatment T_2 (chitosan 10 ml + fungicide 7.5 ml) recorded seed germination of 90.0 % and treatment T_8 (fungicide 7.5 ml) resulted in seed germination of 88.0 %. Among all the seed treatments, lowest seed germination of 64.0 % was recorded in T_1 treatment (untreated control).

The maximum seed vigour index-I (3190) and seed vigour index-II (87.4) were recorded in T_5 treatment followed by T_7 treatment with seed vigour index-I (3071) and seed vigour index-II (78.6). Among all the seed treatments, lowest seed vigour index-I (1709) and seed vigour index-II (44.6) was recorded in T_1 treatment (untreated control).

Seedling mortality was recorded in all the treatments and data are presented (Table 1). All the treatments were found effective in reducing the seedling mortality as compared to control. The lowest per cent seed rot and seedling mortality was recorded in T_5 treatment with 10.7 % followed by T_7 treatment with 18.9 %. Seed rot and seedling mortality of 19.7 %, 22.0 %, 23.4 % and 45.6 % was recorded in T_2, T_6, T_8 and T_4 treatments, respectively. The highest seedling mortality of 75.2 per cent was recorded in T_1 treatment (untreated control).

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Table 1. Effect of seed coatings with biopolymer chitosan, fungicide and biocontrol agents and their combinations on seed quality and seedling mortality in groundnut cv. K-6 seeds inoculated with *S. rolfsii* by rolled paper towel method.

S. No	Treatment details	Germination (%)	Root length (cm)	Shoot length (cm)	Vigour Index-I	Fresh weight (g)	Dry weight (g)	Vigour Index-II	Seedling mortality (%)
T_1	Untreated control	64.0 (53.6)	18.1	8.4	1709	2.3	0.68	44.6	75.2 (63.0)
T_2	Chitosan @ 10 ml + Fungicide @ 7.5 ml	90.0 (73.6)	21.7	11.0	2873	2.9	0.83	73.5	19.7 (26.1)
T_3	Chitosan @ 10 ml + Th4d @ 0.1 g	84.0 (67.3)	21.0	10.4	2658	2.4	0.79	66.8	35.6 (39.5)
T_4	Chitosan @ 10 ml + *Bradyrhizobium* sp. @ 0.5 g	80.0 (65.0)	19.8	9.8	2427	2.4	0.77	63.4	48.2 (44.0)
T_5	(Chitosan @ 5 ml + Fungicide @ 7.5 ml + Th4d @ 0.1 g) + (Chitosan @ 5 ml+ *Bradyrhizobium* sp. @ 0.5 g)	94.0 (79.8)	22.6	11.1	3190	3.0	0.92	87.4	10.7 (17.0)
T_6	(Chitosan @ 5 ml + Fungicide @ 3.5 ml + Th4d @ 0.05 g) + (Chitosan @ 5 ml+ *Bradyrhizobium* sp. @ 0.25 g)	84.0 (67.3)	21.3	10.3	2682	2.7	0.81	68.8	22.0 (27.4)
T_7	(Chitosan @ 2.5 ml + Fungicide @ 7.5 ml + Th4d @ 0.1 g) + (Chitosan @ 2.5 ml+ *Bradyrhizobium* sp. @ 0.5 g)	92.0 (75.6)	22.2	11.1	3071	3.0	0.85	78.6	18.9 (25.5)
T_8	Fungicide @ 7.5 ml	88.0 (69.5)	20.1	9.7	2608	2.6	0.73	64.2	23.4 (28.9)
T_9	Th4d @ 0.1 g	86.0 (68.5)	19.3	9.4	2468	2.4	0.69	60.7	38.4 (42.1)
T_{10}	*Bradyrhizobium* sp. @ 0.5 g	76.0 (61.5)	19.1	9.2	2131	2.3	0.67	50.2	52.9 (46.3)
SE(m) ±		3.87	0.76	0.58	132.48	0.17	0.04	4.81	5.17
CD (p = 0.05)		7.86	1.53	1.18	268.74	0.35	0.08	9.76	10.48
CV (%)		9.12	5.83	9.16	8.19	10.22	7.58	11.37	10.31
SE(d)		2.74	0.54	0.41	93.68	0.12	0.03	3.40	3.65

Fungicide = Evergol Xtend (Penflufen 13.28 % w/w + Trifloxystrobin 13.28 % w/w FS); * Values in the parentheses are angular transformed values

Evaluation and Characterization of Groundnut (*Arachis hypogaea* L.) germplasm lines

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ABSTRACT

In the present investigation, 100 germplasm lines were evaluated and characterized by using six yield and yield contributing traits. Three parameters *viz*., days to maturity (medium -48 % and late 52 %), presence or absence of flowers on the main axis (absent-20 % and presence- 80 %) and100-kernel weight (medium-97 % and high- 3%) were found dimorphic, whereas, shelling outturn showed three states of expression *viz*., low (23%), medium (64 %) and high (13%). The characters of dry pod yield/plot was in the range of 159 g (ICGV 201130) to 755 g (ICGV 201174) and kernel yield/plot was in the range of 97 g (ICGV 201130) to 562 g (ICGV 201174). The genotypes were grouped based on the data and further, based on the objective, the lines will be used in the breeding programme.

Keywords: Characterization, Evaluation, Groundnut germplasm

Groundnut (*Arachis hypogaea* L.) is a major oilseed crop of India and also an important agricultural export commodity, there is a need to obtain high yielding varieties to ensure food security needs of the world's rapidly rising population. Genetic resources provide basic material for selection and improvement through breeding. Conservation and utilization of plant genetic resources are important components of any breeding programmes (Upadhyaya *et al.*,(2008). Use of only few elite germplasm lines and/or cultivars in breeding programs reduces the genetic variation, leading to a narrow genetic base in the groundnut gene pool (Gupta *et al*. 2015). Improving the genetic potential of groundnut for qualitative and quantitative traits is one of the major objectives in most groundnut breeding programs (Upadhyaya *et al*. 2005). The sustainable groundnut improvement programs, therefore, need to discover and incorporate genes from germplasm with high genetic variability for desired traits. Hence, the present study was carried out to characterize and evaluate the groundnut germplasm for yield and yield contributing traits.

MATERIAL AND METHODS

The field experiment was conducted during *kharif*, 2021 at Regional Agricultural Research Station, Palem, Telangana. A total of 100 germplasm lines received from ICRISAT, Patancheru were evaluated and grouped for yield and its contributing traits. Each genotype was sown in 4 rows of 1.5 m length by adopting a spacing of 30 cm x 10 cm in Sparse Replicated Design. Data pertaining to four parameters *viz*., Presence or absence of flowers on main axis, days to maturity, shelling out turn, dry pod yield and kernel yield were recorded were recorded on plot basis, whereas, 100 kernel weight was recorded on single plant basis on five randomly selected plants in each genotypeat appropriate growth stages and grouping was done by using the DUS test guidelines for the characters of presence or absence of flowers on main axis, days to maturity, shelling out turn and 100 seed weight.

RESULTS AND DISCUSSION

In the present study, 100 groundnut germplasm lines were evaluated and characterized by using six traits. The genotypes under study showed wide range of variability for all the traits studied. Frequency distribution for all the characters under study was also computed. Based on days to maturity, genotypes were grouped as medium (48 no.) and late (52 no.) duration groups with a range of 104 days (ICGV 201184, ICGV 201174) to119 days (ICGV 201228, ICGV 3043, ICGV 201164). Based on the presence or absence of flowers on the main axis, the genotypes were grouped into 2 groups *viz*., absent (20 no.) and presence (80 no.). 100 kernel weight was in the range of 36 g (ICGV 201211) to 53 g (ICGV 201278 and ICGV 201115) and based onthis entries were grouped into 2 groups *viz*., medium (97 no.) and high (3 no.). Shelling outturn was in the range of 60 % (ICGV 201234 and ICGV 201224) to 79 % (ICGV 201165) and based on this, the entries were grouped into three groups *viz*., low (23 no.), medium (64 no.) and high (13 no.). Dry pod yield/plot was in the range of 159 g (ICGV 201130) to 755 g (ICGV 201174) and kernel yield/plot was in the range of 97 g (ICGV 201130) to 562 g (ICGV 201174). Based on the study, the genotypes were categorized into different groups and better performing lines for different characters from the pool can be utilized in breeding programmes.

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Table.1 Grouping of Groundnut germplasm lines evaluated at RARS, Palem during *kharif* 2021

Character	Range	Category	No. of Entries
Days to maturity	104-119 days	Medium (101-110 days)	48
		Late (111-120 days)	52
Presence or absence of flowers on the main axis	-	Absent	20
		Present	80
100 seed weight	36 – 53 g	Medium (36-50 g)	97
		High (51-65 g)	3
Shelling outturn	60 – 79 %	Low (< 66)	23
		Medium (66-75)	64
		High (>75)	13
Dry pod yield/plot (g)	159 - 755 g	-	-
kernel yield/plot (g)	97 - 562 g	-	-

Evaluation of the effectiveness of spraying operations carried out by a drone/ unmanned aerial vehicle (UAV) in comparison to the conventional approach for the management of safflower aphids (*Uroleucon compositae* Theob) and safflower capsule borer (*Helicoverpa armigera* Hubner)

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ABSTRACT

The safflower variety ISF-764 was sown in the second fortnight of November, 2020. The Experiment comprised of three treatments Viz., T1: Spraying of Emamectin Benzoate 5% SG (200g /ha), Imidacloprid 17.8 SL (200ml /ha) with UAV; T2: Spraying of Emamectin Benzoate 5% SG (200g /ha) and Imidacloprid 17.8 SL (200ml /ha) with a power sprayer and T3: Untreated control. Both sprayers performed well in the management of Helicoverpa and Aphids. No Helicoverpa larval and Aphids populations were registered in T1: Spraying of Emamectin Benzoate 5% SG (200g /ha), Imidacloprid 17.8 SL (200ml /ha) with UAVs at 3DAS, 10 DAS, respectively. The highest seed yield benefit cost ratio were ecorded in the plot sprayed with UAVs (1691 kg /ha& 4.36).

Keywords: Drone, Evaluation, UAV

Safflower (*Carthmus tinctorius* L.) is one of the most important traditional *rabi* (post-rainy season) oilseed crops in India. In India, it is grown in an area of 12.75 lakh ha, with a production of 53,000 tonnes and productivity 415.7 kg /ha (CMIE, 2016). Safflower occupies an area of 4000 ha with production and productivity of 3000 tonnes and 750 kg /ha respectively in Telangana (CMIE, 2016). Safflower crop is often subjected to various insect pests among which, the important and most devastating pests are aphid, *Uroleucon compositae* Theob. (Akashe *et. al.*, 1999) and safflower capsule borer (*Helicoverpa armigera* Hubner). Seed and oil content losses due to aphids to the extent of 20 to 80per cent have been reported from different parts of country (Singh *et. al.*, 2000). The aphids not only reduce seed yields and oil content, but also lowers quality of petals. The damage caused by capsule borer (*H. armigera*) surpass the loss caused by all insect pests together by their direct damage to the economically important parts (capsule and leaf) of plant and it has been claimed that the loss due to this pest range from 62.6 to 100per cent (Sekhar and Rai, 1989). Though, control of safflower aphids and capsule borers has been achieved by using different insecticides (Neharkar *et. al.*, 2003) farmers were unwilling to spray due to its thorny nature and labor shortage.

Unmanned Aerial Vehicles (UAV) popularly known as Drones, are remotely controlled by the operator with the use of a transmitter or independently according to the programmed route. The use of UAVs in agriculture can contribute to the efficient management of agricultural farms. They have already found applications in precision agriculture, where they are replacing planes and satellites in the remote sensing of crops (Pinter *et al*., 2003; Primicerio *et al*., 2012). Apart from the use of drones in activities that provide information in agriculture, they can also become part of agricultural machinery. At present, efforts are being undertaken to use them to perform spraying of crops with pesticides. Due to their small range, which is mainly caused by the battery capacity, electric drones are chiefly used in operations on the small surfaces of fields situated on different heights or in locations that are hard to access (Berner & Chojnacki 2017). The advantages of the use of drones in the fight against pests include the possibility to quickly reach the place where the operation is to be performed and a short time of its performance; there are no problems connected with soil compaction or crumpling of plants. They can be particularly useful in the case of spot spraying over a large surface with minimum spray fluid. Owing to replacing manual, backpack and tractor sprayers with them, the risk is reduced of poisoning people who perform spraying with pesticides because the spraying drone operator is at a considerable distance from the place of the operation. This sprayer is very useful where human interventions are not possible for spraying of chemicals on crops including rice fields and orchard crops as well as crops under terrain lands. This technology is greatly helpful for the farming community in reducing the cost of pesticide application and environmental pollution and also the biological efficacy of application technology.

MATERIALS AND METHODS

Information on the use of UAVs in the Management of pests is seldom available. Hence, a field experiment was carried out at the Agricultural Research Station, Tandur, Vikarabad District, Telangana state in November 2020. The safflower variety ISF-764 was sown in the second fortnight of November 2020. Standard agronomic practices were followed for better growth and development of plants. The Experiment comprised of three treatments Viz., T1: Spraying of Emamectin Benzoate 5% SG (200g /ha), Imidacloprid 17.8 SL (200ml /ha) with UAV; T2: Spraying of Emamectin Benzoate 5% SG (200g /ha) and Imidacloprid 17.8 SL (200ml /ha) with a power sprayer and T3: Untreated control. For the UAV spray the water volume of 40 L /ha was used, while the power sprayer employed 375 L /ha. Each treatment was replicated thrice. The incidence of *H. armigera* was recorded as the number of larvae/plant at one day before treatment while post-treatment counts were taken at 3 and 10 days after spray. Similarly, The observations on aphid count (5 cm apical twig/plant) were recorded at one before spray and 3, 10 days after spray. The specifications of the UAV, which derived from Maruthi drones PVT. Ltd., were as follows: speed of 2.7 meters/second, spray swath of 3.0 meters, and volume of spray fluid used/hectare: 40 liters. The UAV flew at a flight height of 2.0m above the safflower crop canopy. Wind speed during the time of spraying was 5.2 Km hr^{-1}. The data obtained from treatments were transformed, using square root transformations. Then analyzed by the Analysis of Variance (ANOVA) procedure and General Linear Models (GLM) procedure GEN STAT was used for data analysis. Means separation was done by using the least significant difference (LSD) and Duncan`s Multiple Range Test (DMRT).

RESULTS

The results revealed that one day before spray in all the treatments, the mean relative incidence of *Helicoverpa* larval population ranged from 4.40 to 4.53/plant. While, the mean relative incidence of Aphids (aphids count from 5 cm apical twig/plant) ranged from 41.00 to 41.80/plant. Among the treatments, there were non-significant differences in pest incidence one day before the spray. Both sprayers performed well in the management of *Helicoverpa* and Aphids. All treatments were significantly better than the untreated control in terms of efficacy against the Helicoverpa and Aphids. No populations of Helicoverpa larvae or Aphids were found in T1 after spraying with Emamectin Benzoate 5% SG (200g /ha) and Imidacloprid 17.8 SL (200ml /ha) using UAV at three and ten days after spraying, respectively. On the other hand, plots that were sprayed with a power sprayer received the treatment known as T2: Spraying of Emamectin Benzoate 5% SG (200g /ha) and Imidacloprid 17.8 SL (200ml /ha), the populations of *Helicoverpa* larvae and Aphids were recorded as 0.88, 0.46, 6.53, and 4.67/plant at 3DAS and 10 DAS. Whereas, the untreated control plot (i.e., treatment T3) recorded 5.26 Helicoverpa larvae/plant and 58.07 Aphids populations 10 days after spraying. The plot that was sprayed with UAVs produced the highest seed yield (1691 kg /ha). In a similar fashion, the plot that had been sprayed with a power sprayer recorded a seed yield of 1603 kg /ha. The untreated control plot, on the other hand, recorded a seed yield of 1093 kg /ha. The plot that was sprayed by unmanned aerial vehicles achieved the highest benefit cost ratio of 4.36 (Table 1).

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Table:

Treatments	Safflower capsule borer				Aphids (5 cm apical twig/plant)				Seed yield (kg/ha[1])	Gross Returns (Rs/ ha)	Cost of cultivation (Rs/ha)	Net Returns (Rs./ha)	B:C ratio
	Pre count	3 DAS	10 DAS	% Reduction over control	Pre-Count	3 DAS	10 DAS	% Reduction over control					
T1 (1X)	4.53 $(2.24)^a$	0.00 $(0.07)^a$	0.00 $(0.07)^a$	100	41.67 $(6.49)^a$	0.00 $(0.07)^a$	0.00 $(0.71)^a$	100	1691^c	90093	20643	69451	4.36
T2(1X) Power Sprayer	4.40 $(2.21)^a$	0.88 $(1.16)^b$	0.46 $(0.98)^b$	91.14	41.80 $(6.50)^a$	6.53 $(2.65)^b$	4.67 $(2.27)^b$	91.96	1603^b	85398	20018	65380	4.27
T3 (Control)	4.40 $(2.21)^a$	4.80 $(2.30)^c$	5.26 $(2.40)^c$	0	41.00 $(6.44)^a$	43.36 $(6.62)^c$	58.07 $(7.65)^c$	0	1093^a	58225	17583	40642	3.31
LSD (P=0.05)	0.08	0.05	0.07		0.19	0.10	0.09		87.8				
SEm(±)	0.04	0.03	0.03		0.09	0.05	0.04		3.4				
CV	1.8	2.0	2.6		1.5	1.4	1.3		3.4				

Market rates: 1) Safflower- Rs. 5327 /q 2) Emamectin Benzoate 5 % SG- Rs. 550/ 100g 3) Imidacloprid 17.8 SL- Rs. 2300 / 1000 ml
4) UAVs Spray Cost– Rs. 1500 / ha 5) Manual Spray Cost- Rs. 875 / ha

Figures in parenthesis are square root transformed values

Mean values within a column followed by the same letter are not significantly different by Duncan's Multiple Range Test (DMRT) (P≤0.05).

Reaction of safflower breeding lines to Fusarium wilt

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ABSTRACT

Fusarium wilt (*Fusarium oxysporum* f. sp. *carthami*) is an important disease of safflower, causing 90% yield loss. The pathogen, being mainly soil-borne, is quite difficult to manage using conventional methods. Keeping this in view, the current study was conducted to identify the resistant breeding lines against wilt. A total of 30 multiparent cross-based breeding lines were screened in wilt sick pot and the results revealed that 29 lines were found immune, while one line showed a moderately susceptible reaction to wilt. These breeding lines can be further used in the resistance breeding programme to develop resistant varieties.

Keywords: Breeding lines, Fusarium wilt,Safflower

Safflower (*Carthamus tinctorius* L.) is an oil seed crop, and it is severely affected by*Fusarium oxysporum* f. sp. *carthami* (Foc), *a* fungus causing Fusarium wilt.The infected plants show symptoms such as wilting and leaf yellowing (Weiss 1983). It is a major soil-borne disease in India and is widely distributed in the states of Telangana, Maharashtra, and Andhra Pradesh**.** In India, this disease was first reported in 1975 by Singh *et al*.The repeated use of wilt-susceptible traditional varieties is a major factor causing increased wilt incidence and yield loss of up to 93 percent (Sastry *et al*. 1993). The development of disease-resistant cultivars is the only viable option for controlling Fusarium wilt and is widely recognized as the least expensive, easiest, safest, and most effective method (Agrios 2005). Therefore, the present study was carried out with the objective of finding breeding lines with resistance to wilt.

MATERIAL AND METHODS

The screening of multi-parent cross based breeding lines was done in the wilt sick pot at Indian Institute of Oilseed Research (IIOR), Hyderabad. The soil was sterilized for at 15 psi at 121 °Cfor 30 min and the pathogen was mass-multiplied on sorghum grains as substrate. Semi-cooked sorghum grains (100 g in a 250-mL conical flask) were autoclaved at 15 psi for 20 minutes at 121 °C. Flasks were inoculated with an actively growing fungal mycelial culture grown on PDA and incubated for 15 days at 28 ± 2 °C. The 15-day-old fungal culture was thoroughly mixed in the sterilized soil at a rate of 3 g/kg. Then the susceptible cultivarNira was sown to confirm the pathogenicity of the culture. The inoculum load in the soil before the start of the experiment was 50 x10^3 colony-forming units (CFU)/gram of soil. The experimental material for the present study comprised of 30 multi-parent cross based breeding lines were sown in two rows along with susceptible (Nira) and resistant (TSF-1) checks. Observations were recorded up to 30 days after sowing. The percent disease incidence was calculated by.

$$\text{Percent Disease incidence (\%)} = \frac{\text{Number of infected plants x 100}}{\text{Total number of plants}}$$

According to the scale proposed by Mayee and Datar (1986), the disease reactions were recorded as immune (PDI: 0-1), highly resistant (R) (PDI: 2–10), moderately resistant (MR) (PDI: 11–20), moderately susceptible (MS) (PDI: 21–50), and highly susceptible (HS) (PDI: 51).

RESULTS AND DISCUSSION

In this study, thirty breeding lines were screened for evaluation of resistance in wilt sick pots Among thirty lines, 29 lines (M-F7-3, M-F7-6, M-F7-9, M-F7-11, M-F7-12, M-F7-21, M-F7-25, M-F7-27, M-F7-31, M-F7-32, M-F7-33-2, M-F7-35, M-F7-38, M-F7-40, M-F7-42, M-F7-47, M-F7-50, M-F7-51, M-F7-53, M-F7-57, M-F7-59, M-F7-60, M-F7-62, M-F7-66, M-F7-69, M-F7-71, M-F7-75, MF7-76 & M-F7-78) were immune to wilt with 0% disease incidence and one breeding line viz., M-F7-17 showed moderately susceptible to wilt with 30% disease incidence. While the susceptible check (Nira) and resistant check (TSF1) showed 100% and 0% wilt incidence respectively.

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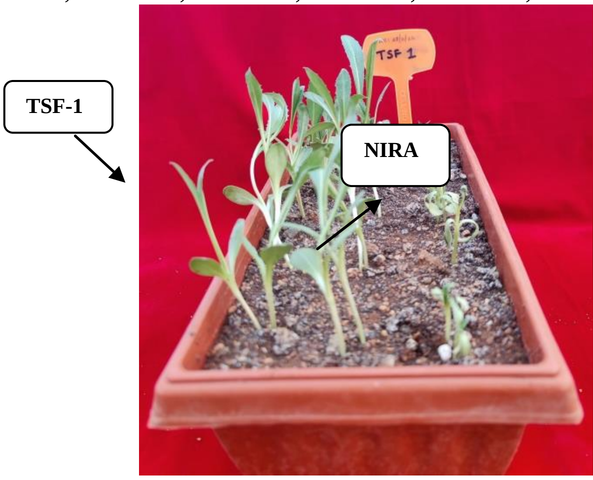

Fig: TSF1

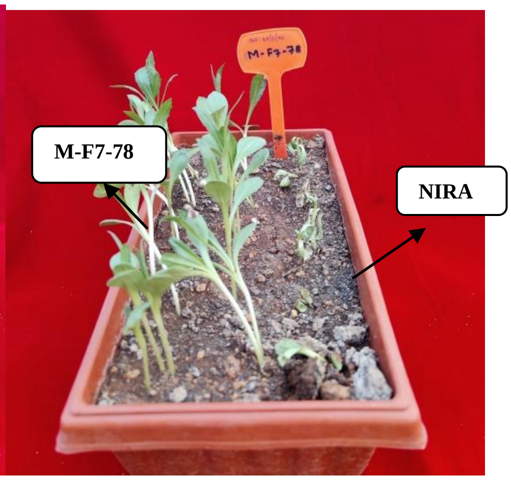

Fig: M-F7-78

Conservation agriculture based practices sustains productivity and profitability and improves health of black calcareous soils under groundnut based production systems

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ABSTRACT

A field experiment was conducted during 2015 to 2019 at Research Farm of ICAR- Directorate of Groundnut Research, Junagadh, India to study the effects of tillage and residue management practices in two groundnut-based cropping systems. It could be concluded that minimum tillage along with residue application has the potential for higher system productivity, profitability, and improve the soil health.

Keywords: Groundnut, Minimum tillage, Productivity, Profitability, Residue application

Peanut is an important oilseed crop in India grown over 4.9 Mha area with production of 8.2 million tonnes of pods during 2017-18 (AICRPG, 2019). India is 3rd largest exporter of peanut-based products with 0.63 million tonnes of exports worth 0.73 billion US$ during 2020-21 (APEDA, 2020-21). About 28 percent or 1.4 Mha area under peanut cultivation comes under light black soils in India in the state of Gujarat. The light black soils of Saurashtra are vulnerable to water erosion owing to poor aggregate stability due to low soil organic matter. Further, as majority of these soils are shallow to medium in depth (Meena *et al*., 2017 and Gandhi and Savalia, 2016) soil conservation is essential for agricultural sustainability in the region. The Conservation Agriculture based on the principles of minimum mechanical disturbance, soil cover with crop residues/cover crops and diversified crop rotations has great potential to conserve and restore soil health. Mulching with crop residues reduces runoff and erosion by improving infiltration and minimizing rain drop beating impact on soil aggregates (Jat *et al*., 2012, 2014).

MATERIALS AND METHODS

The soil of the experimental field was Typic Haplustepts, moderately calcareous, slightly alkaline, low in organic carbon and available nitrogen, and medium in phosphorus and potash. The treatments consisted of four levels of tillage practices in main plots viz. conventional tillage (CT), minimum tillage (MT), zero tillage (ZT), and rota-tillage (RT); two levels of residue management practices in sub-plots viz. no residue application (NM) and residue application (RM); and two cropping systems in sub-sub-plots viz. groundnut+pigeonpea intercropping system (G-P) and groundnut+cotton intercropping system (G-C). The experiment was laid out in split-split plot design with three replications. In CT, plots were prepared conventionally as/farmers' practice in the region by running cultivator twice followed by blade harrow once, in rota-tillage cultivator followed by rotavator once, in minimum tillage cultivator once, while in zero-tillage no tillage operation was done prior to sowing of crops. Before initiating the experimental trial, a general crop of cluster bean was grown during summer, 2015 and tillage treatments were imposed from kharif, 2015. In case of 'residue application' cotton and pigeonpea residues were chopped in smaller pieces and applied in soil/the treatments. Sowing of groundnut 'TG 37A' and intercrops of pigeonpea 'BDN 2' and Bt-cotton was done following recommended package of practices. Groundnut was sown at 30x10 cm spacing and after every three rows of groundnut one row of pigeonpea or cotton was sown. For all the crops 100 percent RDF was applied. Yield data were recorded from 11.4 x 2.4 sq. meter area. Weed observations were taken from a quadrate area of 1 x 1 sq. meter. Soil samples were collected 30 days after crop sowing from 0-15 cm depth during kharif 2015 and 2016 to measure enzymatic activities and soil microbial biomass –carbon (SMBC). Soil moisture content was measured following gravimetric method. Data of two years were pooled and analyzed statistically using ANOVA to test the significance of treatments at 5 percent probability.

RESULTS AND DISCUSSION

Effects on crop productivity: Mean data of three years indicated that rota-tillage produced higher groundnut pod yield and haulm yield but differences were non-significant. Normal tillage gave higher pigeonpea grain yield while minimum tillage produced higher pigeonpea stover yield, and seed cotton yield and stalk yield but differences were significant only for stalk yield of cotton. GPEY was higher under normal tillage but closely followed by minimum tillage with non-significant differences. Groundnut pod yield and haulm yield, and seed cotton yield and stalk yield were higher under residue retention while pigeonpea grain yield and stover yield were higher under residue removal but differences were non-significant. Residue retention increased GPEY over residue removal with non-significant differences. The groundnut+pigeonpea cropping system gave significantly higher groundnut pod yield, haulm yield and GPEY over groundnut+cotton cropping system.

Effects on economic profitability: Minimum tillage generated higher system net returns and gave higher B:C ratio compared to normal tillage. Residue retention increased system net returns with higher B:C ratio over residue removal. The groundnut+pigeonpea cropping system gave significantly higher system net returns and B:C ratio as compared to groundnut+cotton cropping system.

Effects on soil quality: Pooled data over three years show that the minimum tillage along with residue retention and groundnut+pigeonpea cropping system has significantly improved soil available N, available P, and available K in 0-15 and 15-30 cm soil depth compared to normal tillage treatments. Minimum tillage has also significantly improved the cation exchange capacity, organic carbon soil microbial biomass carbon, fluorescein diacetate, alkaline phosphatise, dehydrogenase, β-glucosidase, substrate induced respiration, bulk density, moisture % porosity, total aggregate %, mean weight diameter, geometric mean diameter, aggregate associated carbon, infiltration rate, reduced penetration resistance at both depths compared to normal tillage, no residues and groundnut+cotton intercropping system. These improvements under minimum tillage with residue retention with pigeonpea intercropping systems are due to the synergistic effects like low soil disturbance favours soil pores, water holding capacity, limits nutrient leaching thus enhacing the microbial activities, soil enzymes.

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Effect of provenance on flowering behaviour of parental lines of sunflower (*Helianthus annuus* L.) Hybrid-KBSH-78

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ABSTRACT

The study revealed that sowing of parental lines of sunflower hybrid KBSH-78 at different locations had no significant influence on plant growth specially flowering behaviour and seed yield. However, 50% flowering was observed at 57 DAS in male parent and 62 DAS in female parent i.e., female parent is late in 50% flowering by 5 days compared to male parent. In order to achieve the better synchronization between parental lines and also to enhance seed yield of the seed parent, male parent has to be sown late with two staggered sowings of 3rd and 5th day after sowing of female parent, irrespective of the seed production locations.

Keywords: Provenances, Parental lines, Staggered sowing, Sunflower, Synchronization

Sunflower is an important oilseed crop widely adapted and accepted for its high quality edible oil. The identification of CMS system in sunflower has paved the way for development of superior hybrids with higher productivity of seed and oil. Seed setting and filling problem are the most important constraints in sunflower hybrid production and often considered to be a major reason for low productivity. Synchronized flowering between male and female lines is needed in hybrid sunflower seed production and the extent of seed setting on seed parent is mainly depends on the factors *viz*., potentiality of the CMS lines, synchronized flowering of parents, pollen producibility and viability of male parent, stigma receptivity and duration of female parent, environmental conditions prevailing at the production location etc.

MATERIALS AND METHODS

In sunflower hybrid KBSH-78, the male parent (RHA-92) being early in flowering to female parent (CMS 1103A) is causing problem in achieving higher seed yield of the seed parent. The experiment was laid during rabi 2020-21 to study the effect of environment on flowering behaviour of the parental lines in different locations *viz*., Ranebennur, Bengaluru and Bagepalli with two staggered sowings of male parent i.e., 3rd day and 5th day after sowing of seed parent. Number of days taken from sowing to open 50% of disc florets in a capitulum was recorded in both the parents.

RESULTS AND DISCUSSION

Sunflower is a cross pollinated crop with predominantly hybrids being used for commercial production. Flowering behaviour of parental lines is a prerequisite for successful seed production (Bavage *et al*. 2021). In the present study, sowing of parental lines of sunflower hybrid KBSH-78 at different locations had no significant influence on plant growth, flowering behaviour and seed yield. However, a gap of five days in flowering between the seed and pollen parent was recorded. These results are in agreement with the findings of Kamala *et al*. (1998) and Shakuntala *et al*. (2014) who also recorded a gap of 5 days and 5 to 6 days difference in flowering of parental lines of sunflower hybrids KBSH-1 and RSFH-130, respectively. Similar variation in flowering behaviour of parental lines of sunflower hybrid RSFH-1 was also recorded by Umesh *et al.* (2007). Therefore, in order to achieve better synchronization between parental lines of sunflower hybrid KBSH-78, male parent has to be sown on 3rd and 5th day after sowing of female parent, irrespective of the production locations.

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Genetic architecture and association study of yield and component traits of sesame (*Sesamum indicum* L.) genotypes

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ABSTRACT

In the present experiment, 328 sesame genotypes were evaluated in Summer season 2021 with augmented block design at Project Coordinating Unit (Sesame and Niger), JNKVV, Jabalpur. Twelve quantitative traits were taken into consideration where significant variability was obtained for all the studied traits. The significant positive correlation was observed for primary branches/plant, secondary plant/plant, node to first flower, seed/capsule, capsule length, capsule/plant and plant height with seed yield/plant. On the basis of PCA, 5 PCs obtained more than one eigen value. Overall results revealed that traits and genotypes studied have a considerable level of variability which can be exploited in future breeding programmes.

Keywords: Antioxidants, correlation, PCA, Sesame, Traits

Sesame is an important food oil crop of India. Debate continues for the exact origin of sesame (*Sesamum indicum* L., Pedaliaceae); however, mounting evidence has shown that sesame originated in India (Bedigian 2004) or Africa (Kobayashi 1986). It is an annual, indeterminate plant with a diploid chromosome number of 2n = 26 (IPGRI and NBPGR 2004). The seed contains 50-60% oil which has excellent stability due to the presence of natural antioxidants such as sesamolin, sesamin and sesamol [Brar and Ahuja 1979]. It is useful in many aspects like seeds for oil, seed cake (after oil extraction) as fodder, Seeds as one of the richest sources of calcium carrying many nutrients, seeds having therapeutic properties along with many cosmetic uses. Madhya Pradesh contributes 26.7% and 23.5% share of country’s area (4.24 lakh ha) and production (1.95 lakh tonnes), respectively with productivity of 394 Kg/ha in sesame (DACNET 2021-22). To improve the production and productivity of sesame in India, evaluation of genotypes might be important for supplying area specific or widely adapted improved seeds. Therefore, the present study was conducted for the estimation of correlation and genetic diversity as they are helpful tools in identification of traits for crop improvement and association between them helps a breeder to improve seed yield through directional breeding approaches.

MATERIAL AND METHODS

A set of 328 sesame genotypes were selected from 2400 sesame genotypes based on performance and evaluated in Summer season 2021 with augmented block design at PC Unit (Sesame & Niger), JNKVV Jabalpur. Five competitive plants were randomly selected for recording biometrical observations on twelve quantitative traits days to 50% flowering, days to flower initiation, days to maturity, plant height, number of primary branches, number of secondary branches, number of capsules/plant, number of nodes to first flower, mean capsule length, mean capsule width, number of seed/capsule, internode length, thousand seed weight and seed yield/plant. Phenotypic and genotypic correlations between agro-morphological traits were estimated using the method described by Miller et al. (1958). The data were subjected to Principal Component Analysis (PCA) using the PAST (Hammer *et al.*, 2001) statistical package software. Using this software, the loadings of the genotypes and the traits were determined to clarify the association among principal components and traits, principal components and genotypes, genotypes and their traits and among the different agronomic traits.

RESULTS AND DISCUSSION

Genetic variability plays an important role in crop improvement. The significant positive correlation was observed for primary branches/plant, secondary plant/plant, node to first flower, seed/capsule, capsule length, capsule/plant and plant height with seed yield/plant (Fig 1.). This was in accordance with the findings of Ramesh *et al.* (2000) and Deepa Sankar and Ananda Kumar (2003).

PCA is a well-known method of dimension reduction that can be used to reduce a large set of variables to a small set that still contains most of the information in the large set (Massay, 1965; Jolliffie, 1986). First five principle components obtained more than one eigen value that mean they attain significant variability, where PC1, PC2 and PC3 comprised mainly of secondary branches/plant and capsule/plant, days to flower initiation and days to fifty percent flowering, capsule width and corolla length, respectively. Total eight clusters were obtained out of which cluster I had the maximum genotypes followed by cluster II and III. Cluster I had traits maturity days, plant height and capsule/plant which might be further used for development of new varieties of sesame by combination of desirable traits.

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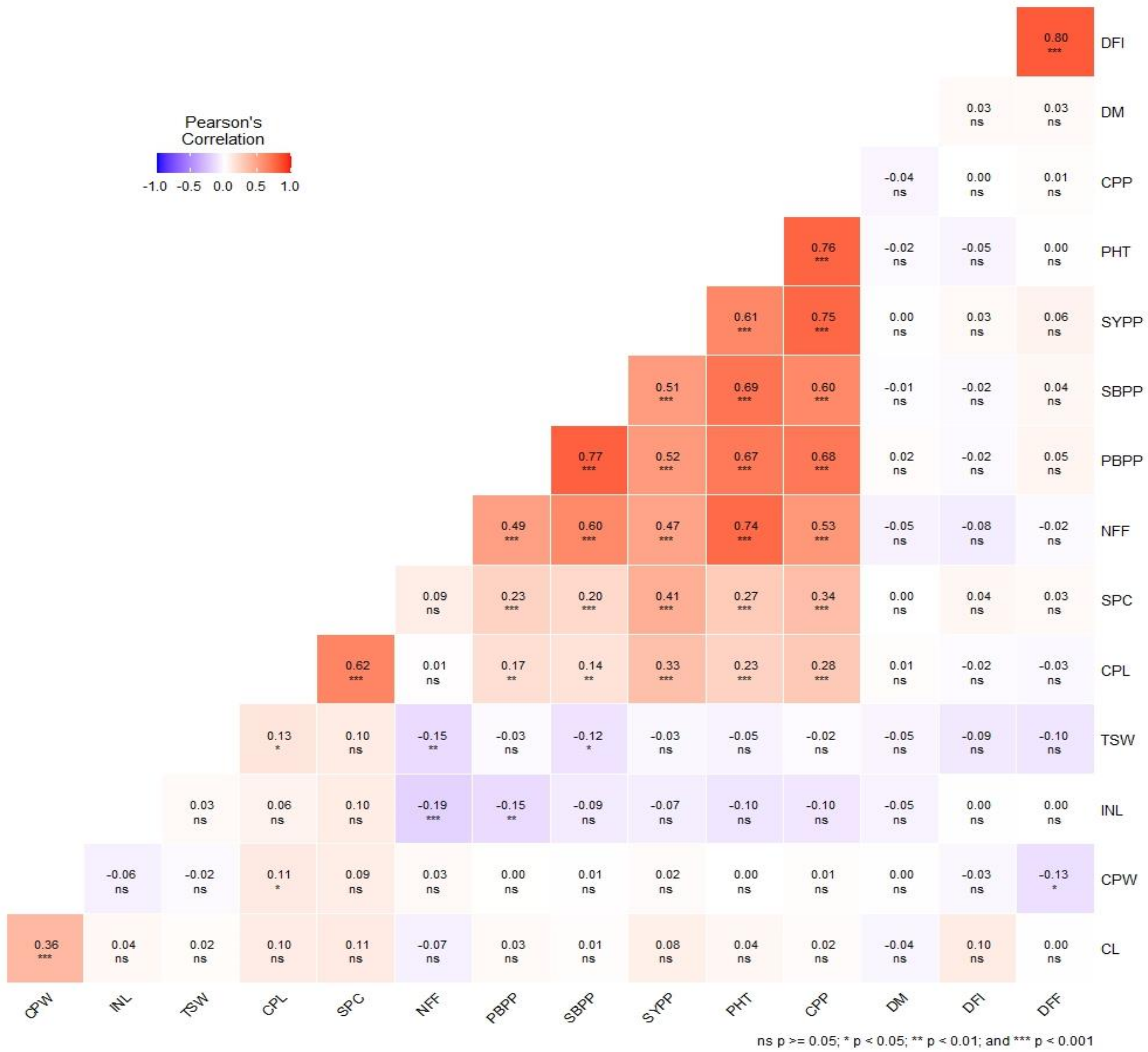

Fig 1.Correlation coefficient analysis for yield and its contributing traits

Traits associated with intermittent drought tolerance in sesame Indian core set genotypes

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ABSTRACT

A field experiment was conducted to investigate the effect of deficit moisture stress on eleven sesame genotypes IC-132171, IC-132186, IC-204445, IC-131500, IC-132207, IC-205471, IC-203962, IC-205353, IC-96229, IC-204966 included with a national check (GT-10). The precise deficit moisture stress (WS) was imposed from flowering to the physiological maturity stage (50-55 days). Results indicated that the morphological, physiological, and yield traits were significantly decreased under WS in comparison to irrigated conditions (WW). Based on the mean performance the genotype IC-204966 was found most superior for capsules number/plant, seed weight, total dry matter, leaf area, and reduced canopy temperature under WS conditions. The correlation analysis of different traits with seed yield indicated that the plant height and number of capsules/plant were highly and positively correlated with seed yield under both WW and WS conditions. The principal component analysis (PCA) revealed that among the traits studied, number of capsules/plant, total dry matter, stomatal conductance, transpiration rate and fatty acid *i.e.*, palmitic acid were the most important traits that accounted for more than half of the total variation among the sesame genotypes studied. Furthermore, the scatter plot revealed that two genotypes, IC 132207 and IC 205471 were stable performers under both stress and irrigated conditions, whereas the performance of check GT-10 varied depending upon conditions.

Keywords: Correlation analysis, Cluster analysis, Genotypes, Intermittent drought, Sesame

Sesame (*Sesamum indicum* L.) is one of the ancient, neglected, orphan and important edible oilseeds known as “queen of oilseeds belongs to the *Pedaliaceae* family. Sesame seeds have nutritionary and healthful quality, have high oil content (50-55%) and rich in both saturated and un-saturated fatty acids (Yoshida *et al*., 2007). Despite its importance, sesame not considered as like other oil seed crops and still remain far behind in terms of genetic improvement Drought is major abiotic stress which affects crop productivity seriously. Moreover, intense and prolonged intermittent drought restricts sesame growth stages and ultimately, causes the seed yield reduction (Boureima *et al*., 2012). Therefore, present study was aimed to study the genotypic variation among traits and their association with seed yield under irrigated and intermittent drought conditions.

MATERIAL AND METHODS

During the study eleven sesame genotypes IC-132171, IC-132186, IC-204445, IC-131500, IC-132207, IC-205471, IC-203962, IC-205353, IC-96229, IC-204966 along with a national check (GT-10) were included and studied under irrigated (WW) and intermittent water stress (WS) conditions. The study was carried for two seasons during year 2018 and 2019 at ICAR-IIOR Research Farm at Narkhoda, Hyderabad. The water stress conditions were imposed by withholding irrigation at flowering stage (45 DAS) and moisture content of the soil was monitored with the help of soil moisture sensors (Proximal Soil SenS) on hourly basis. Data on various morphological traits (plant dry weight, leaf area and leaf dry weight), physiological traits (canopy temperature, SPAD readings and RWC content, stomatal conductance, transpiration), biochemical (fatty acid profile) were recorded when crop appeared to respective stage.

RESULTS AND DISCUSSION

The results indicated that the WS conditions significantly reduced the performance of most of the genotypes; however, among the tested genotypes, IC-204966 was found most superior for capsules number/plant, seed weight, total dry matter, leaf area, with reduced canopy temperature under WS conditions. Furthermore, correlation analysis was carried out to find out the associated of different traits with seed yield under WW and WS conditions. The correlation analysis indicated that the traits such as plant height, number of branches, total dry weight, capsule dry weight, relative water content were positively; whereas canopy temperature was negatively associated with seed yield under both WW and WS conditions. In addition, the principal component analysis (PCA) was performed to find out the contribution of each trait for diversity and also to evaluate the phenotypic diversity exists among the genotypes. The results from PCA revealed that the traits number of capsules/plant, total dry matter, stomatal conductance, transpiration rate and fatty acid i.e., palmitic acid were the most important traits that accounted for more than half to the total variation. Furthermore, the scatter plot revealed that two genotypes, IC 132207 and IC

205471 were stable performers under both stress and irrigated conditions, whereas the performance of check GT-10 varied depending upon conditions.

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Identification of trait specific accessions from safflower germplasm collected in Maharashtra

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ABSTRACT

A set of 59 safflower germplasm accessions collected during exploration tour to nine districts of Maharashtra during 2017 were evaluated for two seasons (2017-18 and 2018-19) alongwith two checks. Trait specific accessions for seed and oil yield (14) and early flowering (8) were identified for utilization in breeding.

Keywords: Germplasm collection, Maharashtra, Safflower, Trait specific accessions

The ICAR-Indian Institute of Oilseeds Research, Hyderabad holds 7027 accessions of safflower germplasm which are being systematically evaluated (Mukta, 2012). Augmentation is a basic requirement for any germplasm repository to supplement the trait specific germplasm for utilization in breeding. Sixty three safflower accessions were collected during an exploration tour to Parbhani, Beed, Hingoli, Latur, Nanded, Osmanabad, Satara, Sangli and Solapur districts of Maharashtra (Latitude 16.01-19.29°N Longitude 74.3-78.19°E) during first fortnight of March, 2017 in collaboration with NBPGR-Regional Station at Akola (Mukta and Chand, 2017). The germplasm was evaluated for two seasons for the identification of trait specific accessions.

MATERIALS AND METHODS

Out of the 63 accessions collected from Maharashtra, 59 accessions were evaluated during *rabi* season of 2017-18 and 2018-19; four accessions did not germinate. The trial was conducted in Augmented block design withsingle row of each accession (5 m) and spacing of 45 cm x 20 cm along with two checks. All standard agronomic practices and prophylactic measures were adopted to raise a good crop and observations were recorded on whole plot basis.

RESULTS AND DISCUSSION

Wide variability was recorded for days to 50% flowering (65-87), seed yield (11.1-48.9 g/plant), 100-seed weight (4.0-7.6 g), oil content (25.2-30.1%) and oil yield (2.9-13.4 g/plant) among the 59 accessions based on mean data for two years. The most promising accessions were identified for (1) seed yield (>34 g/plant) and oil yield (≥10 g/plant); (2) early flowering (65-75 days) (Table 1). Earlier studies have revealed considerable variation in accessions collected from different safflower growing regions of the world (Mukta, 2012) from which trait specific accessions have been identified (Mukta *et al*., 2017). Based on better performance than the check varieties, trait specific accessions for seed and oil yield (14) and early flowering (8) were identified for utilization in breeding.

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Table 1Promising trait specific accessions identified (Mean of 2017-18 and 2018-19)

Accession no.	Collector No.	Days to 50 % flowering	Seed yield/plant (g)	100-seed weight (g)	Oil content (%)	Oil yield (g/plant)
		High seed and oil yield				
GMU-7877(IC-0631941)	NMDC-17	83	49.0	6.4	27.4	13.4
GMU-7911(IC-0631975)	NMDC-51	82	45.9	7.2	28.0	12.8
GMU-7880(IC-0631944)	NMDC-20	78	45.6	6.2	28.8	13.2
GMU-7884(IC-0631948)	NMDC-24	87	43.6	5.1	29.1	12.7
GMU-7901(IC-0631965)	NMDC-41	78	41.0	5.8	29.0	11.9
GMU-7875(IC-0631939)	NMDC-15	83	40.9	5.0	27.5	11.2
GMU-7907(IC-0631971)	NMDC-47	86	40.7	7.2	27.2	11.1
GMU-7871(IC-0631935)	NMDC-11	86	40.5	6.5	27.2	11.0
GMU-7873(IC-0631937)	NMDC-13	83	39.9	5.2	28.8	11.5
GMU-7869(IC-0631933)	NMDC-9	87	38.7	6.5	28.0	10.8
GMU-7920(IC-0631984)	NMDC-60	86	37.6	7.0	26.9	10.1
GMU-7922(IC-0631986)	NMDC-62	82	37.1	7.2	28.2	10.5
GMU-7916(IC-0631980)	NMDC-56	85	36.5	6.3	27.9	10.2
GMU-7881(IC-0631945)	NMDC-21	87	34.9	6.8	28.7	10.0
		Early flowering				
GMU-7898(IC-0631962)	NMDC-38	65	11.1	5.9	26.3	2.9
GMU-7899(IC-0631963)	NMDC-39	69	29.3	5.3	27.3	8.0
GMU-7894(IC-0631958)	NMDC-34	72	21.1	4.8	28.9	6.1
GMU-7895(IC-0631959)	NMDC-35	74	22.2	5.2	29.0	6.5
GMU-7903(IC-0631967)	NMDC-43	74	26.6	6.6	27.5	7.3
GMU-7896(IC-0631960)	NMDC-36	75	24.1	5.2	28.3	6.8
GMU-7909(IC-0631973)	NMDC-49	75	21.0	7.1	27.4	5.8
GMU-7879(IC-0631943)	NMDC-19	75	27.7	5.4	30.0	8.3
Checks	A-1	91	29.9	6.6	23.9	7.1
	Bhima	88	29.0	6.8	26.9	7.8

Oils seeds performed better for different sources of irrigation water as compared to wheat and chickpea in Malaprabha Command Area of Northern Karnataka

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ABSTRACT

In the present scenario of irregular monsoon, in-situ conservation of rain water through farm ponds and providing life saving irrigations utilizing ground water to the agriculture crops is the need of hour. In this context, a study was conducted on evaluation of effect of different sources of irrigation water on important *rabi* crops like safflower, sunflower, wheat and chickpea during *rabi* seasons of 2017, 2018 & 2019 at the Irrigation Water Management Research Center (IWMRC), Belavatagi in North Karnataka. Among the different *rabi* crops tried safflower recorded significantly higher chickpea equivalent yield in all three years as well as in pooled analysis (2.38, 2.04, 1.16 and 1.86 t /ha, respectively) followed by sunflower (1.49, 1.32, 1.28 and 1.36 t /ha, respectively). The results also indicated that, among the *rabi* crops, safflower and sunflower are the least affected crops with respect to sources of irrigation water, whereas chickpea and wheat are much affected with the different sources of irrigation water. Thus, oilseeds like safflower and sunflower performed better as compared to chickpea and wheat with different sources of irrigation water with respect to their growth and performance in Malaprabha Command Area of North Karnataka region.

Key words: Different sources of irrigation water, Safflower, Sunflower, Wheat, Chickpea equivalent yield

Malaprabha project is one of the important irrigation projects in North Karnataka with an ultimate irrigation potential of 2.20 lakh ha. In recent years the canal water release is uncertain due to erratic rainfall over the catchments area of the reservoir leading to less water storage in the reservoir (Yaragattikar *et al*, 1997). Under such circumstances different sources of irrigation water has to be explored to provide the life saving irrigation. In this direction this study was conducted on evaluation of effect of different sources of irrigation water on important *rabi* crops like safflower, sunflower, wheat and chickpea during *rabi* seasons of 2017, 2018 & 2019.

MATERIAL AND METHODS

A field experiment was conducted at the Irrigation Water Management Research Centre (IWMRC), Belvatagi of University of Agricultural Sciences, Dharwad during *rabi* seasons of 2017, 2018 & 2019 under irrigated conditions with three different sources of water namely, pond, bore-well and e-harmonised water on four different *rabi* crops like safflower, sunflower, wheat and chickpea. The centre is situated at 15° 61" N latitude and 75° 23" E longitudes at an elevation of 579 m above mean sea level. The soil was clay (24.7% sand, 14.3% silt and 60.8% clay) in texture having pH: 8.3, EC: 0.32 dS/m, organic carbon:

0.52% available P (12.7 kg/ha) and available K (470 kg/ha). The soil was high in moisture retention capacity with 38.0% at-0.03 MPa and 21.3%, at- 1.5 MPa. The experiment was laid out with factorial RBD design. The treatments were tested in three replications with three irrigation water sources as main factor and four rabi crops as sub factor. All other recommended package of practices was followed as/the requirement of respective crops.

Table 1: Water analysis report of different source of water used in the study

Water Type	pH	EC (dS/m)	TDS (ppm)	Viscosity (cP)	Surface Tension (Mn/m)
Bore well water	6.93	7.37	3060	9.04	52.781
E-harmonised Bore well water	6.98	7.25	2870	8.48	54.376
Pond water (Benni halla stored water)	7.12	1.38	750	8.08	53.252
Filtered bore well water (RO process)	5.24	0.41	220	--	--

Table 2: Effect of different water sources on Chickpea Equivalent Yield (q/ha) and Economics of different *rabi* crops in Malaprabha Command Area

Treatment	Chickpea Equivalent Yield (Kg/ha)				Gross Returns (Rs/ha)				Net Returns (Rs/ha)				BC Ratio			
	2017-18	2018-19	2019-20	Pooled	2017-18	2018-19	2019-20	Pooled	2017-18	2018-19	2019-20	Pooled	2017-18	2018-19	2019-20	Pooled
Main plot (M): Sources of water																
Bore-well water (S1)	1208	1011	883	1034	48316	40446	12811	33858	27282	19411	28599	25097	2.4	2.01	1.46	1.96
E-harmonized water (S2)	1392	1088	1373	1284	55693	43512	14860	38022	34659	22478	32763	29967	2.76	2.17	1.93	2.29
Pond / canal water (S3)	1520	1365	1158	1348	60815	54582	16171	43856	39781	33548	38598	37309	2.98	2.68	1.69	2.45
S. Em.±	25.63	50.91	18.56	31.70	1025.09	2036.38	673.62	1245.03	1025.09	2036.38	673.62	1245.03	0.05	0.10	0.03	0.06
C.D. (P=0.05)	100.61	199.86	72.89	124.45	4024.36	7994.55	2644.97	4887.96	4024.36	7994.55	2644.97	4887.96	0.2	0.39	0.10	0.23
Sub plot (S): Different *rabi* crops																
Chickpea (C1)	1003	743	1091	946	40135	29702	40501	36779	16399	5966	14419	12261	1.69	1.25	1.55	1.50
Safflower (C2)	2383	2042	1156	1860	95303	81675	47208	74729	76957	63329	21516	53934	5.19	4.45	1.84	3.83
Wheat (C3)	618	519	1022	720	24729	20749	38801	28093	4229	249	14545	6341	1.21	1.01	1.60	1.27
Sunflower (C4)	1490	1315	1282	1362	59599	52594	47766	53320	38043	31038	20864	29982	2.76	2.44	1.78	2.33
S. Em.±	40.74	38.542	44.65	41.31	1629.66	1541.68	1730.70	1634.01	1629.66	1541.68	1730.70	1634.01	0.08	0.07	0.07	0.07
C.D. (P=0.05)	121.1	114.52	132.67	122.76	4842.16	4580.75	5142.17	4855.03	4842.16	4580.75	5142.17	4855.03	0.24	0.22	0.20	0.22
Interaction (M × S)																
S1C1	715	566	641	641	28609	22640	9963	20404	4873	-1096	11747	5175	1.21	0.95	0.81	0.99
S1C2	2190	1884	2037	2037	87619	75372	30564	64518	69273	57026	54785	60361	4.78	4.11	1.02	3.30
S1C3	510	392	451	451	20389	15660	7097	14382	-111	-4840	7123	724	0.99	0.76	1.57	1.11
S1C4	1416	1203	1310	1310	56647	48110	19755	41504	35091	26554	32117	31254	2.63	2.23	2.43	2.43
S2C1	945	573	759	759	37819	22907	13112	24613	14083	-829	17269	10174	1.59	0.97	2.50	1.69
S2C2	2477	2038	2258	2258	99075	81504	34530	71703	80729	63158	62321	68736	5.4	4.44	2.73	4.19
S2C3	645	418	532	532	25813	16733	8959	17168	5313	-3767	10480	4009	1.26	0.82	1.30	1.13
S2C4	1502	1323	1413	1413	60067	52904	20964	44645	38511	31348	34707	34855	2.79	2.45	1.18	2.14
S3C1	1349	1089	1219	1219	53976	43560	18805	38780	30240	19824	29275	26446	2.27	1.84	1.35	1.82
S3C2	2480	2204	2342	2342	99216	88148	34633	73999	80870	69802	63167	71280	5.41	4.8	1.77	3.99
S3C3	700	746	723	723	27986	29853	9811	22550	7486	9353	13282	10040	1.37	1.46	1.93	1.59
S3C4	1552	1419	1486	1486	62081	56769	21684	46845	40525	35213	36351	37363	2.88	2.63	1.71	2.41
S. Em.±	70.57	66.76	69.51	68.95	2822.66	2670.28	2682.02	2724.99	2822.66	2670.28	2682.02	2724.99	0.14	0.13	0.11	0.13
C.D. (P=0.05)	211.7	200.27	206.5	206.16	8467.98	8010.83	7968.69	8149.17	8467.98	8010.83	7968.69	8149.17	0.41	0.38	0.31	0.37

Market Price of: Chickpea: Rs. 45/kg Safflower: Rs. 40/kg Wheat: Rs. 30/kg Sunflower: Rs. 40/kg

RESULTS AND DISCUSSION

Chickpea equivalent yield: The results indicated that among the different sources of irrigation water, pond water recorded significantly higher chickpea equivalent yield during all three years (2017, 2018 & 2019) and also in pooled results (1.52, 1.37, 1.16 and 1.35 t /ha, respectively) as compared to bore well water (1.21, 1.01, 0.88 and 1.03 t /ha, respectively) and it was on par with e-harmonized water (1.39, 1.09, 1.37 and 1.28 t /ha, respectively). Among the different *rabi* crops tried safflower recorded significantly higher chickpea equivalent yield in all three years as well as in pooled (2.38, 2.04, 1.16 and 1.86 t /ha, respectively) followed by sunflower (1.49, 1.32, 1.28 and 1.36 t /ha, respectively). The results also indicated that, among the *rabi* crops safflower and sunflower are the least affected crops with respect to sources of irrigation water, whereas chickpea and wheat are much affected with the different sources of irrigation water (Rajkumara *et al,* 2009).

Economics*:* Economics indicates that pond water shown significantly higher gross returns (Rs. 43856 /ha), net returns (Rs. 37309/ha) and BC ratio (2.45) as compared to other treatments.

Soil fertility: The results of soil properties like pH after the harvest of *rabi* crops indicated that, among the different sources, bore well water applied plots recorded significantly higher pH values during all three years (2017, 2018 & 2019) and also in pooled results 8.25, 8.43, 8.67 and 8.45, respectively) as compared to pond water applied plots (7.88, 8.05, 8.07 and 8.0, respectively) and it was on par with e-harmonized water applied plots (8.25, 8.34, 8.42 and 8.34, respectively). Whereas with reference to sub plots i.e., different *rabi* crops tried the pH values recorded were non-significant. The results of EC (dS/m^1) in main, sub plots and their interactions are also non significant (Adamu *et al*, 2014).

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Stability of *Bacillus thuringiensis*(Bt-127) in different biopolymers against UV irradiation

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ABSTRACT

Microbial bioagents offer considerable promise for eco-friendly in insect pest management. Encapsulation using biopolymers is a safe and feasible technique that provides most protection for biopesticides. It improves their stability against UV radiation by coating the *BT* spores and crystals with biopolymers. The stability of the BT spore was observed in biopolymers compared to Bt- technical. Hence, the stability is good in (lingnosulphontae + BT + water, and chitosan + BT + water) formulations @ 5% and 0.1%respectively

Keywords: Biopolymers, Lignosulphonate, Chitosan

Insect pest damage is one of the primary factors contributing to decreased crop production. In India, the average yearly losses from insect pests in major field crops have been reported to be 15.7%, approximately US $ 36.0 billion (Dhaliwal et al., 2015). Lepidopteran pests, such as the tobacco caterpillar (Spodoptera litura (F.), pod borer (Helicoverpa armigera (Hübner), and semilooper (Achaea janata L.), are among the most severe insect pests, causing major damage to cotton, oilseeds, pulses, vegetables, and other crops. (CABI, 2018).

BT is prominent among all insect control products based on diverse commercially available microorganisms, representing roughly 50% of the global market for this type of product.However, the high dose recommendations, short shelf-life, and less persistent nature of such microbial formulations are major bottlenecks.Many studies have shown that UV exposure has a negative impact on BT performance, primarily causing the loss of spore viability and toxin integrity and, as a result, reduced insecticidal effectiveness (Myasnik et al., 2001; Zogo et al., 2019; Zhou et al., 2018).

MATERIALS AND METHODS

From potential strain of Bt-127 is mass multiplied to produce BT technical powder. The obtained technical powder was dissolved in different concentrations (0%, 0.5%, 1%, 2%, 5% and 10%) of lignosulphonate solutions @ BT (0.1g/100ml). Similarly, Bt-technical was dissolved in chitosan polymer solution in concentrations of (0%, 0.1% and 0.5%) at Bt (0.1g/100ml) and free spore suspension was used as control, before and after dissolving in water will be placed on glass Petri-dishes in triplicate. The plates were exposed to Ultra Violet (UVC) irradiation (254 nm) for 5, 10, 15, 20 and 25 min for short exposure. Spore counts through serial dilution and bioassays were done.

RESULTS AND DISCUSSION

When compared with Bt technical after exposing to UV (254nm) at different time interval, the spore count stability was optimal in Bt suspended in polymer solutions. The lignosulphonate + Bt suspension at 5% showed high colony forming units than other polymer suspension. Similarly in chitosan suspension good spore count stability was observed at 0.1%. The stability of Bt spores in polymer suspensions under uv exposure at 254 nm was good compared to Bt technical powder.

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Table: CFU count of coacervate and technical before and after exposure to uv at 254 nm

		CFU count = nX10^10			
Suspensions with Bt	Concentration	0 min	5 min	25 min	9 hrs
Lignosulphonate+ Bt	5%	40	38	39	17
Chitosan + Bt	0.1%	19	18	17	15
Bt-technical	0.1%	11	10	9	5

Genetic variability and heritability studies in sunflower inbred lines

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ABSTRACT

Sunflower (*Helianthus annuus L.*) is one of the important oilseed crops after Groundnut, Rapeseed-Mustard and Soybean. Sunflower is an important crop for production of healthy edible oil for cardiac problems due to which sunflower oil has great demand in commence. Breeding programme aim at development of cultivars with high yield and yield components. A wide range of variation has been reported for seed yield, seed number and other important components of yield. The experiment was conducted at Oilseeds Research Centre, Dr. PDKV, Akola during Kharif 2020-2021, to study the Genetic Variability studies in Sunflower Inbred Lines. The experiment consisted of 24 sunflower inbred lines were evaluated with three checks (DRSF 108, DRSF 113 and PhuleBhaskar) respectively and was laid out in Randomized Block Design. In this study illustrated that, the existence of wide ranges of variations for most of the characters among the sunflower inbred lines, Diversity among morphological traits can influence on heterosis and be reliable marker for prediction hybrid potential. The genus sunflower has a very high variability, in wild ecotypes as well in breeding genotypes. Sunflower genotypes differ in plant architecture, types of branching, flower colour and morphology, number and size of heads, seed size and color and many other traits. Analysis of variation indicated that the mean squares of the genotypes were highly significant for all the characters taken under study. The range of variation, as well as genotypic and phenotypic coefficient of variations were high for seed yield per plant, plant height and test weight indicating the scope of improvement through simple selection procedure for obtaining high yield.Broad-sense heritability estimate was maximum for plant height (98.5), while that for seed yield g per plant (97.4) and head diameter (95.6). Hence, higher heritability estimates for these traits indicated that environmental factors did not greatly affect phenotypic variation of these characters.

Keywords: Genetic, Heritability and Inbred lines, Variability

Sunflower (*Helianthus annuus L.*) is an important oilseed crop, which belongs to the genus 'Helianthus' of the family Asteraceae. It is widely adopted and accepted for its high quality and nutritional edible oil. Due to its high economic importance, the developments of effective hybrids are required with superior yield and quality traits. According to Oilseeds Scenario (2019), IIOR, Hyderabad sunflower contributed area (27.37 m ha) and production (56.07 m.t.) of oilseeds in the world and India placed 17th position in area and 21st position in production respectively. In India sunflower occupies 224.36 '000' ha area, 229.6 '000'tonnes production and 1023 kg ha^{-1} productivity. However according to Fourth Advance estimates of Maharashtra State for the year 2021-2022 in Maharashtra sunflower occupies 266 '00' ha area, 141 '00'tonnes production and 532 kg ha^{-1} productivity.

Variability present in a gene pool of a crop species is important to plant breeder for breeding programme.Classification of germplasm based on agronomic characters plays an important role in plant breeding to select valuable genetic resources to be utilized later in different breeding programmes. The coefficients of variation expressed at phenotypic and genotypic levels are used to compare the variability observed among different characters. A wide range of variation has been reported for seed yield, seed number and other important components of yield (Virupakshappa and Sindagi, 1988). The heritability estimates aid in determining the relative amount of heritable portion in variation and thus help plant breeder in selecting the elite inbreds from a diverse population. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone. The success of any breeding programme depends upon the extent of genetic variability in base population and it is essential to subject a population for selection for achieve improvement in a particular trait.

Object: To study the genetic variability, heritability and genetic advance in 27 inbred lines.

METHODS AND DATA SOURCES

The experiment consisted of 24 sunflower inbred lines were evaluated with three checks (DRSF 108, DRSF 113 and PhuleBhaskar) respectively and was laid out in Randomized Block Design. At maturity five plants from each accession were selected randomly for recording of data on yield and its related characters viz. days to 50% flowering, duration of reproductive phase (days), days to maturity, plant height (cm), head diameter (cm), seed yield (g) and100-seed weight (g).

RESULTS AND DISCUSSIONS

Among inbred lines Table 1 mean seed yield ranges from 6-42 g plant-1 , however EC 601635 (42 g plant-1), GMU 770 (41 g plant-1), GMU 494 (38 g plant-1) and GMU 249 (35 g plant-1) recorded significantly superior and highest seed yield over the three checks PhuleBhaskar (28 g plant-1), DRSF 113 (27 g plant-1) and DRSF 108 (25 g plant-1) respectively. Days to 50% flowering mean ranges from 46-60 days and mean range of days to maturity ranges from 74-91 days, Plant height mean ranges from 78.0 cm (TSG 207) - 154.6 cm (check PhuleBhaskar). Head diameter mean ranges from 9.8 cm (TSG 331) -15.9 cm (check PhuleBhaskar). 100 seed weight mean ranges from 3.5 g (GMU 852) - 6.0 g (DRSF 113).

The success of any breeding programme depends upon the extent of genetic variability in base population and it is essential to subject a population for selection for achieve improvement in a particular trait. The mean squares from analysis of variance for different characters were presented in the Table 2. Analysis of variation indicated that the mean squares of the genotypes were highly significant for all the characters taken under study. The range of variation, as well as genotypic and phenotypic coefficient of variations were high for seed yield per plant, plant height and test weight indicating the scope of improvement through simple selection procedure for obtaining high yield.

The magnitude of PCV values for all the traits was marginally higher than the corresponding GCV values. Phenotypic coefficients of variability ranged from 4.78 to 43.56 %, and the highest PCV was noticed for seed yield per plant and the lowest for Days to maturity. The highest genotypic coefficient of variability was recorded for seed yield per plant (42.99), whereas the lowest GCV was recorded for Days to maturity (4.34). Broad-sense heritability estimates were maximum for plant height (98.5), whereas they were moderate for 100 seed weight (49.5) Genetic advance as per cent of mean (GAM) was highest for seed yield per plant (87.41%) followed by plant height (39.7%), and the other traits showed a moderate-to-low genetic advance.The GCV and PCV were high for seed yield, which indicated the presence of additive genes for this character (Patil*et al.*, 1996, Sujatha*et al.*, 2002 and Virupakshappa and Sindagi, 1987). The genotypic coefficient of variation is not always true to reflect the amount of actual variation which is heritable.

The heritable variation cannot be estimated through genetic coefficient of variation (Burton, 1952).Also the genotypic coefficient of variation along with heritability would give the reliable information on the magnitude of genetic advance to be expected from selection. The heritability in broad sense is described as the ratio of genotypic variance to the total variance in the non-segregating populations (Hanson *et al.,* 1956). Further, it indicates whether there is sufficient genetic variation present in a population which will respond to selection pressure (Milatovic*et al.,*2010) Selection of the genotype based on specific character with high broad-sense heritability will lead to faster and increased gains in the offspring than selecting for specific character with low heritability (Browning *et al.,* 1994).

Broad-sense heritability estimate was maximum for plant height (98.5), while that for seed yield g per plant (97.4) and head diameter (95.6). Hence, higher heritability estimates for these traits indicated that environmental factors did not greatly affect phenotypic variation of these characters.

The present study exhibited very high differences among the genotypes for seed yield almost all yield component characters which may favour the selection and itsfurther utilization in recombination breeding programmes. While selecting appropriate sunflower germplasm, the breeder looks for genetically diverse and superior genotypes which could be utilized in population and heterosis breeding. The genetically diverse sunflower germplasm identified could be utilized in development of diverse inbreds which may be utilized in heterosis breeding. Promising trait specific superior sunflower germplasm accessions identified will serve as donors for the development of trait specific heterotic gene pools which can be further exploited in sunflower improvement.

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Table 1: Range of seed yield and related characters of sunflower inbred lines

Characters	Genotype	Range of characters
Seed Yield g plant-[1]	TSG 17	6
	EC 601635	42
Days to 50% flowering	TSG 197	46
	DRSF 113 (C)	60
Days to maturity	TSG 197	74
	DRSF 113 (C)	91
Plant height (cm)	TSG 207	78.0
	PhuleBhaskar (C)	154.6
Head diameter (cm)	TSG 331	9.8
	PhuleBhaskar (C)	15.9
100 seed wt (g)	GMU 852	3.5
	DRSF 113 (C)	6.0

Table: 2- Genetic variability, genetic parameters, heritability and genetic advance in percent of mean for six quantitative traits in 27 sunflower inbred lines

Characters	Mean sum of squares	σ2 g	σ2 p	Coefficient of variation			GA as per cent of mean
				GCV	PCV	h^2 (b. s.)	
Seed Yield g plant-[1]	200.31	98.84	101.47	42.99	43.56	97.40	87.41
Seed Yield kgha-[1]	18.23	8.71	9.51	5.40	5.65	91.60	10.66
Days to Maturity	27.96	12.61	15.34	4.34	4.78	82.20	8.10
Plant Height cm	922.40	457.77	464.63	19.44	19.59	98.50	39.76
Head Diameter	7.29	3.56	3.732	15.07	15.42	95.60	30.36
100-Seed Wt.(g)	0.97	0.32	0.65	11.65	16.55	49.50	16.89

σ2g – Genotypic variance, σ2p-Phenotypic variance, GCV –Genotypic Coefficient of variation, PCV- Phenotypic Coefficient of variation, h^2 (b. s.)-Heretability in broad sense, GA-Genetic advance.

Safflower heterosis for yield and its contributed characters

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ABSTRACT

Safflower (*Carthamus tinctorius* L.) is one of the major edible oilseed crops grown in winter season in India. The first safflower hybrid released in India for commercial cultivation in all safflower growing regions was based on genetic male sterility system. Twenty two hybrids were tested using line x tester design involving two cytoplasmic male sterile lines during rabi 2018, using Randomized block design with three replications. Twenty two along with three checks 'A-1, PBNS-12, PKV Pink' were evaluated at the field of Oilseeds Research Unit, Dr. PDKV, Akola during rabi 2019-2020 to estimate extent of heterosis in safflower genotypes. Among all the crosses, AKS CMS 2A x GMU 1183 (46.15 % and 44.30%) exhibited highly significant and positive average heterosis for number of seeds per plant over mid and better parent. crosses, AKS CMS 2A x GMU 184 (49.26% and 34.44%) exhibited highly significant and positive average heterosis for 100 seed weight, whereas, cross AKS CMS 2A x GMU 5149 (15.28% and 9.32%) exhibited highly significant and positive average heterosis for volume weight. The highest heterosis and heterobeltiosis in desirable direction were recorded for seed yield per plant in AKS CMS 2A x GMU 1654 (246.96. %) and the cross AKS CMS 3A x GMU 1183 (206.75%) showed highest and significantly positive standard heterosis over the checks i.e. PKV PINK, AKS 207 and PBNS-12.Biotechnological tools, such as genetic engineering need to be perfected for incorporation of mitochondrial male sterility causing factor of sunflower into safflower to develop safflower hybrids which can be more easily produced.

Keywords: Heterosis and Heterobeltiosis, Safflower

Safflower (*Carthamus tinctorius*L.) belongs to Asteraceae family commonly known as “kusum” and has 2n = 24chromosomes. Safflower (*Carthamus tinctorius* L.) Is one of the important rabi oilseed crops of India, Several reports from USAand other parts of the world have demonstrated existence of significant heterosis for yieldand total oil output in the crop. Despite numerous problems encountered currently in thelarge scale production of hybrid seeds in safflower owing to non-availability of simple, efficient and inexpensive mechanisms of cross pollination, such information obtainedfrom large number of crosses involving diverse parental types would be very useful inidentifying superior cross combinations and framing our future breeding strategies in acrop which has been found to offer great promise for semi-arid tracts in the country. This study state that the present status and future prospects of heterosis breeding of safflower in India. In safflower, genetic as well as cytoplasmic male sterility systems are harnessed for the development of hybrid cultivars. However, the male sterility system used for the development of safflower hybrids in India is the GMS system while CMS system is in the final stages of evaluation.

MATERIAL AND METHODS

The experimental material consisted of Twenty two hybrids were tested using line x tester design involving two cytoplasmic male sterile lines (viz., AKS CMS 2 A and AKS CMS 3A) and eleven fertility restorer lines (viz., GMU 1654, GMU 7363, GMU 880, GMU 1894, GMU 7593, GMU 1731, GMU 7573, GMU 6891, GMU 1183, GMU 184 and GMU 5149) during rabi 2018, using Randomized block design with three replications. Twenty two along with three checks 'A-1, PBNS-12, PKV Pink' wereevaluated at the field of Oilseeds Research Centre, Dr. PDKV, Akola during rabi 2019-2020 to estimate extent of heterosis in safflower genotypes. All recommended cultural practices were followed to raise a good crop. The observations were recorded on five randomly selected plants for ten quantitative traits viz., days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of capitula per plant, number of seeds per capitulum, volume weight (g/100ml), 100 seed weight (g), and seed yield per plant (g). Heterosis was calculated over mid parent, better parent and standard check for seed yield, its components.

RESULTS AND DISCUSSION

The analysis of variance for various characters under study is presented in Table 1. The variation among treatments was highly significant for all of the characters. The mean sum of square due to parents (testers), Male (testers) x Female (lines), crosses and parents vs crosses were also found highly significant for all the characters studied except number of branches per plant and number of capitula per plant. This indicates presence of substantial genetic variability for the characters studied.

The variances due to testers were highly significant for all the traits under study except 50% flowering, 100 seed weight and volume weight. The variances due to crosses were highly significant for all the traits under study except number of branches per plant and number of capitula per plant which indicated the presence of significant differences between males and females.

The estimates of heterosis over mid parent (MP) and better parent (BP) for different characters in safflower are presented in Table 2. Heterosis was measured as per cent increase or decrease over mid parent (relative heterosis) and over better parent (heterobeltiosis). For calculation of relative heterosis and heterobeltiosis for days to 50 per cent flowering, plant height, number of seeds per capitulum and days to maturity, parents with less values were considered as better parent and crosses with lower values were considered as heterotic crosses. The magnitude of heterotic effects observed in different characters varied from cross to cross. Positive heterosis is desirable for all the characters studied except days to 50% flowering and days to maturity where negative heterosis is desirable. Heterosis for days to 50 per cent flowering the highest, significant and negative heterosis over mid parent was observed in cross AKS CMS 3A x GMU 1183 (-6.07 %) and over and better parent was AKS CMS 2A x GMU 7593 (-10.20 %). Whereas, in case of days to maturity, the highest, significant and negative heterosis over mid parent and better parent was observed in cross AKS CMS 3A x GMU 6891and AKS CMS 3A x GMU 5149(-5.93 % & -7.86 %, respectively).

Table 1: Analysis of variance for combining ability

Sources of variation	DF	Seed yield (g plant-1)	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of capitula per plant	No. of seeds/ capitulum	100 seed wt. (g)	Volume wt. (g/100 ml)
Replicates	2	5.000	45.288 **	7.106	680.387 **	2.015	4.227	9.652	0.239	0.203
Crosses	21	1281.407 **	58.188 **	65.085 **	127.037 **	6.220	114.855 **	129.666 **	1.731 ***	17.838 **
Females (lines)	1	0.055	30.682	0.242	8.626	2.561	4.379	5.470	0.680	12.393
Males (testers)	10	2647.880 **	86.812	113.212 *	241.871 **	10.179 *	223.445 **	214.615 *	2.471	18.132
Females vs Males	10	43.069 **	32.315 **	23.442 **	24.043 *	2.627	17.312	57.136 **	1.096 **	18.089 **
Error	42	2.303	2.955	4.074	10.118	3.523	11.180	5.826	0.091	1.386
Total	65	415.635	22.102	23.879	68.515	4.348	44.461	45.954	0.626	6.665

Note: * Significant at 5% level of significance.
** Significant at 1% level of significance.

The highest magnitude of heterosis over mid parent and better parent was for plant height at harvest was observed in cross AKS CMS 3A x GMU 1183 (32.63 % and 30.16) respectively. In case of number of primary branches showed heterosis over mid parent and better parent was cross CMS 2A x GMU 1654 (40.35 and 37.93%) respectively. Number of capsules per plant the cross CMS 2A x GMU 1183 (40.0%) andCMS 3A x GMU 1655 (33.33%) showed highest and positive heterosis over mid parent and better parent.Similar results were also reported by Narkhede et al (1986 and 1987) and Deokar *et al* (1992) for both the traits in safflower. These cross combinations can be used in further breeding programme to enhance yield potential through plant height, number of primary branches and number of capsules per plant.

Among all the crosses, AKS CMS 2A x GMU 1183 (46.15 % and 44.30%) exhibited highly significant and positive average heterosis for number of seeds per plant over mid and better parent. crosses, AKS CMS 2A x GMU 184(49.26% and 34.44%) exhibited highly significant and positive average heterosis for100 seed weight, whereas, cross AKS CMS 2A x GMU 5149 (15.28% and 9.32%) exhibited highly significant and positive average heterosis for volume weight. These results are in line of results obtained by Deedawat *et al* (2016) in safflower.

The highest heterosis and heterobeltiosis in desirable direction were recorded for seed yield per plant in AKS CMS 2A x GMU 1654 (246.96. %) and the cross AKS CMS 3A x GMU 1183 (206.75%) showed highest and significantly positive standard heterosis over the checks i.e. PKV PINK, AKS 207 and PBNS-12. The relative heterosis, heterobeltiosis and standard heterosis for above characters in safflower was also reported by several workers in safflower Narkhede*et al* (1986 and1987) and Deedawat *et al* (2016).

Among twenty two hybrids, AKS CMS 2A x GMU 1654 (86.6 g plant-1), AKS CMS 3A x GMU 1654 (82.5 g plant-1), AKS 3A x 1183 (59.1 g plant-1), AKS 2A x 1183 (49.5 g plant-1), AKS CMS 2A x GMU 880 (29.7 g plant-1) and AKS CMS 3A x GMU 1894 (28.7 g plant-1) recorded highest mean seed yield than best check AKS 207 (26.7 g plant-1). However genotype GMU 1183 (49.5 and 59.1 g plant-1) recorded highest yield to both CMS lines.

The present study was undertaken to estimate hybrid safflower breeding should provide farmers with an opportunity to improve productivity, particularly in potential high yield areas and where conventional breeding has apparently reached a yield plateau. CMS system has been found to be the most effective and practical approach for developing safflower hybrids. As hybrid technology has been perfected in safflower, current emphasis is on developing high yielding hybrids in this crop.

CONCLUSION

Hence, above crosses have good genetic potential due to good magnitude of useful heterosis in desirable direction for most of traits that can be utilized in further breeding programme for exploiting hybrid vigour.

Improvement in the seed yield per plant is an important activity of plant breeding. The ultimate seed yield is a complex process that will be affected by many genetic and non-genetic factors. This will help in constructing a suitable plant type and combining desirable expression of different yield components. The present investigation therefore was planned to evaluate the genetic correlation studies in germplasm accessions of safflower.

Table 2: Heterosis (%) over mid-parent (MP) and better-parent (BP) for different characters

Crosses	Seed yield (g plant-1)		Days to 50% flowering		Days to maturity		Plant height (cm)	
	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)
AKS CMS 2A x GMU 1654	246.96 **	176.28 **	5.60 **	3.38	8.77 **	-1.71	10.77 *	8.81
AKS CMS 2A x GMU 7363	14.36 **	7.97	8.48 **	2.53	1.17	-5.12 **	13.24 **	4.12
AKS CMS 2A x GMU 880	18.88 **	-5.41	-3.24 *	-7.00 **	-5.67 **	-6.59 **	0.14	-5.77
AKS CMS 2A x GMU 1894	-10.66 *	-23.23 **	14.04 **	13.08 **	2.64 *	-0.49	16.68 **	6.44
AKS CMS 2A x GMU 7593	2.92	-13.28 **	-0.56	-10.20 **	-0.24	-2.56 *	6.75	6.42
AKS CMS 2A x GMU 1731	-17.13 **	-23.44 **	3.69 *	0.84	-1.38	-3.90 **	13.68 **	8.65
AKS CMS 2A x GMU 7573	18.26 **	14.67 *	6.75 **	0.75	2.55 *	2.18	5.10	1.24
AKS CMS 2A x GMU 6891	12.44 *	11.13	-1.02	-3.97 *	-3.30 **	-3.66 **	7.06	1.55
AKS CMS 2A x GMU 1183	161.85 **	157.09 **	6.43 **	1.53	5.20 **	3.66 **	28.50 **	27.60 **
AKS CMS 2A x GMU 184	-34.37 **	-44.05 **	4.64 **	4.64 **	2.03	-1.71	11.72 *	1.84
AKS CMS 2A x GMU 5149	-2.44	-13.06 *	6.14 **	2.11	2.49 *	-4.63 **	5.97	-1.48
AKS CMS 3A x GMU 1655	231.68 **	163.40 **	5.66 **	0.80	9.99 **	-1.67	6.77	3.67
AKS CMS 3A x GMU 7363	-4.07	-9.73	7.59 **	-0.80	0.90	-6.43 **	6.41	-3.21
AKS CMS 3A x GMU 880	-13.98 **	-31.74 **	-5.33 **	-6.61 **	-0.97	-3.10 **	4.19	-3.03
AKS CMS 3A x GMU 1894	29.67 **	11.10 *	-3.11 *	-6.40 **	0.62	-3.57 **	11.11 *	0.28
AKS CMS 3A x GMU 7593	-3.37	-18.82 **	1.47	-6.12 **	0.00	-1.16	9.40 *	8.45
AKS CMS 3A x GMU 1731	-5.79	-13.24 *	-2.95	-8.00 **	-4.82 **	-8.33 **	-1.41	-6.83
AKS CMS 3A x GMU 7573	12.91 *	9.11	4.45 **	1.12	2.28 *	1.43	3.52	-1.42
AKS CMS 3A x GMU 6891	20.33 **	19.35 **	-1.99	-2.38	-5.93 **	-7.38 **	8.63 *	1.89
AKS CMS 3A x GMU 1183	213.53 **	206.75 **	-6.07 **	-8.05 **	-1.22	-3.81 **	32.63 **	30.16 **
AKS CMS 3A x GMU 184	-42.07 **	-50.76 **	0.62	-2.00	-1.50	-6.19 **	3.30	-6.84
AKS CMS 3A x GMU 5149	-13.04 *	-22.75 **	1.49	-4.80 **	0.13	-7.86 **	6.95	-1.65
RANGE	-42.07 to 246.96	-50.76 to 206.75	-6.07 to14.04	-10.20 to 13.08	-5.93 to 9.99	-8.33 to 3.66	-1.41 to 32.63	-6.84 to 30.16
SE(D)±	1.0460	1.2078	1.1649	1.3451	1.3409	1.5483	2.7366	3.1600
CD 5%	2.1108	2.4374	2.3509	2.7146	2.7061	312.47	5.5227	6.3771
CD 1%	2.8221	3.2587	3.1430	3.6292	3.6179	4.1776	7.3836	8.5258

Note: * Significant at 5% level of significance.
** Significant at 1% level of significance.

Conti…Table 2: Heterosis (%) over mid-parent (MP) and better-parent (BP) for different characters

Crosses	No. of branches per plant		No. of capitula per plant		No. of seeds/ capitulum		100 seed wt. (g)		Volume wt. (g/100 ml)	
	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)	MP(H_1)	BP(H_2)
AKS CMS 2A x GMU 1654	40.35 **	37.93 *	32.94 **	25.56 **	40.24 **	35.29 **	8.94	7.20	-0.53	-6.18 **
AKS CMS 2A x GMU 7363	1.69	0.00	0.00	-8.75	-5.66	-6.25	36.24 **	14.69 **	-0.41	-6.74 **
AKS CMS 2A x GMU 880	0.00	-3.23	-11.63	-17.39 *	9.32	7.32	15.44 **	3.97	5.70 **	-2.17
AKS CMS 2A x GMU 1894	-3.23	-9.09	-14.11	-15.66	-5.41	-11.39	18.37 **	16.94 **	1.18	-4.23 *
AKS CMS 2A x GMU 7593	-1.69	-3.33	-16.46 *	-17.50	10.98	2.13	3.64	1.59	7.50 **	0.87
AKS CMS 2A x GMU 1731	-11.86	-13.33	-19.48 *	-22.50 *	-38.37 **	-43.01 **	38.89 **	33.59 **	1.91	-3.35
AKS CMS 2A x GMU 7573	4.92	0.00	5.04	-8.75	1.30	-1.27	-6.49	-22.99 **	8.00 **	3.67 *
AKS CMS 2A x GMU 6891	3.45	3.45	4.90	-6.25	-14.89 *	-24.05 **	-24.67 **	-36.87 **	0.59	-5.13 **
AKS CMS 2A x GMU 1183	26.67 *	22.58	35.77 **	16.25	46.15 **	44.30 **	27.35 **	23.14 **	7.43 **	3.46
AKS CMS 2A x GMU 184	-7.14	-10.34	-35.37 **	-36.90 **	-26.51 **	-29.89 **	49.26 **	34.44 **	5.83 **	-0.92
AKS CMS 2A x GMU 5149	13.33	9.68	-16.46 *	-17.50	12.16	5.06	25.90 **	21.54 **	15.28 **	9.32 **
AKS CMS 3A x GMU 1655	20.63	8.57	38.73 **	33.33 **	14.79 *	14.12 *	24.82 **	14.77 **	-3.73 *	-5.19 **
AKS CMS 3A x GMU 7363	-16.92	-22.86	-19.46 *	-27.71 **	-1.22	-3.57	0.61	-7.34	7.20 **	4.78 **
AKS CMS 3A x GMU 880	-6.06	-11.43	-10.86	-15.22	-36.14 **	-36.90 **	-2.00	-2.65	1.70	-1.80
AKS CMS 3A x GMU 1894	0.00	-2.86	6.02	6.02	9.80	0.00	26.74 **	16.11 **	3.40 *	2.22
AKS CMS 3A x GMU 7593	-26.15 *	-31.43 *	-32.92 **	-34.94 **	-3.37	-8.51	20.00 **	10.74 *	3.98 *	1.86
AKS CMS 3A x GMU 1731	-7.69	-14.29	-22.29 **	-26.51 **	-6.21	-10.75	27.14 **	19.46 **	0.17	-0.78
AKS CMS 3A x GMU 7573	-25.37 *	-28.57 *	-16.90	-28.92 **	24.53 **	17.86 **	2.98	-7.49 *	7.85 **	7.51 **
AKS CMS 3A x GMU 6891	0.00	-8.57	2.74	-9.64	-8.22	-20.24 **	-20.12 **	-26.82 **	-0.31	-1.82
AKS CMS 3A x GMU 1183	6.06	0.00	40.00 **	18.07 *	45.34 **	39.29 **	11.45 *	-2.01	-0.89	-1.54
AKS CMS 3A x GMU 184	-9.68	-20.00	-32.93 **	-33.33 **	-39.18 **	-40.23 **	19.33 **	18.54 **	1.17	-1.14
AKS CMS 3A x GMU 5149	-15.15	-20.00	-32.92 **	-34.94 **	21.57 **	10.71	6.81	0.00	-1.01	-1.95
RANGE	-20.0 to 40.35	-31.43 to 37.93	-35.37 to 40.0	-36.90 to 33.33	-39.18 to 46.15	-43.01 to 44.30	-24.67 to 49.26	-36.87 to 34.44	-3.73 to 15.28	-6.74 to 9.32
SE(D)±	1.2868	1.4859	2.0168	2.3288	1.5812	1.8258	0.1927	0.2225	0.8942	1.0325
CD 5%	2.5969	2.9986	4.0702	4.6998	3.1911	3.6847	0.3888	0.4490	1.8046	2.0838
CD 1%	3.4719	4.0090	5.4416	6.2834	4.2663	4.9263	0.5198	0.6002	2.4126	2.7859

Note: * Significant at 5% level of significance; ** Significant at 1% level of significance.

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Effect of different organics and Sulphur sources on growth and yield of Sesame (*Sesamum indicum* L.)

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ABSTRACT

A field experiment was carried out during rainy season-2021 at Experimental farm, Oilseeds Research Station, Latur, to evaluate “Effect of different organics and Sulphur sources on growth and yield of Sesame (*Sesamum indicum* L.)” variety TLT-10. Application of Vermicompost @ 2.5 t/ha (T_2) and Gypsum @ 500kg/ha (S_3) produced higher growth, yield and quality traits along with good net returns and B:C ratio.

Keywords: Economics, Growth, Organics, Sesame, Sulphur, Yield

Sesame is called as ‘the queen of oils’ because of extra ordinary cosmetic and skin care qualities. The seeds are used in preparation of baby foods, considered as the substitute for mother milk to compensate the breastfeeding. The oil of the crop consisted 85% unsaturated fatty acid is highly stable and has reducing effect on cholesterol and prevent coronary heart diseases. The oil of the sesame is highly resistant to oxidative rancidity and is characterized for its stability and quality. Because of its excellent quality characters, sesame oil is also referred to as “poor man’s substitute for ghee”. The cake content 6.0-6.2 % N, 2.0-2.2 % P and 1.0- 1.2 % K and can also be used as manure. It is a crop that could be grown by subsistence farmers at the edge of deserts, where no other crops can grow, so it has been called a survivor crop. (Pagal *et al*., 2017). Sesame well grown on loose sandy alluvial soil. The optimum range for growth, blooms and capsule ripening is 24-30^{0}C. Being highly susceptible to water logging, sesame crop can thrive only during moderate rainfall (300-600 mm). Photo – periodically the sesame plant (*Sesamum indicum* L.) is a short-day plant. It is primarily grown in the Latur district of Marathwada region during the kharif and semirabi seasons. Vermicompost application improves physical, chemical and biological properties of soil. (Sujatha & *R*ao, 2019). Beneficial effect of gypsum on yield and yield attributes of Oilseeds may be ascribed to beneficial role of sulphur and Ca present in gypsum which not only improved biotic activity but also helped improve physiochemical properties of soil.

MATERIALS AND METHODS

The present study was conducted on experimental farm Agronomy section, Oilseeds Research Station, Latur during rainy season of 2021. The experiment was conducted on black clayey soil which was low in nitrogen (231 kg/ha), very low in phosphorus (8.55 kg/ha) and very high in potassium (580.89 kg/ha) which was located between 18^{0}05’ North to 18^{0}75’ North latitude and 76^{0}25’ East to 77^0 25’ East longitude with subtropical climate. The experiment was laid out in Factorial randomized block design (RBD) with three replications and nine treatments. The treatments were T1: FYM @ 5t/ha, T2: Vermicompost @ 2.5t/ha, T3: FYM @ 2.5 t/ha. + Vermicompost @ 1.25t/ha, S1: Elemental Sulphur @ 25kg/ha, S2: ZnSO4 @ 20kg/ha, S3: Gypsum @ 500kg/ha. The gross and net plot size of each experiment Growth observations were taken from 5 randomly selected plants from each net plot. Yield observations like Capsule yield and Seed yield are taken from each net plot are taken in yield/plot and convert them to yield /hectare. The observations are statistically tested by “Analysis of variance method” (Panse and Sukhatme, 1967) at 5% level of significance.

RESULTS AND DISCUSSION

There was a continuous increase in plant height and number of branches of sesame was observed up to 75 DAS and remained constant up to harvest. The number of leaves/plant and leaf area/plant increased up to 75 DAS and decreased thereafter. Application of Vermicompost @ 2.5 t/ha (T_2) and Gypsum @ 500kg/ha (S_3) recorded maximum values for all the above mentioned attributes among organics and sulphur sources respectively which was statistically analyzed. The lowest values were recorded by T_1 and S_2. Mean Absolute Growth Rate (AGR) was found highest at 30-45 DAS. Absolute Growth Rate (AGR) for Dry matter & Relative Growth Rate (RGR) for dry matter, was found highest at 45-60 DAS compared to other growth stages. Mean LAI was found maximum at 60 DAS compared to other growth stages. Among organics application of Vermicompost @ 2.5 t/ha (T_2) recorded maximum values for all the yield attributes like seed yield (832.12 kg/ha) and quality attributes like oil content (48.92%) and oil yield (407.07kg/ha). Among sulphur sources application of Gypsum @ 500kg/ha (S_3) recorded maximum values for all the yield attributes like seed yield (840.12 kg/ha) and quality attributes like oil content (49.07%) and oil yield (412.24kg/ha).The lowest values were recorded by T_1 and S_2. Significantly higher B:C ratio (1.77) among organics was obtained with FYM @2.5 t/ha + VC @ 1.25 t/ha (T_2) & higher B:C ratio (1.82) among sulphur sources was obtained with Gypsum @ 500kg/ha (S_3).

Table 1. Effect of Different organics and sulphur sources on Growth, Yield and Quality of sesame

Tr	No. of Branches/plant at harvest	No. of capsule/plant at 75DAS	Leaf area (dm^2) 60 DAS	Dry matter (g/plant) at harvest	Seed yield (kg/ha)	HI%	Test wt. (g)	Oil content (%)	Oil yield (kg/ha)	B:C ratio
A.Organics (T)										
T_1	4.82	47.92	13.48	21.35	668.28	23.94	3.11	46.67	311.88	1.65
T_2	5.62	53.55	16.31	26.93	832.12	26.1	3.43	48.92	407.07	1.71
T_3	5.39	52.66	15.87	25.29	784.89	25.57	3.3	48.19	378.23	1.77
SE ±	0.15	1.35	0.44	0.66	22.11	-	0.2	0.84	15.86	0.06
CD@5%	0.43	4.04	1.3	1.96	66.9	-	NS	NS	47.79	0.16
B. Sulphur Sources (S)										
S_1	5.3		15.34	24.95	773.73	25.59	3.24	47.3	365.97	1.73
S_2	4.82	70.47	13.78	21.12	671.45	24.06	3.12	46.41	311.61	1.58
S_3	5.71	104.50	16.52	27.49	840.12	25.96	3.47	49.07	412.24	1.82
SE ±	0.15	1.35	0.44	0.66	22.11	-	0.2	1.84	15.86	0.06
CD@5%	0.43	4.04	1.3	1.96	66.9	-	NS	NS	47.79	0.16
C. Interaction (TxS)										
SE ±	0.25	2.33	0.76	1.13	38.60	-	0.35	1.46	27.23	0.09
CD@5%	NS	NS	NS	NS	NS	-	NS	NS	NS	NS
CV@5%	7.86	10.56	8.95	7.92	9.78	-	12.57	7.36	8.61	8.66

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Seasonal occurrence of major defoliators of castor in Tamil Nadu

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ABSTRACT

Castor is a non-edible oil bearing crop adapted to dry lands of tropics and semi-arid tropics. The seasonal occurrence of major defoliators viz., semilooper, *Spodoptera* and hairy caterpillars in castor was recorded continuously for last ten years (2012-2022) at Tapioca and Castor Research Station, Yethapur. The results revealed that *Spodoptera litura* was the major defoliator with a mean population of 4.3 larva/plant /year followed by semilooper and hairy caterpillar with 1.74 larva/plant/year and 1.44 larva/plant/year respectively. The maximum population of defoliators was recorded every year during 43rd to 49th standard weeks (October-November).

Keywords: Castor, Defoliators, Seasonal occurrence

Castor *(Ricinus communis* L.), an important non–edible, commercial oilseed crop is grown as a rain–fed crop in Salem, Namakkal and Dharmapuri districts of Tamil Nadu. The major limiting factor in castor production is the attack of defoliators like castor semilooper, *Achaea Janata*, *Spodoptera litura*, hairy caterpillars and capsule borer which causes economic yield loss in most of the released varieties and hybrids. It is estimated that castor yields are reduced by 30-50% due to *A. janata* alone (Rao *et al.*, 2012). Hence, the present study was undertaken to monitor and document the incidence of major defoliators of castor during the last ten years at Tapioca and Castor Research Station, Yethapur.

METHODOLOGY

Studies on the occurrence of defoliators Survey and monitoring of castor insect pests were done in a fixed plot raised with Castor hybrid, YRCH-1 in Tapioca and Castor research station, Yethapur, Tamil Nadu during every year from 2012-2022. The observations on the defoliator larval populations were recorded from 25 plants at fortnightly intervals and the major defoliators and their season of attack in this region was identified based on statistical analysis.

RESULTS AND DISCUSSION

The survey and monitoring studies taken up during 2012-2022 at Tapioca and Castor Research Station, Yethapur indicated that *Spodoptera litura* was the major defoliator with a mean population of 4.3 larva/plant/year followed by semilooper *A. janata* with 1.74 larva /plant/ year (Table 1). The incidence of defoliators was noticed from 36th week to 12th standard week of every year during the vegetative to early reproductive stage of the crop. The maximum incidence of defoliators recorded from 43rd to 49th standard weeks (October-November) of every year coincides with the North West monsoon period (Fig.1). Basappa and Lingappa, (2001) opined similar views that the incidence of *A. janata* is generally noticed from vegetative to early reproductive phase of the crop causes excessive defoliation affecting photosynthesis and crop yield.

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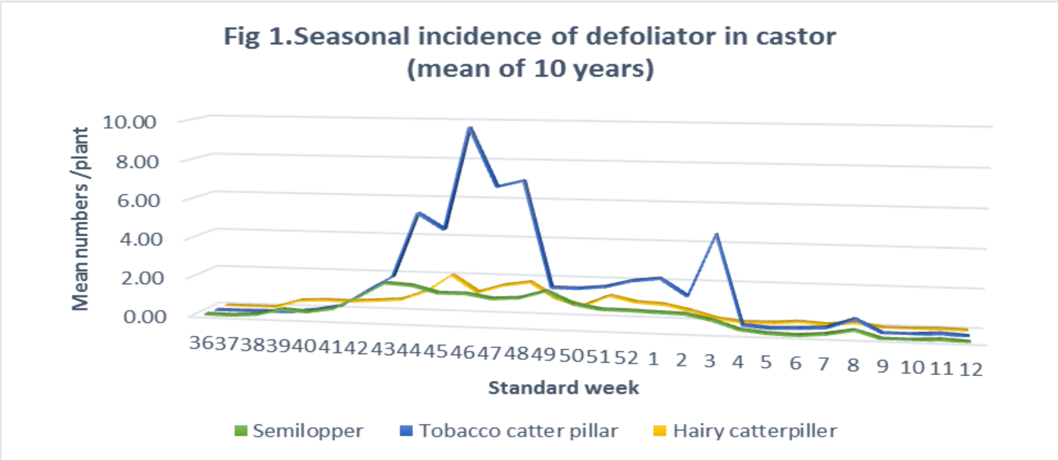
Table 1. Incidence of defoliators in castor at Tapioca and Castor Research station, Yethapur from 2012-2022

Year	Mean No. of defoliator /plant		
	Achaea janata	*Spodoptera litura*	Hairy caterpillar
2012-2013	2.96*± 0.38	0.20±0.05	2.56±0.78
2013-2014	4.06±0.47	3.04±0.30	2.52±0.54
2014-2015	1.50±0.36	2.10±0.48	0.70±0.14
2015-2016	1.11±-0.25	4.85±1.25	1.38±0.33
2016-2017	3.50±0.45	6.02±1.65	1.95±0.04
2017-2018	1.13±0.31	0.96±0.12	0.20±0.08
2018-2019	0.48±0.12	12.41±3.04	0.96±0.14
2019-2020	0.52±0.11	10.15±2.96	1.76±0.26
2020-2021	1.10±0.19	1.90±0.22	2.17±0.85
2021-2022	1.02±0.19	1.41±0.21	0.22±0.04
Mean no. /year	1.74	4.30	1.44

*Mean of observations from 25 plants / observation /month



Seed to Seed Mechanization *Rabi* Groundnut (*Arachis hypogaea)*- Economics & Energy Dynamics

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ABSTRACT

A field experiment was conducted at the Regional Agricultural Research Station, Palem, Nagarkurnool district situated in the Southern Telangana Zone of Telangana state during *Rabi 2018-19*on Mechanization in groundnut. There was a great variation between Farmer's Practice and Complete Mechanization. Mechanization treatment recorded significantly higher pod yield (3246 kg ha^{-1}) over farmer's practice (2524 kg ha^{-1}).It was revealed that 14245 MJ ha^{-1} energy was consumed by Complete Mechanization and 15065 MJ ha^{-1} by Farmers Practice. B:C ratio of Complete Mechanization and Farmers Practice is 3.45 and 2.26 respectively. It was concluded that mechanization is a prerequisite in groundnut for achieving higher productivity with reduced cost of cultivation.

Keywords: Energy Dynamics, Groundnut, Mechanization

Agriculture productivity is greatly influenced by power availability and its optimum use on farms (Singh *et al.*, 2015). During the last 5 decades, farm power availability in India has increased considerably from 0.25 kW/ha in 1951 to 2.24 kW/ ha in 2017. In Telangana, it has increased from 2.485 kw ha^{-1} in 2013 to 2.886 kw ha^{-1} in 2017 which further has to increase to 4.0 kw ha^{-1} (Department of Agriculture & Farmers Welfare, 2022). Empirical evidence confirms that there is a strong correlation between farm mechanization and agricultural productivity. Hence, there is a scope for mechanization in groundnut-growing areas of Telangana state.

METHODOLOGY

A field experiment was conducted at RARS, Palem, Nagarkurnool district situated in the Southern Telangana Zone of Telangana state during *Rabi* 2018-19. The soil of the experimental field was sandy loam in texture, neutral in reaction, non-saline, low in organic carbon content, low in available nitrogen (N), medium in available phosphorous (P_2O_5) and potassium (K_2O).The experiment consisted of two treatments Framers Practice and Complete Mechanization laid out in large plots and data analyzed with two sample t-tests.

Treatment Details		
Parameters	**T_1**	**T_2**
Sowing	Behind the plough	Seed cum fertilizer drill
Weeding	Cattle pair & manual weeding	Tractor mounted weeder
Spraying	Power Sprayer	Tractor mounted sprayer
Harvesting	Manual harvesting	Groundnut digger

RESULTS

Mechanization treatment recorded a higher pod yield (3246 kg ha^{-1}), haulm yield (6160 kg ha^{-1}) over farmers practice (2524 kg ha^{-1}, 5595 kg ha^{-1} respectively).Higher gross returns (1,47,800 Rs. ha^{-1}), net returns (1,14,600 Rs. ha^{-1}) and B:C ratio (3.45) were obtained with Mechanization over farmer practice (1,39,250 Rs. ha^{-1}, 96550 Rs. ha^{-1} and 2.26 respectively). Higher energy use efficiency was observed in Complete Mechanization (13.0) over Farmer's Practice (10.5).

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Table 01: Effect of mechanization on yield, economics and energy dynamics of groundnut

Parameters	Farmers Practice	Mechanization	P-Value
Plant height (cm)	28.5	29.5	0.24
No. of branches plant^{-1}	5.5	7.5	0.03
No. of pods plant^{-1}	19.7	25.6	0.01
Pod yield (kg ha^{-1})	2524	3246	0.03
Haulm yield (kg ha^{-1})	5595	6160	0.11
Shelling (%)	66.06	71.07	0.04
Test weight (g)	37.96	39.20	0.13
Cost of Cultivation (Rs.)	42700	33200	-
Gross Returns (Rs.)	139250	147800	-
Net Returns (Rs.)	96550	114600	-
B: C ratio	2.26	3.45	-
Energy Input (MJ ha^{-1})	15064	14245	-
Energy Output (MJ ha^{-1})	158254	185320	-
Energy Use Efficiency	10.5	13.0	-

Microbial formulations for drought alleviation in Sunflower

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ABSTRACT

An experiment was conducted with 3 microbial formulations (CRIDA resilia 1, CRIDA resilia 2 and one from NBAIM) to alleviate the drought effects on sunflower. Drought affected all the parameters except plant height, leaf number and days to flowering. Seed yield was the most affected with 58% reduction followed by LAI with 52% due to stress. Seed treatment with CRIDA resilia 2 increased seed yield in control by 35% but the same is not effective in ameliorating drought effect.

Keywords: Drought, Microbial formulations, Sunflower

Drought is one of the major factors that limit crop yield. Sunflower, being an all season crop, is subjected to stress at different stages of crop growth. Though use of drought tolerant varieties is the best option, the availability of such varieties is limited. In the recent times number of plant growth promoting soil microorganisms that are beneficial even under drought situations are reportedin different crops (Xuguang Niu *et al* 2018) and also in sunflower (Sandhya *et al* 2009).

An experiment was conducted at Narkhoda farm of ICAR-IIOR during summer 2021-2022 with 2 formulations from CRIDA (CRIDA resilia 1 and 2) and one from ICAR-NBAIM, Mau. CRIDA resilia 1 and 2 are tried as both seed treatment and soil application and combination of both but NBAIM isolate was tried only as seed treatment. A total of 8 treatments were studied including absolute control in 3 replications in split plot design. All the treatments received recommended dose of fertilizers (60:90:30 kg NPK. One set of the crop was subjected to stress from 35 DAS to 75 DAS by withholding irrigation.

There was no difference in days to flowering between control and stress while days harvesting advanced by 10 days. Plant height (2%) and leaf number (1%) are the least affected parameters due to stress but leaf growth in terms of length reduced by 29%, width by 31% and LAI by 52%. Head diameter, TDM and seed weight per plant showed severe reduction (31, 41 and 58% respectively) due to stress but the differences due to treatments is negligible. Seed treatment with CRIDA resilia 2 increased seed yield in control by 35% but not in stress. None of the treatments tried could alleviate the drought effect.

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Identification of sources of resistance to leafhopper (*Amrasca biguttula biguttula*) in sunflower

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ABSTRACT

Among the 135 sunflower lines evaluated during summer, 2020-22, ten lines were confirmed resistant to leafhopper. Leafhopper (*Amrasca biguttula biguttula*) is a major sucking pest that occur mostly in *rabi*/summer season and cause yield loss of up to 40% in India. Chemical control effects pollinators. Host plant resistance is an ecologically and economically promising alternative pest management tool. Presently, none of the available hybrids are leafhopper resistant. Leafhopper resistant cultivars significantly reduces plant protection cost. Stable sources of resistance are needed to be identified to develop resistant cultivars.

MATERIALS AND METHODS

A total of 135 sunflower lines including introgression lines / R gene pool lines (RGP) and high temperature tolerance USDA lines were evaluated during 2020 - 2022 for their reaction to leafhopper. Entries were sown during last week of January with two replications following 60x30cm spacing. Each entry was raised in a single row of 3m length. Test entries were sandwiched between susceptible (Morden/NDCMS-2B/KBSH-44) checks in 2:1 ratio to increase pest load. Leafhopper counts were taken on three leaves (top, middle and bottom) per plant. One week after the peak infestation, injury rating was given on 5 randomly selected plants on 0-5 scale. 0-Free from leafhopper injury; 1-yellowing on leaf edges up to 30%; 2-yellowing and browning up to 40%; 3-yellowing and browning up to 60%; 4-yellowing and browning up to 80%; 5- yellowing and browning of leaves up to 100%. Mean Scale Index (MSI) was calculated and entries were categorized as: Highly resistant (MSI, 0); Resistant (MSI, 0.1-1.0); moderately resistant (MSI, 1.1-2.5); Susceptible (MSI, 2.6-3.5); highly susceptible (MSI, 3.6-5.0).

RESULTS AND DISCUSSION

Leafhopper population was 4.3-20.0/ plant during summer, 2020-22 the highest being on susceptible checks. Seven introgression lines, *viz*., PB-1001, PB-1003, PB-1005, PB-1007, PB- 1008, PB-1014, PB-1019 and one accession, TSG-391 and two RGP lines, RGP-184 and RGP-189 were found consistently resistant to leafhoppers with MSI of 1.0. In the year 2021, 59 (high temperature tolerant and RGP lines), 18 (PI-686681, AMES-31960-6, PI-686489, PI-686651, PI-686521, PI-686550, SEL-1, RGP-195, RGP-189, PI-686504, PS-686739, PI-686808, PI-686800, PI-686490, PI-686833, PI- 686598, PS-686808) were found resistant to leafhopper with a MSI of 1.0. In summer, 2022, among the 53 R gene pool lines, 11 lines *viz*., RGP-162, RGP-172, RGP-178, RGP-186, RGP-200, RGP-201-2, RGP-215, RGP-216, RGP-236, RGP-252, RGP-306 were found resistant to leafhoppers and need confirmation. Susceptible checks showed susceptible reaction in all the years.

Reaction of sunflower lines to leafhopper during summer, 2020-22

ENTRY- Summer, 2020	LH/plant	MSI	Reaction
TSG 391, PB 1001, PB 1003, PB 1005, PB 1007, PB 1008, PB 1014, PB 1019	4.3-11.5	1.0	R
NDCMS-30B, RCR-CMS-104B, PB-1002, PB-1004, PB- 1006, PB-1009, PB-1010, PB-1011, PB-1012, PB-1013, PB-1015, PB-1016, PB-1017	5.3-11.0	1.7-2.3	MR
Morden (Susceptible check)	14.8	3.5	S
NDCMS-2B (Susceptible check)	15.3	3.7	HS
Summer, 2021			
PI-686681, AMES-31960-6, PI-686489, PI-686651, PI-686521, PI-686550, SEL-1, RGP-195, RGP-189, PI-686504, PI-686739, PI-686808, PI- 686800, PI-686490, PI-686833, PI-686598, PI-686808, RGP184	5.2 - 12.5	1.0	R
PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014, PB-1019			
PI-686683, PI-686778, PI-686835, PI-686711, RGP-178, RGP-125, PI-686703, PI-686672, RGP-301, RGP-172, PI-686548, PI-686585, PI- 686680, PI-686641, PI-686750, PI- 686805, PI-686751, PI-686669, PI-686492, PI-686704, PI-686673, PI-686487, PI-686831	4.8 - 13.6	1.2- 2.4	MR
PI-686549, PI-686749, RGP-151, PI-686795, PI-686792, PI-686775, PI-686499, PI-686746, RGP-137, PI-686689, RGP-147	9.6 - 11.6	2.6- 4.0	S
Morden (Susceptible check)	17.3	3.7	S
NDCMS-2B (Susceptible check)	20.0	4.0	S
Summer, 2022			
RGP-162, RGP-172, RGP-178, RGP-184, RGP-186, RGP-189, RGP-200, RGP–201-2, RGP-215, RGP-216, RGP-236, RGP-252, RGP-306	4.5-9.2	1.0	R
RGP-183, RGP-201-1, RGP-164, RGP-198, RGP-171, RGP-134, RGP-167, RGP-189, RGP-195, RGP-240, RGP-307, RGP-301, RGP-161, RGP-238-2, RGP-163, RGP-254, RGP-138, RGP-303, RGP-137	4.0-8.0	1.1-2.5	MR
RGP-140, RGP-147, RGP-111, RGP-151, RGP-302	4.7-7.5	2.7-3.5	S
RGP-160	4.7-10.8	3.8-3.9	HS
KBSH-44 (Susceptible check)	5.3	2.8	S
NDCMS-2B (Susceptible check)	10.8	3.9	HS

LH- Leafhopper/3leaves/plant; MSI- Mean Scale Index; R- Resistant; MR-Moderately resistant; S- Susceptible; HS- Highly susceptible

Evaluation of promising safflower accessions/breeding lines to aphid, *Uroleucon compositae*

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ABSTARCT

Identification of stable resistant sources for aphids is essential for development of aphid resistant safflower cultivars. Among the different lines evaluated, a high oleic acid line, BC_2-F_6-38-9-4-OL was found consistently tolerant to aphid. Another nine accessions were confirmed moderately tolerant.

Keywords: Aphid, Plant tolerance, Safflower

Safflower is one of the healthy and nutritionally rich oilseed crops grown in India. It is grown on residual moisture in *rabi* (winter) season with least application of farm inputs. By decreasing the plant protection cost profitability of the crop, may increase. Aphid susceptible variety may cause a yield loss up to 100%. Therefore, identification of stable sources of tolerance are essential for developing a resistant cultivar.

MATERIAL AND METHODS

Earlier, certain number of germplasm and breeding lines developed at Hyderabad and Solapur were screened under artificial screening method in field during rabi, 2019-20. Among them 17 germplasm accessions and 3 breeding lines with high oleic acid were found tolerant to aphids. All those 20 lines were evaluated for their reaction to aphids during *rabi* season at two locations, Solapur and Hyderabad for two years (2020-22). Susceptible CO-1 variety was raised separately in infester block in November. Test accessions were sown after a month in screening block. When test entries attained stem elongation stage, infester plants were cut and distributed evenly. When susceptible CO-1 was killed, plant injury rating due to aphids was awarded on 5 randomly selected plants in each entry on a 0-5 scale. Further, Aphid Infestation Index was calculated and the entries were categorized.

RESULTS AND DISCUSSION

High oleic acid breeding lines, BC_2-F_6-38-9-4-OL, BC_2-F_6-38-14-15-OL and BC_2-F_6-16-12-OL were found either tolerant or moderately tolerant to aphids in the previous years. These three lines along with 17 other lines were evaluated at Solapur and Hyderabad for two years during *rabi* season. The line, BC_2-F_6-38-9-4-OL was confirmed tolerant to aphids at both the locations in both the years while BC_2-F_6-16-12-OL was found moderately tolerant to aphids. Other lines, BC_2-F_6-16-12-OL, SSF-1860, SAF-1707, SSFG-1818, SF-1910, SF-1910 and have shown either tolerant or moderately tolerant reaction to aphids in both the years. Three accessions, GMU-7943-1, GMU- 7947 and GMU- 7971 were also found tolerant or moderately tolerant to aphids in both the years. Susceptible check, CO-1 has recorded highly susceptible reaction in both locations.

Reaction of promising accessions of safflower to aphids (2020-22)

Entries	2020-21				2021-22			
	A.I.I*		Reaction		A.I.I*		Reaction	
	Solapur	Hyderabad	Solapur	Hyderabad	Solapur	Hyderabad	Solapur	Hyderabad
BC_2-F_6-38-9-4-OL	2.0	2.0	T	T	2.0	2.0	T	T
BC_2-F_6-38-14-15-OL	3.0	2.0	MT	T	3.5	2.5	S	MT
BC_2-F_6-16-12-OL	2.5	2.0	MT	T	3.0	2.5	MT	MT
SSFG-1832	3.0	2.6	MT	MT	3.5	2.6	S	MT
SSF-1896	2.0	2.4	T	MT	3.5	2.6	S	MT
SSF-1860	2.5	2.8	MT	MT	2.5	2.6	MT	MT
SAF-1707	2.5	2.4	MT	MT	2.0	2.7	T	MT
SSFG-1818	2.5	2.2	MT	MT	2.5	2.8	MT	MT
SF-1825	2.0	2.2	T	MT	3.5	2.8	S	MT
SF-1910	2.0	2.0	T	T	2.0	2.8	T	MT
SSF-1911	2.5	2.4	MT	MT	3.0	2.7	MT	MT
GMU-7938	-	2.6	-	MT	3.5	5.0	S	HS
GMU-7943	-	2.3	-	MT	3.5	5.0	S	HS
GMU-7943-1	-	2.4	-	MT	2.0	3.0	T	MT
GMU-7944	-	2.0	-	T	3.0	4.3	S	HS
GMU-7946	-	2.5	-	MT	3.5	4.3	S	HS
GMU-7947	-	2.2	-	MT	2.0	2.9	T	MT
GMU-7948-1	-	2.7	-	MT	3.0	4.8	MT	HS
GMU-7970	-	2.6	-	MT	3.0	4.3	S	HS
GMU-7971	-	2.5	-	MT	2.5	3.0	MT	MT
A-1 (RC)	3.0	3.0	MT	MT	3.0	3.0	MT	MT
CO-1(SC)	4.5	5.0	HS	HS	4.5	5.0	HS	HS

*Aphid Infestation Index; SC-susceptible check; MT-Moderately Tolerant; S – Susceptible; HS-Highly Susceptible

Identification of marker-trait associations for oil content in safflower (*Carthamus tinctorius* L.)

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ABSTRACT

Increasing seed oil content is one of the most important goals in breeding of Safflower (*Carthamus tinctorius* L.). In this study, we identified five marker-trait association and candidate gene (CtDGAT1) showing strong association with oil content in safflower.

Keywords: Genes, Markers, Oil content, Safflower, SSRs

Safflower is one of the most important oil crops worldwide. Oil content is an important trait for safflower breeders in selection of genotypes along with high yield. Little information is available on the application of marker-trait association (MTA) analysis for traits related to oil content in safflower. Association mapping is a powerful tool for the dissection of complex agronomic traits and for the identification of alleles. It is a very efficient and effective method for confirming candidate genes or for identifying new genes. The objectives of this study were to identify marker loci (SSRs) as well as finding candidate genes associated with oil content by using diverse association panel of safflower germplasm lines.

MATERIALS AND METHODS

Safflower association panel consisting of 204 lines were used for the association studies. Phenotypic evaluations were performed at four locations (2 rainfed and 2 irrigated) during 2 years (2016-17, 2017-18). The 250 SSR markers were selected from previous studies which were polymorphic and had high PIC values. Genetic diversity parameters were calculated using PowerMarker version 3.25 (Liu and Muse, 2005). The population genetic structure was studied using Bayesian clustering method implemented in STRUCTURE version 2.3.4 (Pritchard et al., 2000). Mixed linear model (MLM) were applied for assessment of marker-trait associations (MTA) in TASSEL v 5.0 (Bradbury et al., 2007). The association between marker and trait was considered significant at a $P < 0.05$. The phenotypic variation explained by each marker-trait association was studied through correlation coefficient (R^2). For candidate gene association based on sequence homology, putative SNPs/Indels were identified. CLUSTAL W was used for multiple sequence alignment using BioEdit Software version7.0.9.03 and MEGA 7.0 (Tamura et al. 2013) (http://www.megasoftware.net). The gene structures was visualised using the online tool gene structure display server (http://gsds.gao-lab.org/).

RESULTS AND DISCUSSION

Safflower association panel of 204 lines was developed using phenotypic and marker (SSR) data. From phenotypic evaluation across four locations, we found large genetic variation for oil content (20-48%). Association studies was conducted using SSR to identify marker-trait associations controlling oil content in safflower. Safflower germplasm lines were divided into two subpopulations using SSR data with weak population structure. The SSR markers generated a total of 728 alleles and number of alleles ranged from 2-16. The PIC value ranged from 0.15 – 0.74. By using a mixed linear model procedure, we identified five significant marker-trait associations ($P < 0.05$) for oil content i.e., ctdes258, ctdes91, ct102, ct201 and mCtIIOR15. For candidate genes association studies, genes involved in glycerol lipid metabolism, fatty acid biosynthesis and Kennedy pathway were identified and used for further studies. Out of, 20 genes studied, six genes (*CtDGAT1*, *CtPDAT*, *CtFATB*, *CtOleosin4* and *CtOleosin9*) showed nucleotide variation between the set of 20 low and 20 high oil content lines. Sequence analysis clearly indicated two haplotypes for each of these five genes. Allele specific primers were designed for *CtDGAT1*, *CtPDAT* and *CtFATB* genes for trait association. Strong association with one of the alleles of *CtDGAT1* and oil content was observed with an R^2 value of 0.76 in the association panel. The identified and associated markers and genes are expected to be useful in marker-aided selection in safflower breeding programs

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Genetic diversity assessment of linseed (*Linum usitatissimum* L.) germplasm using molecular and morphological markers

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ABSTRACT

From both the morphological and molecular study it can be seen that the genotypes NL 115, TL 16, TL 24, NL 414 and NL 397 were found superior as they possessed high mean for seed yield plant^{-1}, seed yield plot^{-1} and number of capsules plant^{-1}. Thus these genotypes can be used in varietal development programme.

Keywords: Clusters, Diversity, D^2 statistics, Linseed, SSR

Linseed (*Linum usitatissimum* L.) is commonly known as flax. It is third important fiber crop and ranks fifth among oil crops (Deng *et al*., 2011). Linseed oil contains three times as much Omega-3 fatty acid than Omega-6 fatty acid (Lay and Dybing, 1989). Diversity is the basis of selection. It is also required for effective choice of parents for subsequent crossing and selection of the progenies. In the present study, genetic diversity of linseed germplasm is assessed with molecular and morphological characterization which would be helpful in selection of diverse genotypes for flax breeding programme and such lines can be directly used as a variety or as a parent in crossing programme to develop hybrids.

The present research work was carried out during *rabi* 2018-19 at research farm of AICRP on Linseed and Mustard, College of Agriculture, Nagpur and the laboratory facilities for molecular study were utilized from Nuclear Agricultural Biotechnology Division at BARC, Trombay, Mumbai. The material used for the study consisted of 69 germplasm of linseed. The germplasm were raised in randomised block design with two replications. All the recommended package of practices and plant protection measures were taken as per the schedules to raise a healthy crop. Observations were recorded on five randomly selected plants in each replication for 13 different traits. Mahalanobis D^2 statistics were used to analyse the data. For molecular study, out of 69 genotypes, 27 germplasm lines based on phenotypic difference, yield and yield contributing traits and a total of 27 flax SSR primers were used. The dendrogram based on the UPGMA was constructed using Dice coefficient.

Results of molecular study revealed that, the UPGMA analysis distributed the 27 genotypes into 7 clusters with a Dice coefficient ranging from 0.69 to 0.98 and maximum numbers of genotypes (11) were grouped in cluster II. The PIC values calculated for these 14 polymorphic primers were in the range of 0.005 to 0.756. This was supported by the findings of Malge et al (2022) and Saroha et al (2021). Again, the results of morphological diversity analysis based on D^2 statistics divided the 69 genotypes into ten clusters where cluster II was largest comprising of 22 genotypes. Overall study for cluster mean considering all 13 characters indicated that, cluster IV possessed the highest cluster mean for number of primary branches plant^{-1}, 1000 seed weight, seed size, seed yield plant^{-1} and seed yield plot^{-1}. Thus, on the basis of the molecular and morphological studies, it can be concluded that the genotypes NL 115, TL 16, TL 24, NL 414 and NL 397 were found superior as they possessed high mean for seed yield plant^{-1}, seed yield plot^{-1} and number of capsules plant^{-1} and thus can be utilised in varietal development programme.

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Table 1 Grouping of genotypes into different clusters by morphological and molecular markers

Cluster No.	Number of genotypes	Clustering by Tocher’s method (Morphological markers)	Cluster No.	Number of genotypes	Clustering by UPGMA analysis (Molecular markers)
I	20	NL 390, NL 392, NL 394, NL 409, NL 420, NL 413, NL 414, NL 399, NL 408, NL 418, NL 353, NL 385, NL 402, NL 400, NL 375, NL 411, NL 375, NL 417, NL 378, NL 425	I	9	NL 115, NL 353, NL 408, NL 334, NL 374, NL 419, NL 377, TL 16, TL 189
II	22	NL 416, NL 423, NL 383, TL 24, TL 253, T 397, NL 404, NL 398, NL 401, NL 429, Padmini, NL 406, NL 422, NL 424, NL 428, TL 16, TL 189, NL 381, LSL 93, TL 89, NL 382, NL 397	II	11	NL 373, NL 376, NL 402, NL 429, NL 380, NL 428, NL 414, NL 410, TL 253, Padmini, NL 411
III	12	NL 407, NL 427, NL 377, NL 379, NL 334, NL 389, NL 412, NL 396, NL 386, NL 388, NL 380, NL 405	III	1	NL 397
IV	9	NL 391, NL 395, NL 374, NL 339, NL 419, PKV NL 260, NL 410, NL 403, NL 421	IV	2	TL 89, LSL 193
V	1	NL 415	V	1	TL 24
VI	1	NL 384	VI	1	NL 394
VII	1	NL 376	VII	2	NL 417, PKV NL 260
VIII	1	NL 387			
IX	1	NL 426			
X	1	NL 115			

Status quo of insect pests – a decade of survey in Groundnut ecosystem

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ABSTRACT

Groundnut, *Arachis hypogea* L. is an important oilseed crop and the insecticides to manage these pests increase the plant protection cost much if not taken at right time and also result in ecological imbalance. In order to minimize the cost of management and economic sustainability, real time management of the pests is the need of the hour. In this regard, monitoring of incidence of insect pests in groundnut ecosystem was carried out at Main Agricultural Research Station, University of Agricultural Sciences, Raichur, Karnataka for a period for over a decade (2012-2022). The pooled data showed that the maximum damage by *Spodoptera litura* Fab, and leaf miner was noticed during 45-75 days of crop growth wherein, spodoptera damage ranged from 10-25 percent while, the leafminer damage ranged from 5-20 percent. However, there was negligible damage by *Helicoverpa armigera* Hubner. Meanwhile, The leafhopper activity started from 35^{th} standard week and the peak activity was noticed at the 43^{rd} standard week with a foliage damage of 10-15 per cent which continued up to 45^{th} standard week. Later on, the per cent foliage damage due to leafhopper gradually declined. Similarly, the peak activity of thrips was noticed during 40^{th} standard week (4.0/ terminal bud) which continued till 43^{th} standard week and thereafter the population declined.

Keywords: *Arachis hypogea* L., Groundnut, Real-time pest management

Groundnut, *Arachis hypogea* L. is an important oilseed crop and the yield of which is bothered by some of the severe pests attacking it. The low productivity hurdles comprises of number of components specially the pest management in Groundnut ecosystem. The major pests *viz.*, *Spodoptera*, Leafminer and thrips cause economic loss and thrips also act as vector of peanut bud necrosis disease which may account cent percent yield loss if not managed timely. However, much chemical insecticides are used by the farmers to manage these pests which increase the cost of management and also result in ecological imbalance (Ghewande and Nandagopal, 1997 Ghewande and Mishra, 1986). In this regard, incidence of pests in groundnut ecosystem was recorded at three different stages of the crop at Main Agricultural Research Station, University of Agricultural Sciences, Raichur, Karnataka for a period of ten years (2012-2022).

MATERIAL AND METHODS

Field experiment on recording incidence of insect pests on groundnut was carried out for ten years (2012-2022) at Main Agricultural Research Station, Raichur. A set survey procedure was followed wherein the basic information on crop/pests/natural enemies were recorded along with the package of practices followed by farmers and correlated with insect-pest incidence. A minimum of three observations on insect pest's incidence were recorded at three different stages of the crop (vegetative, pod formation and maturity stages) both on research farm and farmer's fields.

RESULTS AND DISCUSSIONS

The leafhopper activity started from 35^{th} standard week and the peak activity was noticed at the 43^{rd} standard week with a foliage damage of 10-15 per cent which continued up to 45^{th} standard week. Later on, the per cent foliage damage due to leafhopper gradually declined. Similarly, the peak activity of thrips was noticed during 40^{th} standard week (4.0/ terminal bud) which continued till 43^{th} standard week and thereafter the population declined. The maximum damage by *Spodoptera litura* Fab, and leaf miner was noticed during 45-75 days of crop growth wherein, spodoptera damage ranged from 10-25 percent while, the leafminer damage ranged from 5-20 percent. However, there was negligible damage by *Helicoverpa armigera* Hubner. Meanwhile, the incidence of insect-pest of on farmers' field during *Kharif* indicated moderate incidence of leafhoppers (1.2 to 5.8/top three leaves) while higher incidence of thrips (2.6 to 5.2/ terminal bud) was noticed during vegetative and pod formation stages. The percent foliage damage due to *Spodoptera* ranged from 10 to 30 per cent while leaflet damage due to leaf miner ranged from 10 to 20 per cent during pod formation stage (Figure 1). Further, the activity of thrips was noticed from first week of August to fourth week of October with peak population during second fortnight of August and first fortnight of September. Among the different species of thrips, *Thrips palmi* Karny and *Frankliniella schultzei* Trybom were predominant.

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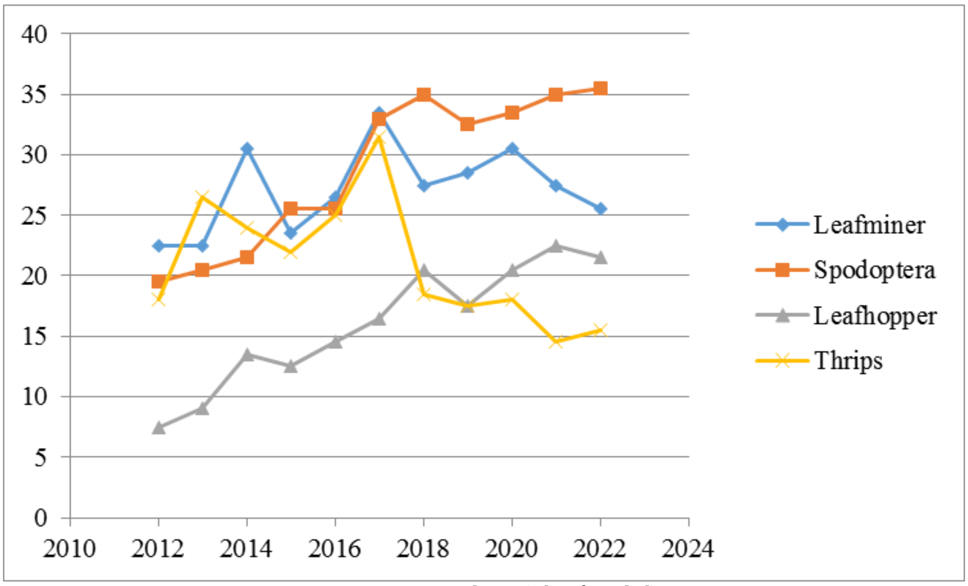

Fig 1: Percent incidence (Kharif-pooled)

Potential and promotion of *Rabi* castor cultivation through drip-fertigation in southern India

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ABSTRACT

Raising castor during winter (*rabi)* season with assured drip-irrigation using hybrids is a new dimension with promise that provides greater stability and higher productivity and avoids many problems of *kharif* castor. It is prudent to expand castor during *rabi* with limited irrigations in southern India especially in Telangana, Andhra Pradesh and parts of Tamil Nadu.

Keywords: Drip-fertigation, *Rabi* castor

The productivity of castor during *kharif* season is low in the southern states *viz.*, Telangana, Andhra Pradesh and TamilNadu and it varies from 311-568 kg/ha depending on rainfall pattern. It is far below than that of Gujarat, Rajasthan (2000kg/ha) which is mainly due to differences in several edaphic, abiotic and biotic reasons. There is an urgent need to bridge the yield gap between two agro-ecosystems which requires specific technologies different for these two situations for sustainability.

MATERIAL AND METHODS

The study was carried out during 2017-18 in association with DAC-NMOOP, mainly to demonstrate the productivity potential and profitability of best management practices (BMPs) of *rabi* castor including drip-fertigation in potential districts of southern India. A total of 50 demonstrations with hybrids, BMPs and drip-fertigation were conducted in Telangana (Ranga Reddy, Mahabubnagar distrcts) and Andhra Pradesh (Ananthapuramu district) and about 75 demonstrations were conducted in the non-traditional districts *viz.*, Perambalur, Villupuram and parts of Salem. The supporting training was arranged in association with TCRS, Yethapur and RDT, Ananthapuramu in A.P for the benefit of farmers, Agriculture department and KVK staff. Critical inputs *viz.*, quality hybrid seeds (YRCH-1 and DCH-519) ; seed treatment chemicals *viz.*, water soluble fertilizers for drip fertigation ; yellow sticky traps ;; secateurs for harvesting were supplied.

RESULTS AND DISCUSSION

During the study period, in Tamil Nadu, castor was found highly profitable over competing cotton and maize crops. With adaptation BMPs and/under drip system very high yield and profits were realized.

During the year the competing crops like cotton was severely affected by pink boll worm and higher infestation of wilt and discoloration of lint owing to higher monsoonal rainfall, which resulted in poor market price (Rs.4500/q). In Koklai village of Namakkal dist, TN drip-fertigation resulted in enhanced castor (YRCH-1) seed yield (3312 kg/ha) over flood irrigation (2340 kg/ha) with saving of 30% irrigation. Blackgram (VBN-6) as intercrop in between castor (DCH-519) rows at 150 cm resulted in additional yield of 943 kg/ha and additional returns of Rs.51,837/ha in Namakkal district. Highly promising castor production in Anantapuramu district of Andhra Pradesh (average 13-17 q/ha) with clear surge in demand for castor expansion and seed requirement was noticed. A clear trend of crop diversification from groundnut with scope for castor + groundnut intercropping and other intercrops was noticed.

Status of Stem Rot Incidence of Groundnut Caused by *Sclerotium rolfsii* in Northern Eastern Karnataka

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ABSTRACT

Groundnut is regarded as “King of oilseed crops” on account of its diversified uses. It’s productivity is challenged by several biotic and abiotic stresses. *Sclerotium rolfsii* Sacc. is one of the major constraints to groundnut production which causes a yield loss of about 25 – 80 %. Hence, the roving survey was conducted during *Kharif* 2021 in North-Eastern Karnataka region. The mean stem rot incidence among the different districts surveyed ranged between 18.89-36.28 per cent. The maximum stem rot incidence was recorded in Vijayanagar (36.28 %) followed by Ballari district (32.83 %). Whereas, minimum stem rot was recorded in Koppal district (18.89 %).

Groundnut (*Arachis hypogaea* L.) is an important edible oil seed crop. India is pioneer in both area and production of groundnut in the world. Due to its extensive cultivation, different biotic and abiotic factors have emerged as a major constraint in the successful cultivation of groundnut. Among the biotic factors, *Sclerotium rolfsii* Sacc. is emerging as a major problem and has become an economically important soil borne pathogen. During the recent years this disease has caused significant losses in groundnut growing areas of Karnataka. Hence, the present study was conducted with an objective to study the status of stem rot incidence in North Eastern Karnataka during *kharif* 2021-22.

MATERIAL METHODS

An intensive roving survey was carried out during *Kharif* 2021 to assess the stem rot incidence in major groundnut growing districts of North Easterm Karnataka, *viz*., Raichur, Ballari, Yadgir, Koppal and Vijayanagara. Further, among each district, three taluks were selected and in each taluk two villages along with 2-3 groundnut plots were surveyed. The survey was carried out during 90 to 110 days old crop stage. The disease incidence was assessed by selecting 50 plants randomly and counting the number of plants showing stem rot symptoms in the field. The per cent incidence of disease at each location was calculated The per cent stem rot incidence was calculated by using following formula.

$$\text{Per cent disease incidence (\%)} = \frac{\text{Number of plants infected}}{\text{Total number of plants examined}} \times 100$$

RESULT AND DISCUSSION

In the present study, stem rot incidence was observed in all the fields during the survey conducted. The overall mean stem rot incidence among the different districts ranged between 18.89-36.28 per cent. The maximum mean stem rot incidence was recorded in Vijayanagar district, which ranged from 29.33 (Nagenahalli village) to 44.66 per cent (Gudekota village) with the mean incidence of 36.28 per cent. This was followed by Ballari district. Here the stem rot incidence ranged from 27.00 (Araliaganur village) to 38.33 per cent (Ramasagara village) with 32.83 per cent mean incidence. In Koppal district the disease incidence ranged from 14.00 (Agoli village) to 23.33 per cent (Hosur village) with mean stem rot incidence of 18.89 per cent.

Thus, data with respect to stem rot incidence in different locations revealed that, *S. rolfsii* is a persistent soil borne disease and the stem rot incidence varies from locality to locality because of conducive weather parameters (temperature, relative humidity, rainfall and cultivars grown), cropping pattern, stage of the crop, cultural practices followed and continuous cultivation of susceptible cultivars over the years. Continuous cultivation of susceptible cultivars over the years increases the inoculum level and become a cause for increasing stem rot incidence day by day. Similar reports were provided by (Kulkarni, 2007; Reddy *et al*. 2020 and Palaiah *et al*. 2019) who reported that continuously growing of any crop over the course of many seasons and years will increase the inoculum level to the point where the epidemic becomes a common occurrence.

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A perspective on linseed breeding and varietal development in India

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ABSTRACT

Linseed (*Linum usitatissimum* L.) is a traditional oilseed crop of India that represents a valuable alternative for cropping systems because of the high quality of the seed oil, which is being increasingly appreciated by consumers, food, cosmetic and eco-materials and industries. The aim of this study was to understand the linseed breeding and varietal development in India in the past to till now. Linseed is also grown in as many as 70 countries across the globe. Several varieties having high seed yield, oil content, Alpha linoleic acid (omega-3 fatty acid), seed colour, size and colour and resistance to wilt, powdery mildew, Alternaria blight and rust and few insect pests like budfly and *Spodoptera* have been developed globally. Even, to develop edible grade low (<5%) ALA lines like Solin in Australia and TL 99 in India have also been developed. However, a comprehensive analysis and historic review of the linseed varieties released in India and breeding methods employed in developing them has not been attempted so far. Hence, this paper aims at bringing out the historical fact on number of linseed varieties released and notified in India along with the breeding methods employed so that suitable breeding strategy can be formulated in improving production and productivity of linseed in India.

Keywords: Breeding methods, Linseed, Varieties

Linseed or seed flax (*Linum usitatissimum*) is one of the oldest cultivated crops grown for seed and fibre. In India, it is grown mainly for seed to extract oil. Cultivated annual linseed probably originated from India, Ethiopia or Iran. Major producers are Canada, Argentina, USA, Poland, Uruguay, Romania, Ethiopia, USSR, China and India. In many European countries, it is mostly grown for fibre. In the USSR, it is grown for seed and in America there is a shift from seed to fibre. In almost all the African countries, it is largely grown for seed. In the recent past, in almost all the countries, there is a shift in linseed cultivation from fibre to seed because of its health and nutraceutical properties.

MATERIALS AND METHODS

The material comprised of primary and secondary data accessed through seednet portal of DAC (https://seednet.gov.in) and the data obtained from different AICRP-Linseed centres. The varieties released and notified by different centres under a State Agricultural University (SAU) is traced and arranged chronologically. The list of varieties released by a state but not notified were also traced based on the available data in the seednet portal (https:// seednet.gov.in/Material/Variety.htm) and confirmed. The number of varieties released by each centre were arrived based on the above data and tabulated. The breeding methods employed while developing each of these varieties were also compiled and tabulated (data not shown).

RESULTS AND DISCUSSION

Linseed is a self-pollinated crop and its genetic improvement has so far been carried out through conventional breeding methods mainly of selection and hybridisation (Duk et al. 2021). High yielding exotic types from Afghanistan, Argentina, Australia, Canada, France, Germany, the Netherlands, Sweden, and the USA and the USSR were introduced by different research institutions of linseed growing states. However, few promising selections for different traits could be made from these germplasm. For these reasons, mass- selection from the introduced material could not be successfully employed. Pure-line selection was used in the earlier stages of linseed improvement in India. Almost all the cultivars developed up to 1940 were pureline selections and cultivars, ‘NP-12’, ‘NP-121’ and ‘NP-124’ were developed using this method and were popular in northern states and spread to other states during these periods. Few other varieties developed using this method include ‘T-1’ in Uttar Pradesh; ‘B-67’ and ‘B-96’ in West Bengal; and ‘S-48’ in Karnataka.

Perusal of the breeding methods employed in India in developing linseed varieties from 1975 onwards indicated that hybridization followed by selection had been practiced mostly. Pedigree breeding has been the predominant breeding method adopted and sparingly its modifications (bulk pedigree) have been followed by various linseed breeders. Altogether, out of 93 linseed varieties, 39 were selections from germplasm either local or exotic or cross derivatives involving germplasm as one or both parents. Multi-parent derivatives were 11 and the rest were inter-varietal crosses. Identification of suitable trait specific and diverse germplasm and multi-parent crossing is recommended for further broadening the genetic base of the crop.

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Agribusiness incubation in niger growing tribal FPOs in Andhra Pradesh

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INTRODUCTION

The area under Niger witnessed a reduction from around 8000 ha in 2012-13 to 3729 ha in 2021-22 in Andhra Pradesh. Sustaining and enhancing the area, production and productivity of Niger will enhance the house hold food security and income security of small and marginal tribal households. Hence a study has been undertaken in High Altitude and Tribal Zone (HAT) of Andhra Pradesh with the objective to explore the possibilities of FPO's in orienting thier activities towards Niger cultivation, value addtion, branding and marketing of the Niger oil.

METHODOLOGY

The *modus operandi* for achieving self sustained processing units of Niger oil in the form of a producer company in the operational areas of the FPOs in HAT Zone of Andhra Pradesh is presented here under.

This will help to reorient the functional FPO's in the vicinity towards Niger cultivation on a wider scale. Also for capacity building in processing, packaging and marketing of the Niger oil for culinary purpose.

In addition, Regional Agricultural Research Station, Chintapalli under Acharya N.G.Ranga Agricultural University is doing research activities for improvement of the varietal performance of the Niger crop a traditional oilseed cultivated by local tribal farmers.The improved cultivars will be shared with FPOs in the vicinity for the proposed value addtion, branding and marketing of the Niger oil for culinary purpose.

RESULTS AND DISCUSSION

The hypothetical value chain anticipated to be created is presented here under.

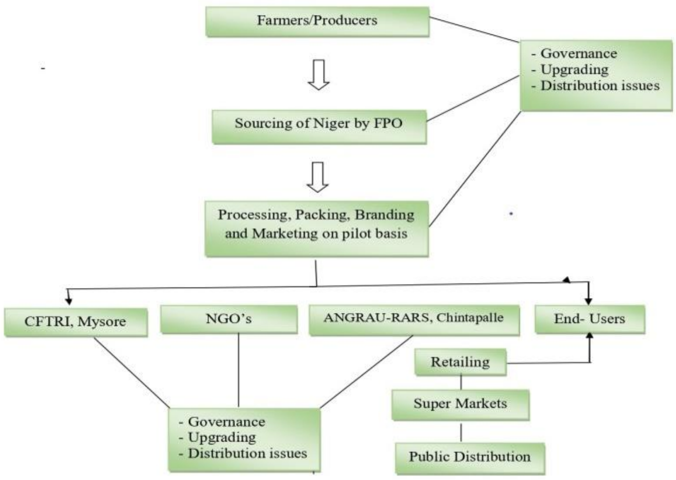

Fig 1: Hypothetical Value Chain proposed for Niger growing tribal farmers in A.P

Online platform

For greater marketing opportunities of Niger based culinary oil, suppy of Niger seed for household ornamental pots and agro-tourism purpose an online platform can be created in any of the e commerce websites like Amazon, flipkart *etc*. The following are the steps to create a online sales point with anticipated hurdles in creating such market linkage.

Out comes

The demand for healthy culinary oil in the niche markets and availability of local sources of culinary oi for public distribution and government consumption like hostels will enable proposed incubation much cost effective:

Raise in the per capita income of the tribal member farmers of the FPO

Nutritional security for the tribal producer households

Raise in the per capita fat consumption with highest linoleic acid content andhence better health out comes

Relevance/practical utility for small farmers

Agri business incubation in tribal populations in Visakhapatnam District

Entrepreneurship development in tribal farmers of Visakhapatnam district there by creating sustainable livelihoods resulting in socio economic development of tribals farmers.

To increase the absolute income of the poor in the value chain

To sustain the relative income of the poor in the value chain

Four aspects of Value chain Analysis are Systematic Mapping of the actors,

Identification ofthe distribution of benefits, examining the role of upgradation i.e. making the product attractive for all sorts of consumers i.e., wider market. Coverage and finally the role of governance/ Institutional linkages required for theScaling up of the proposed project.

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Table 1. Work plan for agri business incubation of Niger growing tribal farmers in A.P

Activity	Direct Output	Target
Capacity building of the FPO members and their orientation towards establishing Niger processing units	Well distributed Niger processing units in the operational area of theFPO	Involving 3000 membersof the FPO in Niger oilseed processing
Capacity building of the FPO members and their orientation towards Niger crop production	Attaining requisiteNiger seed harvest	Involving 3000 membersof the FPO in Niger oilseed production
Packaging and market linkage of the brandedNiger oil product	Branded Niger oil product available inthe market	Self sustained processingunits of Niger oil in the form of a producer company in the operational area of the Proposed FPO

Assessment of inter-relationships between yield and yield attributes in safflower *(Carthamus tinctorius* L.*)*

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ABSTRACT

Character association studies in 29 genotypes of safflower for seven characters conducted at Agricultural Research Station, Tandur revealed significant positive association of single plant yield with test weight, number of effective capitula per plant, plant height and number of seeds per capitulum. Estimates of direct and indirect effects of component characters on single plant yield at genotypic level revealed that test weight contributed for maximum positive direct effect on single plant yield followed by days to maturity, plant height and number of seeds per capitulum. Also, these traits had positive and significant association with grain yield. Critical analysis of character association and path analysis showed that these characters should be given importance to isolate superior lines with genetic potentiality for high grain yield.

Keywords: Inter-relationships, Path analysis, Safflower, Yield attributes

Safflower, a multipurpose crop, was grown for centuries in India for its healthy oil rich in polyunsaturated fatty acids (linoleic acid 78%). Traditionally, this crop was also grown for its flowers having orange-red dye (carthamin) extracted from its brilliantly coloured flowers which was used as fabric dye and food colouring. Safflower is also cultivated since decades for its medicinal uses.

Seed yield, is a complex character. It is cumulative and interactive effect of a number of component traits. Direct selection for yield *per se* results in low genetic gain due to its low heritability, dictating plant breeders to realize the importance of component traits. A sound knowledge of character association forms an integral part of a programme for making improvement in complex characters like yield. Genotypic correlations reveal the existence of real associations, whereas the phenotypic correlations may occur by chance.

Correlation between different characters is important in planning selection programmes. But the correlation coefficients only denote the total association existing between a pair of characters which themselves are the result of the interaction between various features of the plant. But a dependent character is an interaction production of many mutually associated component characters and change in any one component will disturb the whole network of cause and effect system. The path coefficient analysis (Wright, 1921) takes into account the cause and effect relation between the variables and is unique in partitioning the association into direct and indirect effects through other independent variables. The path coefficient analysis also measures the relative importance of causal factors involved.

MATERIALS AND METHODS

The experimental material comprised of twenty-nine genotypes of Safflower (*Carthamus tinctorius* L.) grown in Randomized Block Design at Agricultural Research Station, Tandur, Vikarabad Dist Telangana, India, during *Rabi*, 2021-2022. Observations on seven different quantitative characters *viz.*, days to 50% flowering, days to maturity, plant height, number of effective capitula per plant, number of seeds per capitulum, test weight and single plant yield were recorded. Correlation coefficients were calculated at genotypic level using the formulae suggested by Falconer (1964). Path coefficient analysis, suggested by Wright (1921) and elaborated by Dewey & Lu (1959), was used to calculate the direct and indirect contribution of various traits to yield. For statistical analysis, OPstat online version software package was used.

RESULTS AND DISCUSSION

Correlation studies: The character test weight (0.950) followed by number of effective capitula per plant (0.652), plant height (0.519) and number of seeds per capitulum (0.320) manifested significant and positive correlation with single plant yield at genotypic level. The association of plant height with number of effective capitula (0.238), number of seeds per capitulum (0.476) and plant yield (0.519) was positive and significant. Its correlation with test weight (0.102) was positive and non-significant. Number of effective capitula per plant recorded positive and significant relationship with test weight (0.741) and plant yield (0.652).

Single plant yield exhibited highest significant positive genotypic association with test weight, number of effective capitula per plant, plant height and number of seeds per capitulum. These results are in conformity with the results of Vinod Kumar and Rajesh Patil (2020). Jadhav et al (2018) reported significant and positive correlation of seed yield with number of effective capitula per plant and test weight. These results are also in conformity with those of Shivani et al (2010) and Mohtasham et al (2012).

Hence, it can be inferred that selection based on any one of these traits either alone or in combination, will result in identifying high yielding strains. Days to 50% flowering and days to maturity had negative and non-significant association with grain yield. So, selection for that trait may not be rewarding for yield enhancement.

Path co-efficient analysis: The study on direct and indirect effects of component characters on single plant yield at genotypic level revealed that, various yield related traits influenced the yield not only through their direct effects but also through indirect contributions. The character, test weight (1.291) recorded the highest direct effect on single plant yield followed by days to maturity (0.877), plant height (0.360) and number of seeds per capitulum (0.157). Significant direct effect of days to 50% flowering (-1.131) was observed on seed yield. Several characters viz., days to 50% flowering, days to maturity, plant height and number of effective capitula per plant contributed indirectly through test weight. The pronounced positive direct effect of test weight was also reported by Vinod Kumar and Rajesh Patil (2020), Pushpavalli and Kumar (2017) and Mohammed and Elmogtaba (2018).

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Table 2. Estimates of Genotypic (G) direct (diagonal and bold) and indirect (non diagonal) effects of component characters on seed yield in Safflower genotypes

Characters	Days to 50% Flowering	Days to Maturity	Plant Height	Number of effective capitula/ Plant	Number of Seeds / Capitulum	Test Weight (g)
Days to 50% Flowering	-1.131	0.877	-0.088	0.129	-0.043	0.138
Days to Maturity	-1.131	0.877	-0.088	0.129	-0.043	0.138
Plant Height	0.276	-0.213	0.360	-0.109	0.075	0.132
Number of Effective capitula / Plant	0.318	-0.246	0.086	-0.458	-0.003	0.957
Number of Seeds / Capitulum	0.309	-0.240	0.171	0.010	0.157	-0.088
Test Weight (g)	-0.121	0.094	0.037	-0.340	-0.010	1.291

*Significance at 5% level, ** Significance at 1% level

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Test Weight (g)	-0.121	0.094	0.037	-0.340	-0.010	1.291

FLDs on need based plant protection in oilseeds: impact in enhancing productivity and profitability under farmers' conditions

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ABSTRACT

Frontline demonstrations in oilseed crops were conducted on farmers' fields in different agro-ecological situations on need based plant protection during 2015-16 to 2021-22 to show the productivity potential and profitability of Improved Technologies (IT). The results indicated that, the IT plots recorded higher mean seed yield, gross returns, additional net returns and B:C ratio than the farmers' practice plots indicating the technical and economic feasibility of IT. To speed up the dissemination of plant protection technologies and scale-up the demonstrations, partnerships between extension agencies, state departments of agriculture and input agencies, must be established.

Keywords: FLDs, Improved technology, Pests and diseases, Partial budgeting technique

The major factors affecting the productivity of oilseeds are biotic and abiotic stresses. Among biotic constraints for oilseeds production, insect pests and diseases are of major concern causing severe losses at different growth stages. Vulnerability of majority of the cultivars of oilseed crops to insect pests and diseases continues to be one of the major factors responsible for the lower productivity and wider fluctuations in production (Rabindra *et al*., 2007).

The continuous cultivation of oilseed crops without proper crop rotation has led to depletion of soil nutrients as well as increase in pest and disease incidence causing upto 40% yield loss (Gowda *et a1*. 2007). FLDs conducted on need based plant protection in oilseeds recorded mean productivity improvement of 36% and 23% and ANR of Rs. 7222 ha^{-1} and Rs. 6372 ha^{-1} under rainfed and irrigated conditions respectively as compared to FP plots (Kumar *et al*., 2014).

Several technologies and management options have been developed by the respective All India Coordinated Research Projects (AICRP) on oilseed crops, that can significantly reduce the losses due to insect pests and diseases, but adoption of these technologies by farmers has been far less than anticipated. Realizing the importance of extending these technologies for managing insect pests and diseases in oilseed crops at farmers' level, frontline demonstrations (FLDs) were conducted to show the productivity potential and profitability of need based plant protection.

MATERIALS AND METHODS

The improved technology (IT) i.e. need based plant protection included seed treatment with pesticides (insecticides and fungicides) and prophylactic sprays (biological or chemical) and spray of safer pesticides as and when required based on the nature of the pest and its damage symptoms. The IT was demonstrated on 0.40 ha plot in comparison with farmers' practice (FP) of no spraying/indiscriminate use of pesticides, in order to provide farmers an opportunity to compare, evaluate and choose themselves the best practice based on their own criteria. The pests and diseases targeted were shoot webber and capsule borer and powdery mildew in sesame, safflower (aphids and alternaria leaf spot), sunflower (leaf hoppers, thrips and whitefly, powdery mildew and alternaria leaf spot in rabi irrigated conditions), castor (semilooper, capsule borer and wilt) and mustard (mustard aphid, painted bug and powdery mildew).The FLDs conducted on five oilseed crops at various locations in India during 2015-2022 were considered for analysis. A total of 401 FLDs were conducted to demonstrate the potential benefits of IT.

Partial budgeting technique (Birthal, 2003) was used to estimate additional net returns and benefit cost ratio (B:C ratio) of the demonstrations. The technology is economically feasible, if the profits are higher compared to those of farmers' practice.

RESULTS AND DISCUSSION

The results indicated that, IT plots recorded mean productivity improvement in the range of 13.7% to 45.9% compared to FP plots. Highest increase in the mean productivity was observed in safflower (45.9%) followed by sesame (45.1%), mustard (33.7%), sunflower (17.0%) & least increase was observed in castor (13.7%) (Table 1).

The cost of cultivation increased by 9.21% with IT (Rs. 23469 ha^{-1}) compared to FP (Rs. 21489 ha^{-1}). But, the Gross monetary returns (GMR) increased by 27.4% with IT (Rs. 69199 ha^{-1}) as compared to FP (Rs. 54327 ha^{-1}) indicating the importance of need based plant protection under rainfed conditions. The higher GMR realized by the farmers indicated the economic feasibility of the technology. The additional net return (ANR), which is a true indicator of economic worth of the practice was Rs. 12892 ha^{-1}. The benefit cost ratio was 2.95 in IT and 2.53 in FP (Table 1).

The FLDs have shown the potential of IT (need based plant protection) to step up the productivity significantly by reducing losses due to insect pests and diseases and increasing the income of farmers. Low adoption of insect pest and disease management by farmers was reported in groundnut (Kumar and Jain, 2011). Medium to high resource use management was observed for insect pests and disease management in castor (Venkattakumar et al., 2012).

To speed up the dissemination of plant protection technologies and scale-up the demonstrations, partnerships between extension agencies, state departments of agriculture and input agencies, must be established. A multifaceted approach to farmers' education on identifying the damage symptoms of various insect pests and diseases of oilseed crops, identifying the suitable time and stage of the crop for taking control measures and ensuring timely availability of quality inputs/ chemicals and biologicals will benefit the farmers in minimizing the losses from pests and diseases and enhancing the productivity of oilseeds.

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Table 1. Productivity potential and profitability of FLDs on need based plant protection

Crop	No. of FLDs conducted	Mean Seed Yield (kg/ha)		Increase over FP (%)	CoC (Rs/ha)		Increase over FP (%)	GMR (Rs/ha)		Increase over FP (%)	ANR (Rs/ha)	B:C ratio	
		IT	FP		IT	FP		IT	FP			IT	FP
Sesame (Five years)	76	531	366	45.1	17871	16222	10.2	40670	28315	43.6	10706	2.28	1.75
Safflower (Three years)	96	958	657	45.8	20794	17540	18.6	48056	33364	44.0	11438	2.31	1.90
Sunflower (Two years)	62	2159	1846	17.0	27368	27225	0.5	122916	104987	17.1	17786	4.49	3.86
Castor (Two years)	127	766	674	13.7	17592	17002	3.5	33455	29353	14.0	3511	1.90	1.73
Mustard (One year)	40	1571	1175	33.7	33719	29456	14.5	100898	75615	33.4	21020	2.99	2.57
Mean	**401**	**1197**	**943**	**26.9**	**23469**	**21489**	**9.2**	**69199**	**54327**	**27.4**	**12892**	**2.95**	**2.53**

IT-Improved Technology, FP-Farmer practice, CoC – Cost of cultivation, GMR - Gross Monetory Returns, ANR - Annual Net Returns, B;C ratio - Benefit cost ratio

Effect of the growth and yield attributes of sunflower and chickpea with response to different doses and methods of Phosphorus Solubilizing Bacteria in combination with different Phosphorus levels

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ABSTRACT

A study was conducted on sunflower and chickpea in sandy loam soils during *Rabi* 2020 at PJTSAU, Rajendranagar, Hyderabad. This study was focused to know the response of the liquid and powdered PSB on growth and yield attributes of sunflower and chickpea. For this experiment the treatment combination includes, different methods (liquid and powdered) and doses (@ 3 and 6 kg ha^{-1} for soil application and 50 ml L^{-1} for drenching) of Phosphorus Solubilizing Bacteria (PSB) along with different phosphorus levels. Phosphorus plays a key role in photosynthesis, metabolism of sugars, energy storage and transfer, cell division, cell enlargement and transfer of genetic information. Inoculation with PSB known to produce the growth hormones like Indole - Acetic Acid and Gibberillic Acid which might favour to increase plant height. The results reported that there was a significant effect of PSB on the plant height, Head diameter, number of pods/plant and non-significant effect on plant stand and test weight. Among, all the treatments the highest plant height (124.33 cm) and head diameter (16.23 cm) at maturity stage in sunflower was seen with 75% P + PSB @ 6 kg/ha and the highest plant height (51.13 cm) and number of pods/plant (26.07) at maturity stage in chickpea was seen with 50% P+ PSB @ 6 kg/ha. There was a non significant effect of PSB on plant stand and test weight. With the application of the PSB there was a reduction of the application of the phosphorus fertilizer to the extent of 25% in sunflower and 50% in chickpea.

Keywords: Drenching, Plant height, Soil application, Test weight

India is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural economy of the country. Oilseeds are among the major crops that are grown in the country apart from cereals. Sunflower is one of the oil seed crop in India. It is a potential source of high quality edible oil, ranges second next to soybean. India during yasangi (rabi) 2020-21 sunflower crop has occupied 1.041 lakh hectares (2.572 lakh acres) as against 1.050 lakh ha (2.595 lakh acres) during the same period in 2019-20. In Telangana state, yasangi (rabi) 2020-21area covered under sunflower was about 7,596 ha (18,770 acres). Chickpea is one of the major rabi pulse crop. Among, the pulses chickpea is known as “King of Pulses”. In Telangana the area contribution for chickpea was 1.03 lakh hectares.

Phosphorus (P) is one of the essential elements that are necessary for plant development and growth; it makes up about 0.2% of a plant’s dry weight. It is second only to nitrogen among mineral nutrients most commonly limiting the growth of crops. On average, the phosphorus content of soil is about 0.05% (w/w); however, only 0.1% of this phosphorus is available for plant use (Zhu *et al.*, 2011). Traditionally, the challenge of soil phosphorus deficiency is addressed by the application of phosphorus fertilizers. However, the majority of the applied fertilizer phosphorus is not available to plants and the addition of inorganic fertilizers in excess of the amount that is commonly employed to overcome this effect can lead to environmental problems.

Phopshorus Solubilizing Bacteria (PSB) play an important role in enhancing phosphorus availability to plants by lowering soil pH and by microbial production of organic acids and mineralization of organic phosphorus. Introduction of PSB in the rhizosphere of crop also increases the efficiency of the phosphate fertilizer.Thus adopting proper nutrient management practices in conjugation with PSB will help and improve the yield and quality of chickpea besides maintaining the soil fertility. (Singh and Singh, 2014).

MATERIAL AND METHODS

The experiment was laid out in Randomized Block Design with three replications. There were totally eleven treatment, which were randomly allotted.
Treatment detail of both sunflower and chickpea

Treatment	Treatment detail
T1	N100P100K100
T2	N100P0K100
T3	N100P0K100 + PSB-D
T4	N100P0K100+PSB-SA1
T5	N100P0K100+ PSB-SA2
T6	N100P75K100 + PSB-D
T7	N100P75K100+ PSB-SA1
T8	N100P75K100 + PSB-SA2
T9	N100P50K100 + PSB-D
T10	N100P50K100+ PSB-SA1
T11	N100P50K100 + PSB-SA2

The growth attributes like plant height of sunflower and chickpea was measured by using the scale.

Yield attributes:

Dry matter production: Ten plants were uprooted from each plot at each stage. They were shade dried by removing root portion from each plant and later oven dried at 65º C till constant weight was observed.

Head diameter: At grain filling stage the diameter of head was measured with the help of thread which was placed on the scale and reading was noted.

No. of pods per plant: At pod filling stage the no. of pods from tagged ten plants were counted from each plot and readings were taken and average is calculated for each plot.

RESULTS AND DISCUSSION

Plant Height: There was a significant increase in the plant height (cm) with the increase in the phosphorus level up to 75% level. Among all the treatments T_{10} (116 cm) *i.e.*, 50% P+ PSB-SA_1 was at par with the T_1 (115.8 cm) *i.e.*, 100% NPK. Inoculation of PSB also known to produce growth hormone like Indole- Acetic Acid and Gibberillic Acid might also favour to increase plant height. Zafar *et al*. (2011).

There was a significant increase in plant height (cm) of chickpea with the increase in phosphorus up to 50% level. . The increase in growth might be due to the enhanced photosynthetic efficiency. Inoculation of PSB which are known to produce growth hormones are likely to favour increased plant height.

Yield Attributes: There was a significant increase in the head diameter of sunflower with PSB application and P levels. The head diameter of sunflower at crop maturity varied from (8.73 to 16.23 cm). Among, all the treatments highest head diameter (16.23 cm) was obtained in T8 and the lowest head diameter (8.73 cm) was noticed in T2.

The data reported that there was a significant increase in the number of pods/plant due to PSB application and P levels. Number of pods/plant at maturity stage usually ranges from (13.4 to 26.07). Among all the treatments, highest number of pods /plant (26.07) was observed in and the lowest number of pods /plant (13.40) was observed in T2.

Dry matter Production:

Sunflower: Application of PSB as soil application with increasing level of phosphorus showed significant increase in dry matter production compared to drenching of PSB, and produced a significant increase in dry matter production against the 100% NPK. Highest dry matter accumulation was recorded in T8. The values of dry matter production due to PSB applied treatments was high as compared to the control. It could be due to the better production of the nutrient in plants either from organic and inorganic P sources in soil due to activities of PSB, which could have contributed to improving the dry weight of shoots. Ali *et al.* (2014).

Chickpea: There was significant increase in dry matter production with 50% P for both methods of PSB application *i.e.*, soil application or drenching against T1 (100% NPK). Highest dry matter production was seen in T8. Higher yield of chickpea due to phosphorus application was attributed to better growth of plants in terms of plant height and dry matter production, which resulted in adequate supply of photosynthates for development of sink under high level of level

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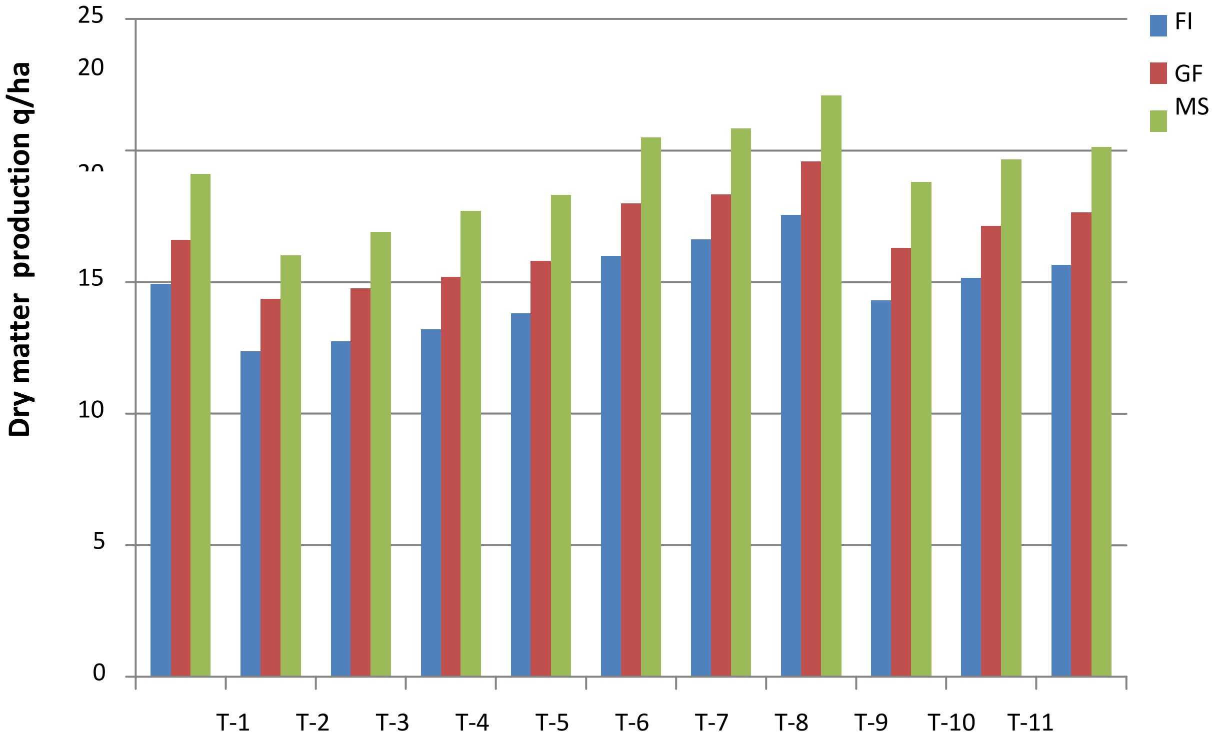
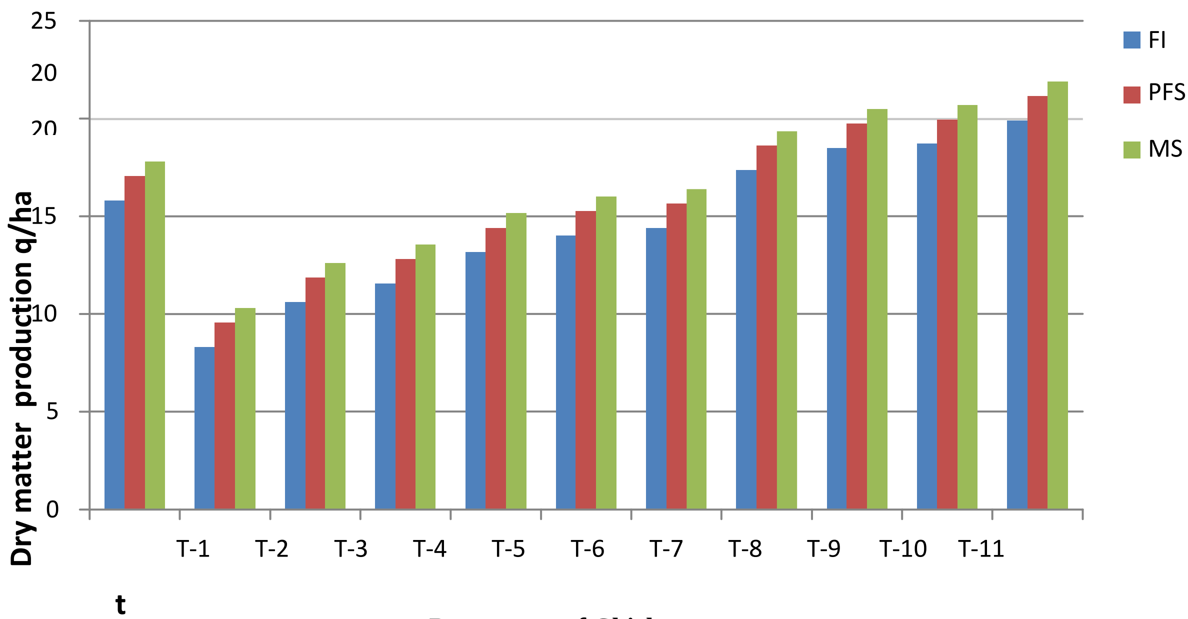


Dry matter of Sunflower



Dry matter of Chickpea

Combining ability, heterosis and gene action for yield and its component traits in castor (*Ricinus Communis* L.)

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ABSTRACT

An investigation on combining ability, heterosis and gene action for yield and its component traits in castor was carried out at AICRP Castor, UAS, Bangalore involving fifty hybrids developed from five pistillate lines as females and 10 testers as males. Analysis of variance revealed significant differences among parents and crosses for all yield attributing traits. The line YRCP-1 and tester RG-3160 showed significant positive effect for seed yield. The cross MCP-1×RG- 3160, expresses significant SCA effect for earliness, spike lengths, capsules on primary spike and seed yield/plant. Hybrids MCP-1 × RG-2787 (157.50 g) and DPC-22 × RG-2787 (186.77 g) involving poor performing parents produced high magnitude for seed yield/plant and yield attributing traits like 100 seed weight and oil percent (%).

Castor (*Ricinus communis* L.) is a non-edible oil seed crop mainly grown for oil extraction for multipurpose usage. The source of a hydroxylated fatty acid, ricinoleic acid adds industrial qualities to the oil. Despite prior breeding programme achievements in the establishment of regionally suited cultivars and hybrids, an integrated plant improvement strategy could lead to even more advancement. Objectives for present study are to identify promising general combiner(s), their gene action and stable heterotic cross combination(s) for seed yield and its attributing traits in castor.

MATERIAL AND METHODS

Fifty hybrids produced using five lines *viz.*, YRCP-1, YRCP-2, MCP-1, DPC-22 and ICP- 30 and ten testers RG-72, RG-3798, RG-3160, RG-2787, RG-2722, ICS-240, ICS-253, ICS-258, ICS-234 and YRC-1904. Hybrids were sown in RCBD with two replications along with their parents and three standard checks during *kharif* 2020 at AICRP Castor UASB. Mean value of five plants were utilised and variance due to different sources was subjected to ANOVA (Panse and Sukhatme, 1967) and to L x T analysis.

RESULTS AND DISCUSSION

Results revealed that, the line YRCP-1 and tester RG-3160 showed significant positive effect for seed yield.

The cross MCP-1×RG- 3160, expresses significant sca effect for earliness, spike lengths, capsules on primary spike and seed yield/plant. Hybrids MCP-1 × RG-2787 (157.50 g) and DPC-22 × RG-2787 (186.77 g) involving poor performing parents (low seed yield plant-1) produced high magnitude for seed yield/plant and yield attributing traits like 100 seed weight and oil percent (%). Almost all crosses, particularly those involving the pistillate parents YRCP-1 and MCP-1, showed the highest positive standard heterosis for seed yield/plant over checks and parents. These findings are comparable to those of Golakia et al. (2004), Venkataramana *et al*. (2005), Ramesh *et al*.(2000), Patel *et al*. (2012) and Lavanya *et al* (2018).

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Performance of sesame variety YLM-66 (SARADA) under Cluster Frontline Demonstrations in Andhra Pradesh

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ABSTRACT

A total of 1530 Cluster frontline demonstrations were conducted in farmers' fields with sesame variety YLM-66. The demonstration yields with YLM-66 and recommended package of practices ranged between 7.37 q ha-

^{1} to 8.13q ha^{-1} with average yield of 7.71 q ha^{-1} which was 30.08% higher than the farmer's practice (5.93 q ha^{-1}). The average net returns of 39201 Rs. ha^{-1} and benefit cost ratio of 2.81 were recorded with improved technology against net returns of 26573 Rs. ha^{-1} and benefit cost ratio of 2.34 in farmers' practice.

Keywords: Net returns and extension gap, Sesame, YLM-66, Yield

Sesame (*Sesamum indicum L.*) is an ancient oilseed crop grown in both tropical and sub tropical regions of the world. India ranks second in the world in terms of sesame-growing area (12.4%) with about 1.7 million hectares with a total production of 0.74 million tonnes and productivity of 431 kg ha^{-1} (FAOSTAT, 2020). The crop has a large diversity in cultivars and cultural systems which indicates a great opportunity for higher increase in productivity of sesame.

MATERIALS AND METHODS

Sesame is one of the major oilseed crops cultivated in rainfed areas of India, which is major source of income for small and marginal farmers in Andhra Pradesh. A total of 1530 Cluster frontline demonstrations were conducted by KVKs of 15 major sesame producing districts in Andhra Pradesh with YLM-66 (SARADA) as demonstration variety in farmers' fields and local varieties in check plots during 2017-2021 in rabi and summer seasons. The gross returns, net returns and benefit cost ratio were calculated based on the prevailing prices of inputs and outputs. The technology gap, extension gap and technology index were calculated by using yield gap analysis.

RESULTS AND DISCUSSION

The results indicated that the average grain yield of sesame was higher in demonstration plots (7.71 q ha^{-1}) compared average grain yield of check plots (5.93 q ha^{-1}) with 30.08% increase in yield. The technology gap of 1.42 and extension gap of 1.78 were recorded. The average net returns and B:C ratio of demonstration plots were 39201 Rs. ha^{-1} and 2.81 and for control 26573 Rs. ha^{-1} and 2.34 respectively. From the present study it is evident that cluster front line demonstrations of sesame with YLM-66 registered higher yields and net returns by adopting recommended practices when compared to check plots. Replacement of local farmer's practice and local varieties would be another viable option to enhance the production as well as net returns from sesame crop. Technological and extension gaps may be filled by the efforts of extension agencies through popularizing recommended package of practices, advisory services, field visits and by organizing exhibitions and field days.

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Effect of vrikshayurveda based herbal kunapajala and their doses on mustard productivity

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ABSTRACT

The study was conducted during *rabi* (2020-2021) with Indian mustard at D7 Block of Norman E. Borlaug Crop Research Centre, GBPUAT, Pantnagar. The design used for experimentation was factorial randomized block design (FRBD) with additional treatment. Moreover, crop yields *viz.*, grain yield, stalk and biological yield was resulted significantly more with nettle based herbal kunapajala with higher rate of application. Similarly, control treatment resulted more grain yield, stalk and biological yield as compared to rest treatment. Thus, nettle based herbal kunapajala with higher rate of application performed better seed quality and crop yields.

Indian agriculture is facing downward spiralling of natural resources due to incessant use of synthetic fertilizers and ground water lifting, especially after green revolution. The key emphasis of green revolution was to make self-sufficient in food grain production by enhancing crop productivity and to meet out the grain requirement of the growing population. In addition, fertilizer subsidy scheme (1977) aided farmers procuring power and disbursed more in agricultural fields. These practices increase in food grain production but at the cost of deterioration of natural resources. Thus, farming community is forced to vortex of dire necessity to twin focus on maximisation of crop production sustainably and preservation of natural resources. In this context, organic manure that has inherent capacity to supply essential micro and macronutrients for balanced and timely contribution on growth and development of plant but also for enhancing soil health will be the need of hour.

MATERIALS AND METHODS

The field experiment was conducted at NEBCRC, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India (latitude of 290 01' N and longitude of 790 48' E and at an altitude of 243.83 meters above mean sea level (MSL)) during *rabi* 2020-21. The soil of the experimental site was loam in texture and belongs to order Mollisol. Factorial randomized block design with additional treatment was followed for this study and replicated thrice. Factor A consisted of different herbal kunapajala concoctions *viz.*, nettle based herbal kunapajala (KJ_1), general weeds based herbal kunapajala (KJ_2) and integrated based herbal kunapajala (KJ_3). Factor B consisted of different rate of applications *viz.*, 500 l/ha, 1000 l/ha, 1500 l/ha and 2000 l/ha. The size of each plot was 6 m × 2.5 m. The study was conducted during *rabi* 2020-21 and 2021-22 with mustard crop and Kranti variety was used. The distance between the two rows was 30 cm and in between the plant was 10 cm. The seed rate followed in the study was 5 kg/ha.

RESULTS AND DISCUSSION

The grain yield was significantly more with KJ_1 (1362.4 and 1556.5 kg/ha) as compared to KJ_3 and KJ_2 during 2020-21 and 2021-22. Under doses treatment, D_4 (1390.5 and 1582.3 kg/ha) resulted significantly superior grain yield which was statistically at par with D_3 (1320.1 and 1487.4 kg/ha) as compared to other treatments during both years. The interaction effect was non-significant during both years. Across control versus rest treatment, control treatment (1401.7 kg/ha) resulted significantly superior grain yield being at par with rest treatment (1245.4 kg/ha) during first year. Non-significant effect was produced during second year but higher grain yield was recorded in control treatment (1613.6 kg/ha) as compared to rest treatment (1445.8 kg/ha).

The stalk yield and biological yield was resulted significantly more with KJ_1 (4296.8, 4454.2 and 5659.2, 6172.7 kg/ha, respectively) as compared to other treatments. Across doses treatment, D_4 (4373.5, 4620.3 and 5764.0, 6364.6 kg/ha, respectively) resulted significantly more stalk and biological yield being at par with D_3 as compared to D_2 and D_1 during both years. The interaction effect was non-significant as during both years of experimentation. Across control versus rest treatment, non-significant effect was noticed during both years but higher stalk yield was resulted in control treatment (4463.3 and 4520.0 kg/ha) as compared to rest treatment (4017.4 and 4317.6 kg/ha). Similarly in biological yield, control (5865.0 kg/ha) resulted significantly more being at par with rest treatment (5262.9 kg/ha) during first year. Whereas, non-significant effect was noticed during second year but higher biological yield was recorded in control treatment (6295.6 kg/ha) followed by rest treatment (5925.4 kg/ha).

In present study, significantly more crop yield was observed in nettle based herbal kunapajala with higher dose of application might be due to production of more dry matter, number of branches and yield attributes. Whereas, reproductive phase was also longer in nettle based herbal kunapajala with higher dose might also be a factor for enhancing grain yield by extra time to translocate the photosynthates from source to sink. In general, more grain yield was observed during second year was due to occurrence of precipitation during the month of January which has reduced the aphid population. The control treatment might be due to better production of dry matter and yield attributing characters. Application of synthetic fertilizers which has faster release rate of nutrient into soil and made ease to uptake by pants. In addition, synthetic fertilizers contain readily available form of nutrients, where plants can uptake easily. **Sutar *et al.* (2017)** observed application of jeevamrutha @1000 l/ha gave significantly more grain yield (1412 kg/ha) of cowpea crop. The results are in accordance with the findings of **Vishwajith (2019); Aher *et al.* (2019).**

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Table 1: Effect of herbal kunapajala concoctions and their doses on Crop yields of Indian mustard

Treatmen	Crop yields							
	Grain yield (kg/ha)		Stalk yield (kg/ha)		Biological yield (kg/ha)		Harvest index (%)	
	2020-2021	2021-2022	2020-2021	2021-2022	2020-2021	2021-2022	2020-2021	2021-2022
Herbal kunapajala concoctions								
KJ_1	1362.4	1556.5	4296.8	4454.2	5659.2	6172.7	24.04	25.29
KJ_2	1122.4	1331.2	3729.6	4114.6	4852.1	5607.9	23.09	23.76
KJ_3	1251.5	1449.7	4025.9	4383.7	5277.5	5995.5	23.68	24.13
SEm±	35.882	41.452	107.415	96.250	137.921	94.037	0.307	0.752
CD (p=0.05)	104.7	120.9	313.5	280.9	402.5	274.4	NS	NS
Doses								
D_1	1047.9	1326.6	3538.9	3941.8	4586.8	5430.5	22.89	24.46
D_2	1223.3	1386.8	3889.9	4274.4	5113.2	5823.3	23.81	23.82
D_3	1320.1	1487.4	4267.4	4433.5	5587.6	6083.0	23.62	24.46
D_4	1390.5	1582.3	4373.5	4620.3	5764.0	6364.6	24.10	24.83
SEm±	41.432	47.865	124.032	111.140	159.258	108.585	0.355	0.869
CD (p=0.05)	120.9	139.7	362.0	324.3	464.8	316.9	NS	NS
Control vs rest								
Control	1401.7	1613.6	4463.3	4520.0	5865.0	6295.6	23.90	25.74
Rest	1245.4	1445.8	4017.4	4317.6	5262.9	5925.4	23.60	24.39
SEm±	74.693	86.290	223.601	200.360	287.106	195.754	0.640	1.566
CD (p=0.05)	218.0	NS	NS	NS	838.0	NS	NS	NS
Interaction								
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Improvement in seed germination potential and adaptability of vegetable soybean (*Glycine max* l. *Merr.*)

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ABSTRACT

The germination problem in vegetable soybean variety Karune is most limiting factor for its wide spread cultivation. The problem of inherent germination problem was aimed to eradicate by developing segregating vegetable soybean line with high germination potential by crossing with EC 538828 which is yellow bold seeded with better germination with rapid seed feeling rate and resistance to several diseases. 14 out of 460 segregating lines were vegetable type with green seed, sweet taste, high germination potential and resistance to major diseases.

Keywords: Soybean, Soybean seed, Seed germination, Vegetable soybean

Vegetable soybean is yet to be a potential venture of utilization of health benefit of soybean in India. Traditional soy products *viz.* soy milk, *tofu* is commercially available in Indian market but off flavor associated with is a bottleneck for its acceptance. The green seeds are quick-to-cook, free from off-flavour, and similar means of utilization like other beans viz. green pea, chick pea, makes it convenient for the common household to include vegetable soybean in the daily cuisine. Vegetable soybean is rich in protein (13%), cholesterol-free fatty acids (57%), TSS (6.5%), phosphorus (158 mg/100g), calcium (78 mg/100 g), vitamin B1 (0.4 mg/10g) and vitamin B2 (0.17 mg/100g). The seed oil and protein content varies from 13.07 to 15.58% and 33.3 to 38.6% respectively (Rao et al 2002). In addition to high protein content, it is a natural source of isoflavones and tocopherols.

In India the only two vegetable type soybean variety namely Swarna Vasundhara and Karune were released for cultivation in Jharkhand and Karnataka. These varieties are not suitable for central zone which is hub of soybean due to its incompatibility to climate, poor seed germination and susceptibility to Rhizoctonia arial blight. To address this problem vegetable variety Karune (green seeded) was crossed with EC 538828

MATERIALS AND METHODS

Karune is the vegetable variety which was released for cultivation in Karnataka. This is selection from vegetable lines received from AVRDC, Taiwan. This variety was crossed with EC 538828 which is bold yellow seeded with average 100 seed weight 18-20g. This variety is having early maturity with less reproductive due to rapid seed feeling and also resistant to major diseases of soybean. The preference for vegetable type lines is absence of pubescence. EC 538828 is devoid of pubescence on plant and pods quite similar to Karune. The RIL's were developed following pedigree method. Initial selection of lines were made on the basis of seed colour, plant pubescence intensity, sweetness (sensory evaluation), seed size and pod shattering. The seed germination potential was followed on the seeds of individual RIL.

RESULT AND DISCUSSION

460 segregating RILs advanced to F5 were screened on the basis of field emergence rate, rapid seed development trait, number of pod/plant, seed size, 100 seed weight at green stage, tolerant or resistance to diseases. 315 lines were green seeded and 145lines yellow seeded. The problem of seed germination was solved by achieving 14 green seeded lines with high field emergence rate (75-85percent) with higher seed weight and disease resistance. Yokomizo and Vello (2000) reported 28 to 46%increase in germination percentage in topcrosses with large seeded exotic parent and an increase of 54 up to 60% in topcrosses with small seeds exotic parent. 317 lines shown tolerant/ resistance to different diseases.50 lines were found susceptible to Rhizoctonia Arial blight and 103 lines were shown the symptom of Yellow Mosaic Virus disease. At picking stage (green stage) 100 seed weight among the RIL's ranged from (25.54-70.01g) as compared to vegetable type parent Karune with 65g. 200 lines were found with puberulent pod (pubescence absent) which is mostly 3 seeded preferable for vegetable soybean. Pod size at green stage varied from 5.0-7.5 cm as compared to Karune (7.4 cm). In India, the usage of vegetable soybean like other common legumes would be in the interest of the economy, especially in the backdrop of the prevailing crunch scenario in legumes and pulses sector with wide gap between demand and supply.

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Effect of phosphorus and sulphur levels on soil nutreint status in sunflower (*Helianthus annuus* L.)

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ABSTRACT

A field experiment was conducted to study the response of Sunflower to Phosphorus and Sulphur levels at Agricultural College Farm, Bapatla, during *rabi,* 2018. The experiment was laid out in randomized block design with factorial concept replicated thrice with ten treatments. The Phosphorus and Sulphur status in soil increased with increasing levels of phosphorus from 0 to 135 kg P_2O_5 ha^{-1} but significant upto 90 kg P_2O_5 ha^{-1} whereas, the highest level of sulphur i.e., 30 kg S ha^{-1} recorded significantly higher uptake of Phosphorus and Sulphur soil at all growth stages of Sunflower

Keywords: *Phosphorus levels, Sulphur levels, Sunflower*

Sunflower (*Helianthus annuus* L.) ranks second to soybean among annual field crops grown for edible oil. Phosphorus helps in alleviating the yield and its attributes by supplying energy required for metabolic processes. Sulphur, a quality nutrient that plays a major role in growth and metabolism especially by its effect on proteolytic enzymes, helps in the synthesis of amino acids and chlorophyll content. Majority of soils contain substantial reserves of total phosphorus but most of it remains relatively inert with only less than 10 per cent of soil phosphorus enters the plant-animal cycle thereby reducing the effectiveness of phosphorus fertilization. In view of the above facts, a field experiment was conducted to know the effect of different levels of phosphorus and sulphur levels on soil nutrient status at different growth stages of sunflower.

MATERIAL AND METHODS

A field experiment was conducted at the Agricultural College Farm, Bapatla, during *rabi*, 2018. The soil of the experimental site was sandy clay with a pH 7.06, electrical conductivity of 0.15 dSm^{-1}, medium in organic carbon (0.51 g kg^{-1}), available nitrogen (203 kg ha^{-1}), available phosphorus (26.5 kg P_2O_5 ha^{-1}), available potassium (224 kg K_2O ha^{-1}) and deficient in sulphur (9.2 mg kg^{-1}). The experiment was laid out in randomized block design with factorial concept replicated thrice with ten treatments. The treatments comprising of three levels each of phosphorus (45, 90 and 135 kg P_2O_5 ha $^{-1}$) and three levels of sulphur (10, 20 and 30 kg S ha^{-1}) with a single control. Soil samples were collected at different growth stages of crop growth. Phosphorus and Sulphur content in soil samples was estimated by Olsen *et al*, (1954) and Hessel (1971).

RESULTS AND DISCUSSION

Available P content in soil was significantly influenced by different levels of phosphorus and sulphur at all the growth stages. At vegetative stage, application of 135 kg P_2O_5 ha^{-1} being on par with 90 kg P_2O_5 ha^{-1} recorded significantly higher available P (31.39 kg ha^{-1}) and 13.98% increase over control .At flowering and harvest stages application of 135 kg P_2O_5 ha^{-1} being on par with 90 kg P_2O_5 ha^{-1} maintained superiority by recording significantly higher available P over corresponding lower levels of 45 kg P_2O_5 ha^{-1} and control. There was an increase in the available P over initial soil status (26.5 kg P_2O_5 ha^{-1}). Available S was significantly influenced by different levels of sulphur at the growth stages. At vegetative stage, application of 30 kg S ha^{-1} recorded significantly higher available S (19.52 mg kg^{-1}) which was 75.22 % increase over control whereas, the lowest available S (11.14 mg kg^{-1}) was observed in control. At flowering and at harvest also crop fertilized with 30 kg S ha^{-1} recorded significantly higher available S compared to 0, 10 and 20 kg S ha^{-1}. The increase in available S content in the soil after harvest of the crop might be ascribed to adsorption of part of applied sulphur on organic matter and thereby reducing the leaching losses of sulphur.

Fig.1 Effect of phosphorus and sulphur levels on soil phosphorus content (kg ha $^{-1}$) at different growth stages of sunflower

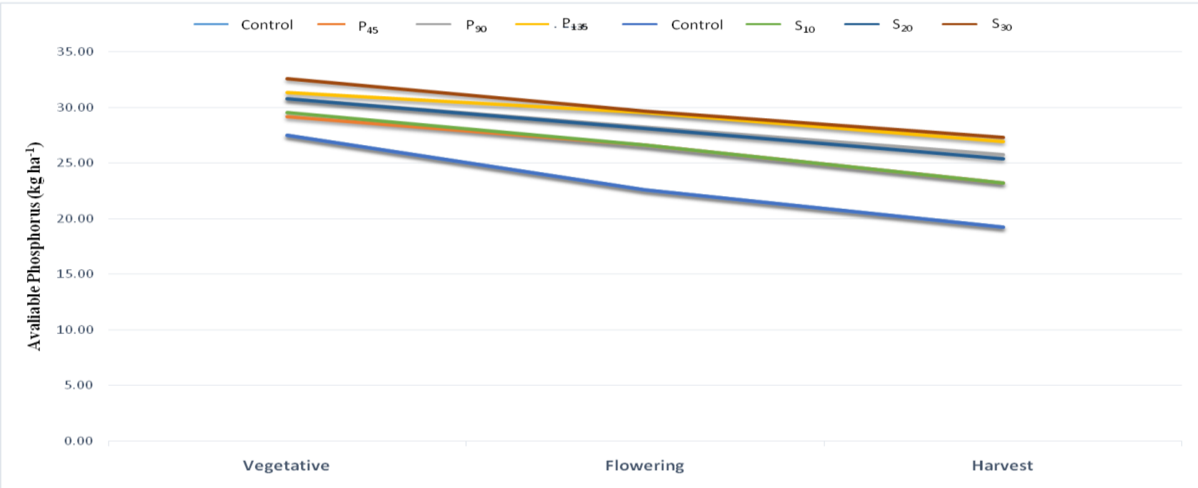
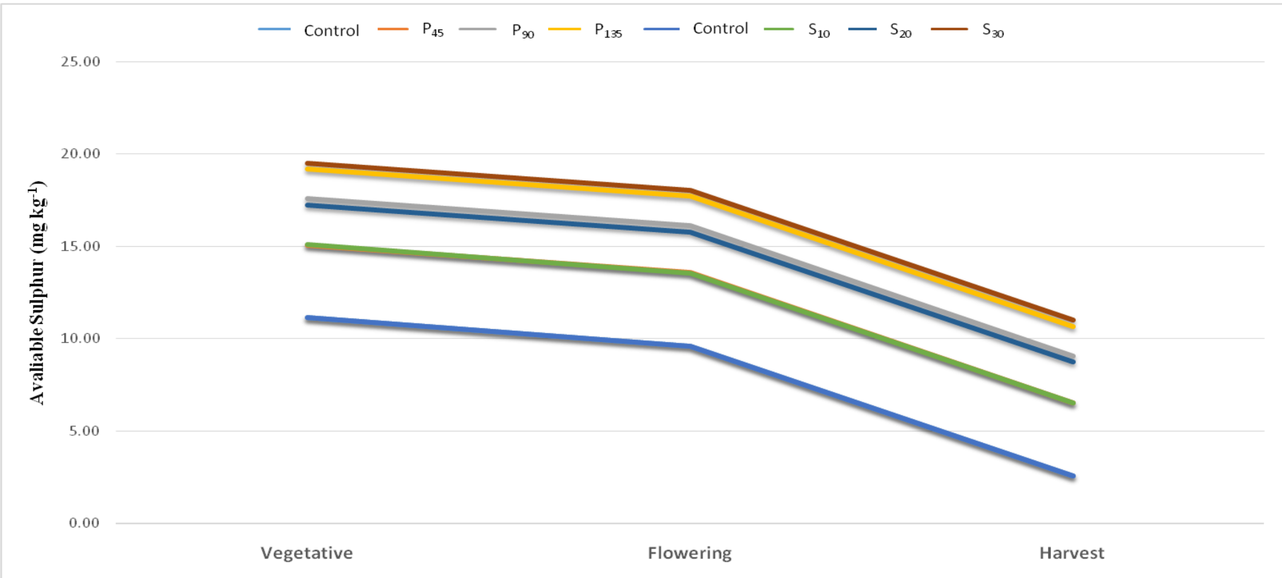


Fig.2 Effect of phosphorus and sulphur levels on soil sulphur content (kg ha $^{-1}$) at different growth stages of sunflower



Mutagenic sensitivity analysis in soybean (*Glycine Max* L. Merill)

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ABSTRACT

The seeds of soybean were treated with nine different doses of Gamma rays and six different doses of EMS to study the mutagenic sensitivity of physical and chemical mutagen. The treated seeds along with control were sown to raise M_1 generation. Germination percentage was recorded in laboratory as well as in the field condition the higher doses showed drastic reduction in germination, and survival percentage. The Probit analysis showed that the LD_{50} value of Gamma rays based on laboratory and field germination was 335.68 Gy and 283.40 Gy respectively while for EMS it was 0.28% and 0.23% respectively.

Keywords: $LD_{50,}$ Mutagen, Probit analysis, Soybean

Soybean is one of the most important oilseed crop widely cultivated in India. However, the productivity of Indian soybean cultivars is almost half as compared to the world average. Being self pollinated crop, narrow genetic base and very delicate flower structure, creation of variability through traditional breeding method is very difficult in soybean crop. Hence mutation breeding method is very useful tool. Mutation breeding work in soybean crop has yielded in identification of many mutant lines with desirable traits like high germination and survival % (Rehman *et al*. 1994). The mutation breeding programme will be effective if the information on lethal dose 50 is available with us. Hence present research was undertaken with the aim to study the LD_{50} dose of physical and chemical mutagen.

MATERIALS AND METHODS

Seeds of soybean cultivar AMS 100-39 was irradiated with nine different doses of Gamma rays viz. 100, 150, 200, 250, 300, 350, 400, 450, 500 Gy, and six different doses of EMS viz. 0.1%. 0.15%, 0.2%, 0.25%, 0.3% and 0.35 %. The irradiation treatment was given at BARC, Trombay, Mumbai while EMS treatment was given in the laboratory at Regional Research Centre, Amravati. These treated seeds along with dry and wet control were used for germination study in laboratory and field condition. Randomized block design was used for the experiment in which each plot comprised of 5 rows of 3 meter length. The survival percentage was also recorded. The LD_{50} dose was estimated by probit analysis based on D.J. Finney, (1952)

RESULTS AND DISCUSSION

The median lethal dose (LD_{50}) is based on the assumption that low doses of irradiation produce minimum impacts on the genome, which rarely generate phenotypic changes; whereas high doses may produce multiple impacts on the genome which consistently produce aberrations or negative changes. Therefore, the first step in a mutagenesis-based breeding process is to determine the LD_{50}. In the present research experiment, germination percentage in laboratory (Table 1) showed gradual reduction as compared to dry and wet control. LD_{50} value for Gamma rays and EMS was 335.68 Gy and 0.28% respectively. Similar results were also reported by Padavai and Dhanavel (2004) and Singh & Kole (2005). As only LD_{50} value is not a suitable criterion to decide doses of mutagen because survival of mutant is important than germination. Hence, the germination and survival percentage was also recorded in field condition (Table 2). In field condition, it was found that germination and survival percentage decrease with increase in mutagenic treatment. The decrease in the survival percentage was associated with the increase in the dose/concentration of both the mutagens (Khan and Tyagi 2009). The data subjected to probit analysis estimated the LD_{50} values as 283.40 Gy and 0.23% for Gama rays and EMS respectively.

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Efficient production of induced double haploid (DH) plants derived from anther culture

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ABSTRACT

The success of DH technology dependents on the efficacy of optimized protocol that could be utilized for large scale production of homozygous lines. In this study, anther culture protocol was established using *invitro* colchicine treatment of haploid callus derived from anthers of niger (*Guizotia abyssinica* L.F. cass). Flower buds at uninucleate stage were kept for 24 hours cold pre-treatment followed by anther inoculation. 30-40 days old callus were subjected to different colchicine treatments (0, 0.025%, 0.05%, 0.1%, 0.2%) for different time intervals (6,16, 24, 30, 48hours). Colchicine treated (CT) callus were transferred to greening media followed by transferring to shooting media. Observations of greening and shooting percentage were taken with reference to control. The greening percentage found to be decreased (34%) compared to control (40%). However, 90-95% and 85-90% increment in shooting and rooting percentage was observed at 0.2% CT for 30 hours as compared to control which showed 15-20% shooting and 40-45% rooting. It was concluded that the incorporation of CT at callus stage increase the overall efficiency of DH production.

To keep pace with the skyrocketing demand of vegetable oil and reduced dependency on import, there is a need to focus on indigenous oilseed crops such as, Niger (*Guizotia abyssinica* L.F. Cass). Niger is a minor oilseed crop which consists of 32-40% quality oil and 18-24% protein in the seeds. Despite its considerable importance, self-incompatibility and high outcrossing pose difficulty in breeding through conventional methods (Tesfaye *et al*. 2010; Sarvesh *et al.* 1993). Double haploid (DH) technology is one of the alternatives to overcome the problem and develop inbred lines in a lesser time. Anther culture involves two basic steps for DH production *i.e*., callus induction followed by regeneration, and physical or chemical treatment for chromosome doubling (Purbiya *et al.* 2021; Chambhare *et al*. 2022). Of the several techniques that have so far been used, colchicine is the widely employed doubling agent. Colchicine is an alkaloid and a spindle inhibitor which acts on dividing cells by binding to tubulin, disrupting the normal polar segregation of sister chromatids and results in doubling chromosome number. Mostly colchicine is treated *ex-vitro* in tiller stage or hardening stage by injection which will lead to doubling of haploid plants but it has no effect on efficiency of anther culture protocol. Incorporation of colchicine in callus stage increases the efficiency in DH production along with doubling of plants. Thus, colchicine is considered in the anther culture protocol for double haploid production in the study.

MATERIAL AND METHODS

For anther culture, Niger seeds of JNS28 variety were grown in the fields of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. Buds of 7 days old carrying microspores at uninucleate stage were isolated and kept for 24 hours cold pre-treatment. For inoculation, buds were surface sterilized using Tween 20, 1% Bavistin and 0.1% HgCl2 for 5 min followed by rinsing thrice using distilled water in each step. Anthers were dissected from disc florets (consisting of stigma and five fused anthers) and were inoculated on MS media fortified with 2, 4-D (2 mg/l) + KIN (0.3 mg/l) hormones for callus development. About 40 anthers were inoculated in each plate. Cultures were kept in dark chamber at 25 ± 1^0 C for callus induction. The induced anther derived calli that was 30-40 days old were sub cultured on media with and without colchicine to know the effect of colchicine treatment (CT) on callus greening, shooting and rooting. Different concentrations of colchicine *viz.,* T1 (0.025%), T2 (0.05%), T3 (0.1%) and T4 (0.2%) were incorporated in callus inducing media (MS+2 mg/l 2,4-D, 0.3% KIN) for different time durations *viz.,* 6, 16, 24, 48 and 30 hours and callus was sub-cultured. They were then transferred to the charcoal containing media, (MS+ 0.5mg/l BAP + 0.5mg/l charcoal) to initiate greening in callus followed by transferring in shooting media (MS+0.5mg/l BAP +0.5mg/l KIN), rooting media (MS+2 mg/l IBA), hardening and acclimatization.

RESULTS AND DISCUSSION

In the present study, anther derived calli in MS+2 mg/l 2,4-D+0.3 mg/l KIN were transferred to different concentrations of colchicine added in MS + 2 mg/l 2,4-D+0.3 mg/l KIN for different time durations after 25 days of callus initiation (Fig 1). After treatment, they were transferred to greening media MS+0.5 mg/l BAP+0.5 mg/l activated charcoal. In this study, the greening percentage of colchicine treated callus was found to range from 11% to 46% as compared to control which was 40%. A 24 hours of 0.05% CT callus showed a high greening percentage of 46% followed by 6 hrs (0.025% CT), 16 hrs (0.2% CT) and 48 hrs (0.1% CT). The green calli obtained from each CT and control treatments were transferred to the shooting media (MS + 0.5 BAP + 0.5 KIN). The CT callus showed significantly higher shooting percentage compared to untreated callus. Shooting percentage of treated callus ranged from 25-90% whereas in control it was recorded as 19%. Maximum shooting percentage was observed in 0.2% CT for 30 hrs (90% shooting) followed by 0.025% CT for 30 hrs (69% shooting). 0.2% CT for 30 hrs showed 4.5 times more shooting followed by 0.025% CT for 30 hrs which showed 3.45 times more shooting response as compared to control. The overall observation showed that the CT callus showed more, and rapid shoot generation as compared to control. The treated callus was observed to show more rooting compared to control. Rooting percentage of treated callus ranged from 20-87% whereas rooting percentage in control was 40%. Maximum rooting percentage was observed in 30 hrs CT at 0.2% concentration with 87% rooting followed by 30 hrs CT at 0.025% concentration and 24 hrs treatment of 0.2% concentration with 70% rooting. The objective of colchicine treatment is not only to increase the shooting percentage response but also to induce diploidization during the culture processes, so that by the end of the culture cycle, DH plants can be obtained in larger numbers for better selection efficiency. Like Niger anther culture, our previous work in rice anther culture, (Pusadkar *et al*., 2018), green callus percentage and overall plant regeneration percent increased by 70-80 % in CT callus stage as compared to control.

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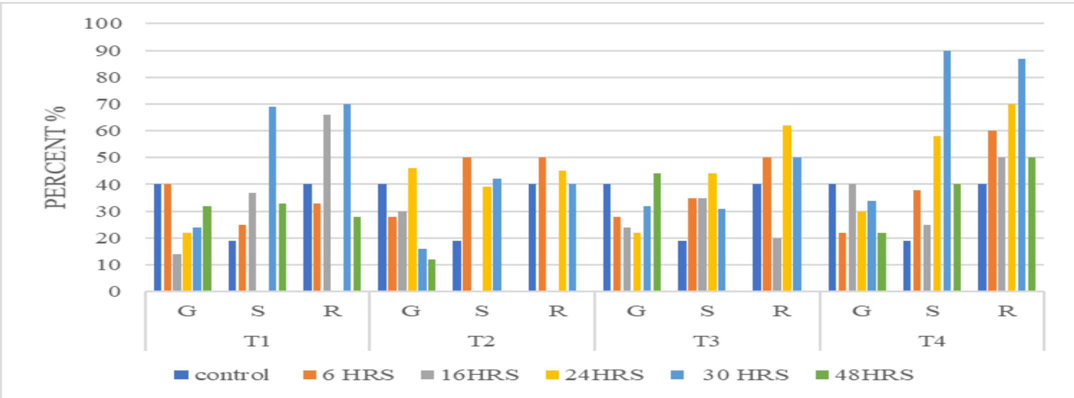

Fig 1. Overall response of colchicine treated and untreated callus (control) for different time exposures
Legends: T1-0.025% CT; T2- 0.05% CT; T3- 0.1% CT; T4- 0.2% CT; G-Greening %; S-Shooting%; R-Rooting %

Conservation agricultural practices for improving productivity and soil health under Rice-linseed cropping system in *Vertisol*

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Conservation Agriculture is a farming system that can prevent losses of arable land while regenerating degraded lands (Vlek and Tamene, 2009). Dumanski *et al.* (2006) explained that conservation agriculture is the integration of ecological management with modern, scientific, agricultural production. It promotes maintenance of a permanent soil cover, minimum soil disturbance, and diversification of plant species. Lal (2001) explained the historical development of agriculture with tillage being a major component of management practices. No-tillage and direct seeding is an effective crop production method for reducing production costs and soil conservation (Huang *et al*., 2011). Rice – based cropping systems form an integral part of agriculture in Chhattisgarh. Several intensive rice based cropping systems have been identified and are being practiced by the farmers. However, suitable rice based cropping has to be evaluated, to assess the stability in production. Inclusion of oilseeds in the cropping system is more beneficial than cereals followed by cereals (Kumpawat, 2001).

METHODOLOGY

An experiment was carried out during *rabi* season (Linseed) of 2018-19 and 2019-20 followed by the rice crop in *kharif* during 2018 and 2019 at Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. In rice crop, treatments comprised with nine tillage with nutrient management practices *i.e.* conventional tillage (CT)-transplanted rice (TPR) 100 % recommended dose of fertilizer (RDF), CT-TPR 100 % RDF + 2 t FYM, CT-TPR 100 % RDF (75 % inorganic + 25 % FYM), CT-direct seeded rice (DSR) 100 % RDF, CT-DSR 100 % RDF + 2 t FYM, CT-DSR 100 %, zero tillage (ZT)-DSR 100 % RDF, ZT-DSR 100 % RDF + 2 t FYM and ZT-DSR 100 % RDF (75 % inorganic + 25 % FYM) were laid out in randomized block design with three replications. In *rabi* season, linseed crop was grown in the split-split plot design with three replications. The residual of nine rice treatments as mention above were taken in main plot to study the effect of tillage and nutrient applied to rice on linseed crop. While, three direct applied tillage to linseed was assigned in sub-plot and three direct applied nutrients to linseed was taken as sub-sub plot treatments. The nine tillage and nutrient management practices of rice as mentioned above was taken as residual treatments and taken main-plot for linseed crop. In sub plot three tillage *viz.* linseed CT, linseed ZT+R (Residue) and linseed ZT and in sub-sub plot, three nutrient management practices *viz.* linseed 100 % RDF, linseed 100 % RDF + 2 t FYM and linseed 100 % RDF (75 % inorganic + 25 % FYM) was studies. The recommended dose of fertilizer was taken 60:30:30 @ N: P2O5:K2O kg ha^{-1}. Linseed variety RLC-92 was taken as test crop. Energy inputs were calculated and estimated in mega joule (MJ) ha^{-1} with reference to the standard values prescribed by Mittal *et al.* (1985). The standard energy coefficient for seed and straw of rice and linseed was multiplied with their respective yields and summed up to obtain the total energy output.

RESULT

Due to the residual effect of tillage with nutrient management practices of rice, the significantly higher plant population of linseed was observed at the initial stage under the treatment of RRCT-DSR 100 % RDF (75 % inorganic + 25 % FYM) as compared to others, but it was at par with the treatment of RRCT-DSR 100 % RDF, RRCT-DSR 100 % RDF + 2 t FYM, RRZT-DSR 100 % RDF + 2 t FYM and RRZT-DSR 100 % RDF (75 % inorganic + 25 % FYM) on mean basis (Table 1). Number of primary branches of linseed was not influenced significantly due to various residual of tillage with nutrient management practices of rice on mean basis. As regards to residual of tillage with nutrient management practices of rice, the significantly higher number of secondary branches plant^{-1} of linseed was found under RRCT-DSR 100 % RDF + 2 t FYM as compared to others, On the other hand, the minimum number of secondary branches plant^{-1} was observed under the treatment of RRZT-DSR 100 % RDF (75 % inorganic + 25 % FYM) on mean basis. The highest growth parameters in RRCT-DSR 100 % RDF + 2 t FYM, might be due to the direct seeded rice which normally leave better soil condition, allow for better seed bed preparations for succeeding crops. Furthermore, the application of 100 % RDF an additional amount of 2 FYM was given which improved the soil physico-chemical properties in rice (Tarwariya and Maurya, 2013). The addition of nutrients through decomposition of FYM also enhanced the availability of nutrients for succeeding crop of linseed (Rathod *et al.*, 2012; Jitti, 2012).

With regards to residual of tillage with nutrient management practices of rice, significantly higher number of filled capsules plant^{-1} was obtained under the treatment of RRCT-DSR 100 % RDF + 2 t FYM as compared to others treatments (Table 1). The direct effect of tillage revealed that the treatment of linseed CT produced the highest number of filled capsules plant^{-1}, which being significantly better than treatment of linseed ZT, but produced comparable filled capsules plant^{-1} to that of linseed ZT+R on mean basis. Residual effect of tillage with nutrient management practices of rice on linseed revealed that the highest number of seeds capsule^{-1} and test weight was obtained under the treatment of RRCT-DSR 100 % RDF + 2 t FYM, which was significantly higher as compared to others, but it was at par to the treatment of RRCT-TPR 100 % RDF+ 2 t FYM and RRCT-DSR 100 % RDF on mean basis. The residual effect of tillage with nutrient management practices of rice, the highest seed yields of linseed was recorded under the treatment of RRCT-DSR 100 % RDF + 2 t FYM. This treatment produced comparable seed yield to that of RRCT-TPR 100 % RDF + 2 t FYM and RRCT- DSR 100 % RDF. Direct effect of tillage, the higher seed yield was obtained under the treatment of linseed CT, but it was at par to treatment of linseed ZT+R on mean basis.

Zero tillage recorded significantly higher energy use efficiency, energy profitability and energy productivity as compared to conventional tillage (CT). This might be due to saving of energy in zero tillage as compared to conventional tillage. Sorokhaibam *et al.* (2017) showed that the higher input energy was consumed by conventional tillage than no-tillage practices and gross energy output of conventional tillage was at par with no-tillage, but net energy output was higher under no-tillage.

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Table 1: Growth parameters, yield attributes and yield as influenced by residual of tillage with nutrient management practices of rice, direct effect of tillage and nutrient management practices in linseed under rice-linseed cropping system

Treatments	Plant population (no. m^{-2})	Number of branches Primary	Number of branches Secondary	Number of filled capsule	Number of seeds capsule	Test weight (g)	Seed yield (q ha^{-1})
A. Main plot (Residual of tillage with nutrient management practices of rice)							
R1: RRCT-TPR 100 % RDF	238	4.77	17.89	50.58	8.13	6.49	14.12
R2: RRCT-TPR 100 % RDF + 2 t FYM	242	4.94	20.14	60.25	8.49	6.68	16.99
R3: RRCT-TPR 100 % RDF (75 % inorg + 25 % FYM)	246	4.85	17.99	53.59	8.2	6.57	15.07
R4: RRCT-DSR 100 % RDF	256	4.94	19.11	60.09	8.46	6.64	16.37
R5: RRCT-DSR 100 % RDF + 2 t FYM	260	4.98	21.4	62.49	8.74	6.89	17.32
R6: RRCT-DSR 100 % RDF (75 % inorg + 25 % FYM)	262	4.85	18.33	55.18	8.27	6.6	15.18
R7: RRZT-DSR 100 % RDF	244	4.9	18.04	47.8	8	6.48	13.17
R8: RRZT-DSR 100 % RDF + 2 t FYM	252	4.79	18.69	55.99	8.3	6.62	15.77
R9: RRZT-DSR 100 % RDF (75 % inorg + 25 % FYM)	253	4.64	17.74	46.2	7.8	6.35	12.63
SEm±	**4.24**	**0.14**	**0.28**	**0.43**	**0.09**	**0.08**	**0.36**
CD (p=0.05)	**12.71**	**NS**	**0.84**	**1.29**	**0.28**	**0.25**	**1.08**
B. Sub plot (Tillage)							
T1: Linseed CT	256	5.16	19.37	57.15	8.43	6.67	15.94
T2: Linseed ZT+R	243	4.8	19.3	56.24	8.37	6.64	15.77
T3: Linseed ZT	252	4.61	17.68	50.66	8	6.46	13.83
SEm±	**2.78**	**0.1**	**0.15**	**0.28**	**0.05**	**0.06**	**0.12**
CD (p=0.05)	**7.98**	**0.29**	**0.43**	**0.8**	**0.13**	**0.17**	**0.35**
C. Sub-Sub plot (Nutrient management practices)							
N1: Linseed 100 % RDF	247	4.84	18.7	54.56	8.22	6.43	15.36
N2: Linseed 100 % RDF + 2 t FYM	249	5.01	19.72	56.53	8.52	6.99	16.15
N3: Linseed 100 % RDF (75 % inorg + 25 % FYM)	252	4.7	17.92	52.96	8.05	6.35	14.03
SEm±	**2.65**	**0.1**	**0.14**	**0.28**	**0.04**	**0.04**	**0.12**
CD (p=0.05)	**NS**	**NS**	**0.41**	**0.77**	**0.12**	**0.1**	**0.33**

Variability analysis for agronomic traits in Indian mustard (*Brassica juncea* L. Czern & Coss) germplasm

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ABSTRACT

Eighty four inbred lines of mustard were evaluated during 2021-22 at ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur. Analysis of data revealed significant variability for all observed traits except days to flower senescence and days to maturity. Highest variability was recorded for biological yield followed by plant height and Main shoot length (cm). Days to flowering senescence and days to maturity had low variability observed. Plant height and1000-seed weight was observed moderate variability. Promising lines were identified for number of days to flowering initiation (<46 days), long main shoot length (>95cm), number of seeds per siliqua (>18), 1000-seed weight (>6.5g).These promising lines shall further be used in hybrid breeding programme as parental lines, as well as in varietal development programme.

Rapeseed–Mustard is an important group of oil seed crops grown in India. These crops contribute maximum oil to the total domestic edible oil production. *Brassica juncea* is the pre dominant species of rapeseed mustard group and covers almost 80% of the total acreage under rapeseed-mustard. These crops suffer form a number of biotic and abiotic stresses, which causes fluctuation in their production every year. The large spectrum of genetic variability in a population depends on the amount of the genetic variability among genotypes and offer better scope for selection. The magnitude of heritable variation in the traits studied has immense value in understanding the potential of the genotype for further breeding programme.

MATERIALS AND METHODS

Eighty four inbred lines were evaluated at Directorate of Rapeseed-Mustard Research. These were grown in augmented block design in 2 rows plot of 3 meter length at 45cm row to row and 10cm plant to plant spacing. Nine traits *viz.* days to flowering initiation, days to flower senescence, days to maturity, main shoot length (cm), plant height (cm) at maturity, number of seeds per siliqua, biological yield, seed yield and 1000-seed weight (g) were recorded.

RESULT AND DISCUSSION

Highest variability was recorded for biological yield followed by plant height and Main shoot length (cm). Days to flowering senescence and days to maturity had low variability observed. Plant height and1000-seed weight was observed moderate variability. Promising lines were identified for number of days to flowering initiation (<46 days), long main shoot length (>95cm), number of seeds per siliqua (>18), 1000-seed weight (>6.5g).

CONCLUSION

Highest variability was recorded for biological yield followed by plant height and Main shoot length (cm). Days to flowering senescence and days to maturity had low variability observed.

Promising lines were identified for number of days to flowering initiation (<46 days), long main shoot length (>95cm), number of seeds per siliqua (>18), 1000-seed weight (>6.5g).

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Table: 1, Mean and Range for agronomic traits in inbred lines of *B. juncea*

Parameters	Mean	Minimum	Maximum	Range
Days to flowering initiation (days)	46	35	53	18
Days to flowering senescence (Days)	85	69	105	36
Days to maturity (days)	134	115	147	32
Plant height (cm)	196	150	237	87
Main shoot length (cm)	79	63	103	40
Biological yield/plot (g)	3401	1890	4850	2960
Seed yield (g/plot)	998	507	2026	1519
Number of Seeds per Siliqua	16	11	22	11
1000-seed weight (g)	5.2	3.0	7.7	4.6

Analysis of genetic diversity in groundnut (*Arachis Hypogaea* L.)

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ABSTRACT

The genetic diversity among 105 groundnut germplasm for 11 characters was measured by employing D^2 statistic and these were grouped into 15 clusters. The average D^2 values of inter cluster distances, showed maximum distance between Cluster V and XV (12283.79) followed by inter cluster distance (11278.47) between III and XV. The clusters were ranked based on the overall score across 11 traits. Accordingly, cluster X was superior which indicates the presence of most promising genotypes in them. Hundred pod weight and harvest index had maximum contribution of 43.64% and 21.76% respectively to the divergence of genotypes.

Keywords: Cluster distance and percent of contribution, D^2 statistics, Groundnut, solitary clusters

Groundnut (*Arachis hypogaea* L.) is self-pollinated, allotetraploid annual legume with chromosome number 2n = 4X = 40. The genetic diversity is pre-requisite in selecting the parents for hybridization. Studies on genetic diversity and variability are playing vital role in successful breeding programme. Mahalanobis generalized distance estimated by D^2 statistic (Rao, 1952) is a unique tool for discriminating population considering a set of parameters together rather than infusing from indices based on morphological similarities and phylogenic relationships.

MATERIAL AND METHODS

The experimental material consisted of 105 genotypes including five checks (K-1812, Dh 256, R-8808, K-9 and TMV-2). It was laid out in an augmented random block design during *Kharif* 2021 at AICRP on Groundnut Research block, MARS, University of Agriculture Sciences, Raichur. The observations were recorded on days to fifty percent flowering, days to maturity, pod yield per plant, number of matured pods per plant, 100-pod weight, kernel yield per plant, 100-kernel yield, haulm yield per plant, shelling percentage, harvest index and oil content.

RESULTS AND DISCUSSION

Intra and inter relation of clusters : The maximum inter cluster distance was found between cluster V and cluster XV (12283.79) followed by cluster III and cluster XV (11278.47), IV and XV (8481.17) and cluster V and XIII (7581.40). The least inter- cluster divergence was noticed between cluster II and VI (168.67). It indicates that crossing between these clusters helps in production of transgressive segregants or better recombinants.

Contribution of different characters towards divergence: . The maximum contribution towards genetic divergence was found to be from hundred pod weight (43.64%) by taking first rank 2383 times out of total number of combinations, followed by harvest index (21.76%), days to maturity (15.38%), shelling percentage (6.63%), haulm yield per plant (5.6%) and number of matured pods per plant (3.72%). Whereas, the minimum contribution towards genetic divergence was from kernel yield per plant (0.01%) followed by pod yield per plant (0.42%), days to 50% flowering (0.88%), hundred kernel weight (0.93%) and oil content (1.03%).

NRCG-CS-641, ISK-I-2021-3, NRCG-HFS(VB)-101 and NRCG-HFS(VB)-48 showed high *per se* performance with divergence and can be utilized as potential parents and crossing among themselves would result in high heterotic expression for yield components.

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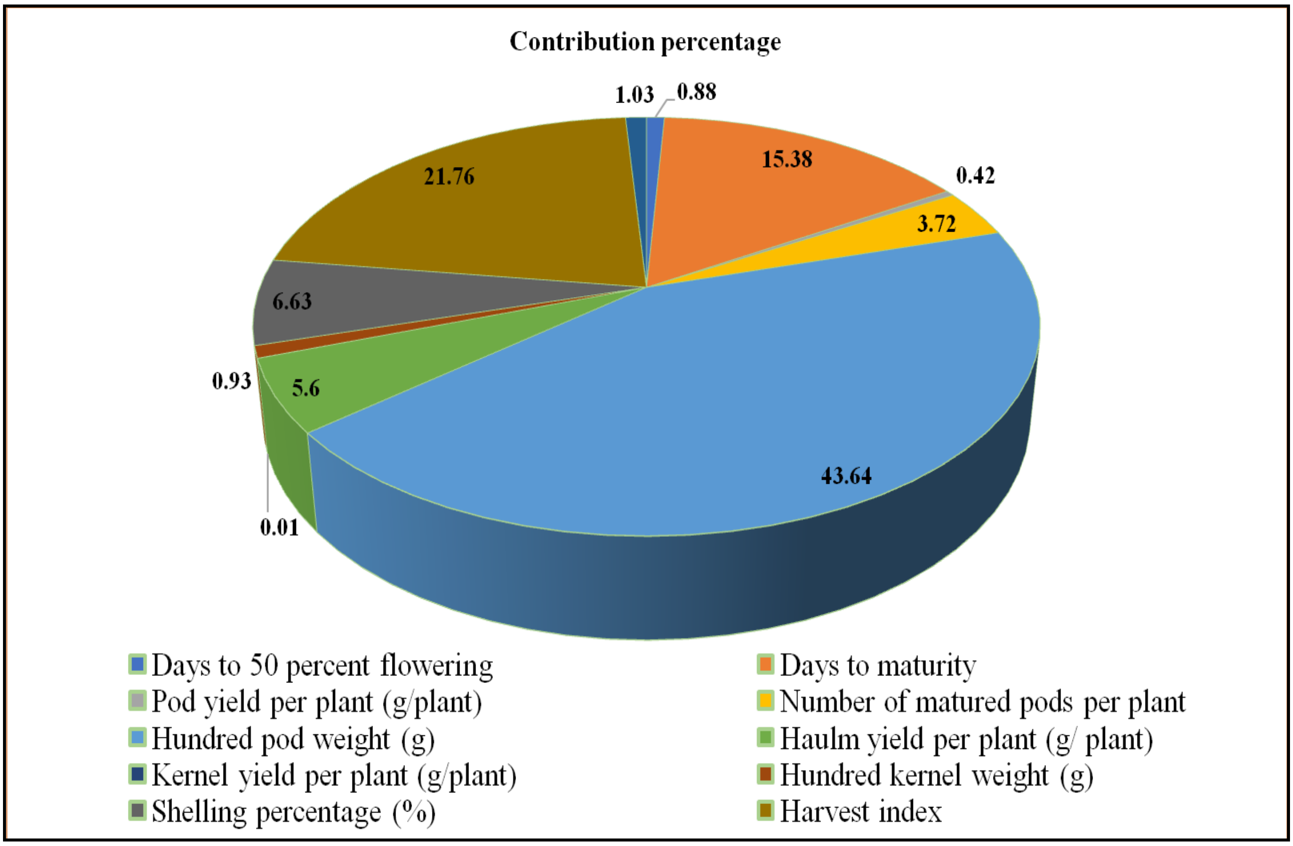

Genetic variability for phenological and yield contributing traits in soybean [*Glycine max* (L.) Merr.]

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ABSTRACT

A field experiment was carried out with 711 soybean genotypes to assess the genetic variability for phenological and yield contributing traits. A large genetic variation for was observed among the genotypes for phenological, yield contributing traits and pod borer tolerance. Variance analysis found that all the traits differed significantly for different source of variations. Except days to maturity, all the traits studied exhibited moderate to high heritability and genetic advance. This suggests that the selection based on these traits would be useful in improving the grain yield. Days to first flowering showed significant positive association with days to 50% flowering, pod initiation, days to maturity, plant height, no. of pods per plant and seed yield. Further, association analysis revealed that the incidence of pod borer significantly reduced seed yield. Principal component analysis revealed that phenological traits *viz*., days to 50% flowering, pod initiation and days to maturity were closely associated and were the main contributors in PC1. Path analysis revealed plant height and no. of pods per plant has highest direct influence to seed yield.

Keywords: Augmented, Maturity, Pink bod borer, Soybean, Variability, Yield

Soybean [*Glycine max* (L.) Merr.] is an important food legume crop cultivated worldwide for its protein and oil content. Soybean seed contains oil (range 8.3–27.9%) and highest protein concentration (range 34.1–56.8%) which is higher than any major legume crop, thus making it a unique crop in the family Leguminosae. During 2020, soybean contributed 61% of world's oilseed production with 367.8 million metric tons harvested (Soystats, 2022). Phenology (time to flowering and maturation) plays a key role in crop adaptation and productivity in specific environments. Yield is a quantitative trait controlled by cumulative effect of large number of genes governing various interdependent quantitative factors. Analyzing the genetic variability and association of various traits with seed yield is significant for developing high yielding cultivars suitable to specific environments.

MATERIALS AND METHODS

The experimental material comprising 714 soybean accessions (including exotic collections, indigenous collections and cultivars) were grown in an augmented design (Federer 1956) with 11 blocks and 3 checks 'JS 335', 'DSb 21' and 'DSb 34' randomized in each block during kharif 2022 at ICAR-IARI's Regional Research Centre, Dharwad (15.49° N, 74.98° E), India. Sowing was done in the last week of July in order to expose the crop to rust and pink pod borer. Each accession was grown in single row of 1.5m length with a spacing of 40 cm x 10 cm. Rust susceptible variety 'JS 335' was planted every tenth row. Observations were recorded phenological traits (days to 50% flowering, pod initiation, days to maturity), qualitative traits (flower colour), quantitative traits (plant height, no. of pods per plant and seed yield) and biotic stress (rust and pink pod borer). Data analysis was done in r software.

RESULTS AND DISCUSSION

The Analysis of Variance (ANOVA) for traits studied showed that the accessions were significantly different. This indicated that sufficient genetic variability was present among the accessions (Table 1). A high range was observed for days to first flower (29 to 55 days) and days to maturity (62 to 104 days) among the accessions. A large genetic variation for was observed among the genotypes for yield contributing traits and pod borer tolerance. However, none of the accessions including the checks showed resistance to rust disease. Variance analysis found that pod borer damage had the highest GCV (95.32), followed by seed yield (93.38) and no. of pods per plant (69.65). except for days to maturity, high heritability coupled with high to moderate to high genetic advance was found for most of the traits studied which suggests that ample opportunity exists in germplasm collection for improvement of these trait.

Association analysis revealed that days to first flowering had significant positive association with days to 50% flowering, pod initiation and days to maturity, indicating that in general early-flowering lines also mature early (Figure 1). Days to first flowering also positively correlated with plant height, no. of pods per plant and seed yield. The nature of this association would appear to be that late-flowering genotypes had more time for vegetative growth ang higher yield under short-day conditions compared to extra-early and early plants. Further, association analysis revealed that the incidence of pod borer significantly reduced seed yield. Path analysis found that yield contributing traits such as plant height and no. of pods per plant has highest direct influence to seed yield. This indicates true relationship with seed yield and direct selection for these traits would result in higher breeding efficiency for improving seed yield.

Principal component analysis revealed that out of seven, only three principal components (PCs) exhibited more than 0.5 Eigen values and showed about 90.5% total variability among the traits studied (Table 2). The PC1 exhibited highest per cent variability (57.5%) followed by PC2 (24.7%), PC3 (8.29%), PC4 (4.70%), PC5 (3.24%), PC6 (1.31%) and PC7 (0.23%) among the accessions for the traits under study. The PC1 was dominated by phenological traits such as days to first flowering, days to 50% flowering, pod initiation and days to maturity. PC2 was dominated by yield contributing traits like plant height and PC3 accounts no. of pods per plant. The accessions having highest PC scores and those present in different PC components could be used for improvement of concerned traits in soybean breeding program.

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Table 1. Estimates of variability parameters for various quantitative traits

Trait	Mean	Range	Standard Deviation	CV	GCV	PCV	Heritability Broad sense	Genetic Advance	Genetic Advance as % of mean
Days to first flowering	40.62	28.76-55.42	4.64	2.57	11.12	11.42	94.93	9.08	High
Days to 50% flowering	42.67	30.76-57.76	4.53	2.26	10.32	10.57	95.43	8.88	High
Days to pod initiation	46.02	25.58-59.91	4.54	2.19	9.5	9.75	94.96	8.79	Medium
Days to maturity	83.49	62.61-105.61	6.6	5.62	5.73	8.03	50.9	7.04	Low
Plant height	28.29	7.23-65.03	11	8.13	37.17	38.09	95.23	21.17	High
No. of pods per plant	13.61	0-148.53	9.93	18.72	69.65	72.24	92.97	18.86	High
Seed yield per plant	1.31	0-11.52	1.21	55.33	61.53	84.24	53.36	1.22	High
Seed yield per plot	9.14	0-52.94	8.53	12.8	93.38	94.31	98.04	17.43	High
Percent pod borer damage	20.73	0-100.72	19.97	16.38	95.32	96.71	97.14	40.18	High

CV: Co-efficient of variation; GCV: Genotypic co-efficient of variation; PCV: Phenotypic co-efficient of variation

Table 2. Eigen values, % variance and Cumulative % of variance of soybean genotypes

Traits	Principal component	Eigenvalue	% of variance	Cumulative % of variance
Days to first flowering	PC1	4.025	57.507	57.507
Days to 50% flowering	PC2	1.730	24.709	82.216
Days to pod initiation	PC3	0.580	8.292	90.507
Days to maturity	PC4	0.329	4.701	95.208
No. of pods per plant	PC5	0.227	3.242	98.449
Plant height	PC6	0.092	1.316	99.765
Seed yield per plot	PC7	0.016	0.235	100.000

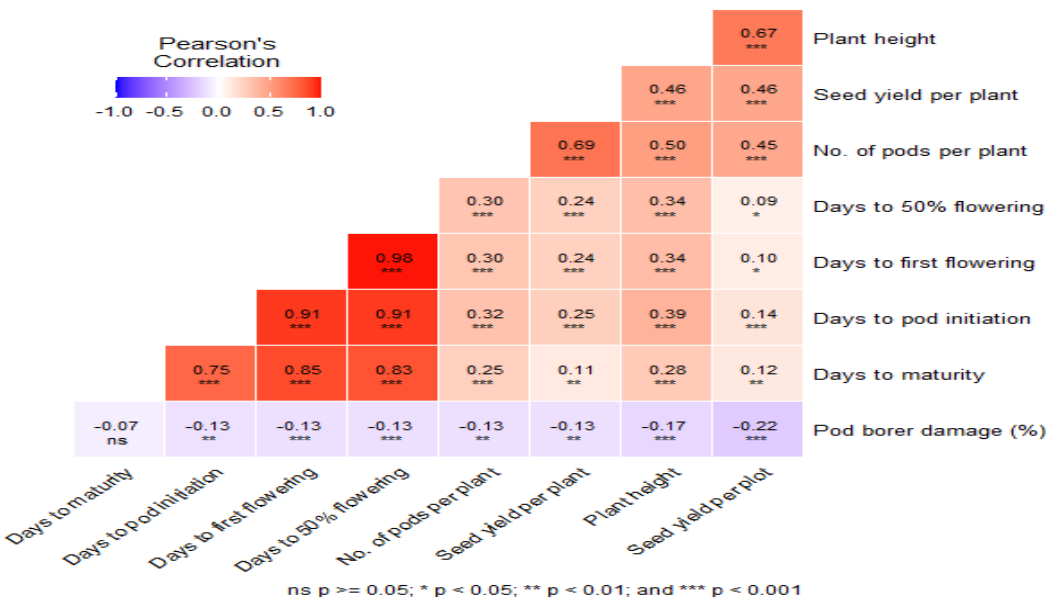

Figure 1. Correlation coefficients for phenological and yield contributing traits in soybean

Unravelling the genetic variability in *Brassica juncea* germplasm for morphological and biochemical traits to identify suitable donor

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ABSTRACT

In the present study, multivariate analysis was carried out among 87 germplasm accessions using 12 agro morphological traits and 9 biochemical parameters. Highest variation was observed for seed yield per plant (CV-52.35 %), glucosinolate content (CV-51.59 %) and oleic acid (CV- 42.88 %). Principal component analysis led to the identification of six principal components which explained 80 % of total variation. The first (PC1) and second principal component (PC2) explained 26.02 and 18.26 %, respectively of total variation. Total germplasm accessions are grouped in to the six clusters and cluster III and IV shows maximum inter cluster distance.

Oleiferous brassicas (rapeseed and mustard) are the major contributor of edible oil globally and ranks third after soybean and oil palm. At national level, rapeseed-mustard is second major oilseed crop in terms of area and production after soybean. *Brassica juncea* (L.) Czern & Coss (AABB, 2n=36) is a premier oilseed crop and most dominating species of this group and occupies more than 90 % of total acreage. In India, it is grown over an area of 9.17 million ha with production and productivity of 11.75 MT and productivity of 1178 kg/ha during 2021-22. Oleiferous brassicas are an important dietary component in India and oil quality is determined by fatty acid composition.

Indian mustard is the premier oilseed crop in India; therefore exploring genetic diversity for morphological traits and fatty acid profiling is a trailblazing step for its genetic improvement. **By** utilization of genetically diverse germplasm accessions in breeding programs will provide opportunity to harness allelic richness for creating new gene combinations. Therefore, present study is carried out to study genetic divergence and principal component analysis in different Indian mustard germplasm.

MATERIALS AND METHODS

The experimental material consists of 87 germplasm accessions of Indian mustard procured from ICAR-NBPGR, New Delhi and complete set were grown in paired row of 3.0 meter each during *rabi*, 2021-22 at Research Farm, RLBCAU, Jhansi (U.P.). Recommended package of practice was followed to raise a good crop and observations were taken on 12 morphological traits and 9 biochemical parameters. Principal component analysis and cluster analysis is carried out by R- package.

RESULTS AND DISCUSSION

The significant variations for all the traits were observed and maximum variation was observed for seed yield per plant (CV- 52.35 %), glucosinolate content (51.59 %) and oleic acid (42.88 %). Seed yield per plant varied from 1.3 g (EC765812) to 16.76 g (EC 766514) and it can be used as a parent for yield improvement. Improvement in oil content is also a challenging task and oil content in germplasms varied from 31.3 % (EC 766402) to 51.9 % (EC 634281) and the parent EC 634281 can be used as donor for oil content. Significant variation in fatty acid profile was observed among germplasm accessions and genotype EC 766124 recorded maximum 70.69 % oleic acid along with low linolenic acid (8.70 %) and erucic acid (5.8 %).

Principal component analysis revealed that only first six principal components (PCs) recorded Eigen values more than one and cumulatively these six PCs explained 80 % of the total variation. The first PC contributed 26 % variation and followed by 16.26 % by PC-II. Linoleic acid (15.11), followed by glucosinolate (13.77), oil content (12.67), oleic acid (8.87), palimitic acid (8.13), linolenic (7.54), seeds per silique (7.05), days to 50 % flowering (4.92) and days to 100 % flowering (4.59) contributed positively to first principal component and more than 80 % portion is covered by these traits only.

The cluster analysis grouped total accessions in to six groups. Cluster-I comprised maximum number of genotypes (79) whereas, cluster 2, 4 and 5 consist two accession in each cluster and cluster 3 and 6 accommodated only single genotype. Maximum intra cluster distance was observed by cluster-I (492.24). The maximum inter-cluster distance was found between the cluster-I and cluster-III (562.85). In maximum cases inter-cluster distances were higher than the intra-cluster distance that shows presence of wider genetic diversity among the germplasms of distant grouped.

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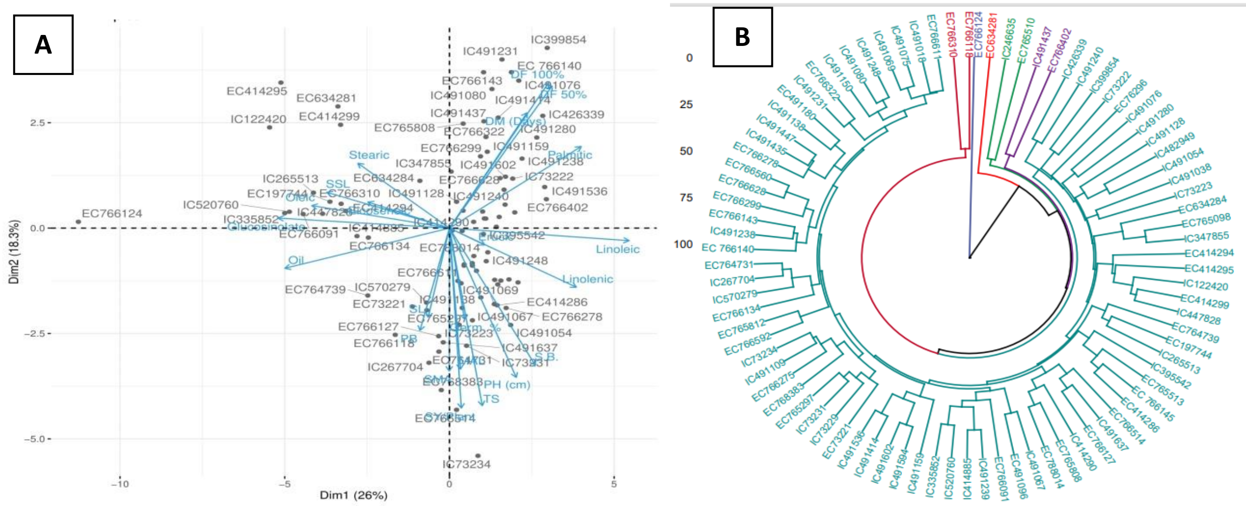

Fig. Biplot from Principal Component Analysis (A) and Circular dendrogram from cluster analysis (B)

Morpho-physiological diversity of Indian mustard (*Brassica juncea* L.) germplasm for terminal heat tolerance

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ABSTRACT

Two hundred genotypes with seven checks of Indian mustard were sown at two different interval (timely and late) in augmented block design for trait association and comparative phenotyping against heat stress at terminal stage. Correlation studies revealed that seed yield per plant had significant positive association with plant height, number of primary branches per plant, number of secondary branches per plant, leaf area index, total number of siliqua per plant, siliqua on main shoot and 1000- seed weight under both normal and late sown conditions. Based on results of heat screening parameters like heat susceptibility index, yield stability index and percent yield change, genotypes viz. NDRE-4, EC-399300, DRMR-13, DRMR-9, DRMR-7, DRMR-357, DRMR-6, EC-766423 and IM-76 were found promising for terminal heat tolerance.

India is cultivating nine oilseed crops as primary source of oil under the diverse agro-climatic condition. Among them, oilseed *Brassica* stands second after soybean (44.5%) in terms of area (rapeseed-mustard-24.98 %) whereas, in production it stands third (27.45 %) after soybean (33.77 %) and groundnut (30.40 %) however, stand first in edible oil production in the country (35.87 %). In India or Bundelkhand region, delayed sowing of the mustard crop after harvesting of rice, groundnut and cotton exposes to the high temperature stress during reproductive stage therefore terminal heat stress not only impaired the seed filling, thereby causing lower seed weight and seed yield that may be upto 50 % and 6-10 % reduction in oil content may also observed. Therefore, screening of mustard germplasm against the terminal heat stress is the need of time to strengthen resilience and will stabilize the mustard productivity.

MATERIALS AND METHODS

The present study was carried out during *rabi* 2021-22 at Seed and Research Farm, RLBCAU, Jhansi. A set of two hundred genotypes with seven checks of Indian mustard were sown in augmented block design at two different sowing dates for comparative phenotyping by calculating the yield stability index, heat stability index

(HSI)), yield stability index (YSI) and percent mean change and association analysis is carried out in both the situations.

RESULTS AND DISCUSSION

Under the heat stress, in general yield reduction was noticed and the average yield reduction was 50.36 percent whereas, maximum yield reduction of 87.88 % was observed in (EC-766311) and the yield increment was observed under heat tolerant genotypes and maximum increment was observed for NDRE-4 (50.91%). The lowest value of HSI was reported by NDRE-4 (-0.92) followed by the EC-399300 (-0.83), DRMR- 13 (-0.51), DRMR-9 (-0.42), DRMR-7 (-0.38), DRMR- 357 (-0.27), DRMR- 6 (-0.11), EC- 766423 (-0.07) and IM-76 (-0.01) and these genotypes are categorized as the promising genotypes for heat tolerance. The high value of YSI is considered promising with respect to heat tolerance and vice versa. The highest value for YSI was recorded by the genotype NDRE-4 (1.51) followed by EC-399300 (1.46), DRMR-13 (1.28), DRMR-9 (1.23), DRMR-7 (1.21), DRMR-357 (1.15), DRMR-6 (1.06), PM-26 (1.04), EC-766423 (1.04) and IM-76 (1.01) and these values were generally in the same direction as observed under HSI. Based on all three indicators, nine heat tolerant genotypes were identified viz. NDRE-4, EC-399300, DRMR-13, DRMR-9, DRMR-7, DRMR-357, DRMR-6, EC-766423 and IM-76. Correlation studies suggested that seed yield per plant had significant positive correlation with plant height, number of primary branches per plant, number of secondary branches per plant, leaf area index, total number of siliqua per plant, siliqua on main shoot and 1000- seed weight under both normal and late sown conditions.

Effect of split application of nitrogen and nano-urea supplementation on growth, yield and economics of linseed (*Linum usitatissimum* L.*)*

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ABSTRACT

A field experiment was conducted during *rabi*, 2021-22 at MARS, UAS Raichur, Karnataka to study the effect of split application of nitrogen and nano-urea supplementation on growth and yield of linseed (*Linum usitatissimum* L.). The results revealed that application of 100 % N (Two Splits - 50% N as basal + 50% N as top dressing) recorded higher seed yield of linseed which was found at par with the 75% N (Two Splits - 50% N as basal + 50% N as top dressing). The growth parameters, yield attributes and seed yield of linseed was significantly higher with two sprays of nano-urea @ 3ml /litre each at flower initiation stage and capsule development stage, which was found almost at par with the two sprays of 2% urea at flower initiation and capsule development stage. Economic analysis revealed that higher gross monetary returns and net monetary returns were noticed under the application of two sprays of nano-urea @ 3ml /litre each at flower initiation stage and capsule development stage.

Keywords: Linseed, Nano urea, NUE

Linseed also referred as flax (*Linum usitatissimum* L.) cultivated as a commercial or subsistence crop in over 30 countries. It is a great source of nutrients and contains 33 to 47 per cent of oil. Linseed oil is used for industrial uses. Plant nutrition is crucial for agriculture production and crop quality. The reason for low yield of linseed is poor fertility, inadequate use of fertilizers and traditional crop management practices. Nitrogen is one of the most important nutrients for linseed, is often applied for higher yield and better quality. Losses of nitrogen from agricultural fields due to leaching (NO_3) and gaseous emissions (NH_3 and N_2O) have been the leading causes of environmental pollution and one of the factors responsible for climate change. In order to get maximum benefit from nitrogen use, it should not only be applied in right quantity but also at right time. Application of nitrogen not synchronizing with the demand of the plant may result in various losses. The use of nano-fertilizers is the most important application of nano-technology in agriculture so far. Nano-fertilizers are aimed to make nutrients more available to leaves, consequently increasing nutrient use efficiency. Since no studies have been carried out to evaluate the effect of split application of nitrogen and nano-urea supplementation on growth yield and economics of linseed (*Linum usitatissimum* L.) so far. In this regard, the present investigation was carryout to assess the effect of nano-urea supplementation on growth, yield attributes, yield, quality, nitrogen use efficiency and economics of linseed.

MATERIAL AND METHODS

A field experiment was conducted during *rabi*, 2021-22 at MARS, UAS Raichur, Karnataka. The soil of the experiment was medium black clayey in texture with alkaline in reaction and medium in organic matter, low in available nitrogen, medium in available phosphorus and available potassium. The experiment was laid out in split-plot design assigning nitrogen management through fertilizers (4) treatments to main plots and nitrogen management through nano urea (5) treatments to subplots with three replications. Linseed crop variety NL-115 @ 25 kg/ha was sown at a spacing of 30 cm X 5 cm with a recommended dose of fertilizer 40:20:20 kg NPK per hectare. Full dose of phosphorus and potassium was applied as basal to all the treatments, whereas nitrogen was applied in two splits i.e. 50 % N as basal and 50 % N as top dressing at 30 DAS. The crop was sown on 27th November, 2021 and harvested on 16th March, 2022. The gross and net plot sizes were 4.5 m X 4.2 m and 3.8 m X 3.8 m, respectively.

RESULTS AND DISCUSSION

Effect of nitrogen management through fertilizers: Application of 100 % N (Two Splits - 50% N as basal + 50% N as top dressing) recorded higher seed yield of linseed which was found at par with the 75% N (Two Splits - 50% N as basal + 50% N as top dressing). The growth and yield attributing characters of linseed *viz.*, plant height at harvest, primary branches at harvest and number of capsules per plant of linseed were followed almost similar trends. In case of economic analysis higher gross monetary returns, net monetary returns and B:C ratio were noticed under the application of 100 % N (Two Splits - 50% N as basal + 50% N as top dressing) . The growth parameters, yield attributes and economics were found lowest under the 25% N (Two Splits - 50% N as basal + 50% N as top dressing). The optimum dose of nitrogen application (100 %) in two splits coincided with the critical stages of growth in the grand growth phases. It helped in maintaining the higher level of available nitrogen in the soil at these growth stages and throughout the growing period, accentuating greater uptake of nitrogen, higher nitrogen percentage of seed and stover yield augmenting the higher values of yield contributing characters *viz.*, number of capsules per plant and number of seeds per capsule, 1000 seed weight which ultimately resulted in higher seed and stover yield.

Effect of nitrogen management through Nano-Urea: The growth parameters, yield attributes and seed yield of linseed was significantly higher with two sprays of nano-urea @ 3ml /litre each at flower initiation stage and capsule development stage, which was found almost at par with the two sprays of 2% urea at flower initiation and capsule development stage. Foliar application of nano-fertilizers is aimed to make nutrients more available to leaves, consequently increasing nutrient use efficiency. The release of nitrogen when crops need it, eventually leading to increases in N efficiency through decreases in N leaching and emissions. Nano-scale nutrients when sprayed on plant leaves, are taken by two mechanisms: one by direct uptake or stomatal uptake and second is by surface absorption. Due to ultra-small particle size, such nutrients can rapidly be taken by the plants and as a consequence minimize the nutrient losses. Inside the plant cell, these nutrients slowly release the active nutrient component which involves itself in the plant's cellular metabolism for their growth and development (Yogendra Kumar *et al.*, 2021). This resulted in higher growth and yield parameters in linseed consequently higher seed and stover yield of linseed. In case of economic analysis highest gross monetary returns and net monetary returns were noticed under the application of two sprays of nano-urea @ 3ml /liter each at flower initiation stage and capsule development stage. The higher net monetary returns of linseed might be due to higher growth /yield components coupled with higher seed yield. However, the B:C ratio was found higher under the two sprays of 2% urea at flower initiation and capsule development stage .

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In vitro and *In vivo* evaluation of new fungicide molecules against grey mold of castor

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ABSTRACT

Grey mold of castor caused by *Botryotinia ricini* (Godfrey) is an important disease of castor. A study was conducted on *in vitro* and *in vivo* evaluation of seven new molecules of fungicides against *Botryotinia ricini* revealed that, among combination fungicides Fenamidone 10% + Mancozeb 50% WG recorded 100 per cent inhibition of mycelial growth at concentration of 500 and 1000 ppm under *in vitro* and *in vivo* (96.30%) next to Propiconazole (100%).

Castor is the most important non-edible oilseed crop of arid and semi-arid regions and contains 40-60 per cent oil content. The yield of castor is affected largely by grey mold which is caused by *B. ricini* (Godfrey), is devastating and difficult disease to manage. It causes direct damage to inflorescence and castor capsules, due to which yield loss could be as high as 100 per cent (Anjani, 2012). Availability of resistant source, is very negligible against the disease. Thus it is essential for spraying of fungicides at right time for the management of the disease. In the present study some of the new combination fungicides were tested both under laboratory and glasshouse condition for their efficient management of the disease.

MATERIALS AND METHODS

New fungicides molecules at different concentrations have been evaluated under both *in vitro* and *in vivo* conditions against grey mold of castor. *In vitro* and *in vivo* evaluation of 7 new combi fungicides was done by poison food technique (100, 250, 500 and 1000ppm) and spraying on detached spikes of castor at (500 and 1000ppm) different concentrations with replications. For *in vivo* diagrammatic scale (Sussel *et al.,* 2009) was considered to scoring.

Per cent inhibition of mycelial growth over control was calculated by using the formula.

$$I = \frac{C-T}{C} \times 100$$

Where,
I = Per cent inhibition,
C = Growth in control
T = Growth in treatment

RESULTS AND DISCUSSION

In vitro evaluation of seven combination fungicides against *B. ricini* revealed that 100 per cent mycelial growth inhibition in Fenamidone 10% + Mancozeb 50% WG at both 500 and 1000ppm concentration. Whereas, in Glass house evaluation the best performed fungicides on infected detached spikes of castor was Propiconazole 250EC (100%) followed by Fenamidone 10% + Mancozeb 50% (96.30 %) at both concentrations. The results are in accordance with Rashid *et al*. (2014) wherein the results were efficient for management of grey mold in Chickpea for combination fungicides of systemic and contact. .

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Estimation of combining ability and heterosis for seed yield and its attributing traits in Sunflower (*Helianthus annuus* L.)

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ABSTRACT

Field experiment was conducted to estimate the combining ability and heterotic effects of sunflower hybrids. Twelve lines and six testers were crossed in Line × Tester mating design to generate 72 hybrids *during Rabi /* summer 2021, which were further evaluated in *Kharif 2022* along with checks at UAS, GKVK, Bengaluru. The cross-combination CMS 335 A × RHA 95 C10 exhibited better *per se* performance and standard heterosis for seed yield plant^{-1} and oil content. Further the lines (CMS 17, CMS 335, CMS 597) and the testers (RHA 95C-10, RHA 278) exhibiting desirable combining ability should be preferentially used in hybrid development and testing for commercial exploitation.

Keywords: Combining ability, Heterosis, Sunflower, Hybrids, GCA, SCA

Hybrids generally have higher genetic potential for seed yield, uniform maturity, oil content, earliness, fertilizer/ nutrient response and buffer action against resistance to biotic and abiotic stresses than open-pollinated populations. One of the most effective ways to increase the yield is the usage of heterosis by using two line hybrids. The heterotic hybrid performance is based on the combining abilities of its parents. Combining ability studies provide information on the magnitude and nature of gene action involved *viz.*, additive genetic variance and dominance variance, which aid in selection of parents and crosses for successful hybrid development (Sapkale *et al 2016*). With this information the present investigation was conducted to assess the *per se* performance and general combining ability (*gca*) of CMS-lines and restorer lines for seed yield and its components and also to assess the specific combining ability (*sca*) and heterosis of the hybrids for seed yield and it's components.

MATERIALS AND METHODS

The experiment was conducted at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru. The experimental material comprised of twelve cytoplasmic male sterile lines derived from the *Helianthus petiolaris* source and were used to cross with the six RHA lines in Line × Tester fashion (Kempthorne, 1957) during *Rabi summer* 2021.

The resultant 72 hybrids along with the checks *viz;* KBSH-41, KBSH-42, KBSH-44 and KBSH-53were evaluated in RCBD during *Kharif* 2022. Simultaneously, 18 parental lines were evaluated in separate trial following RCBD during *Kharif 2022*. Observations were recorded on five representative/ randomly selected plants in each entry/genotype (hybrids, parents and check) for eight quantitative traits.

RESULTS AND DISCUSSION

The ANOVA (Table 1) revealed the existence of highly significant differences among genotypes, parents, lines, crosses and parents vs crosses for all the traits under the study. Significant variances for parents *vs* crosses suggested the presence of heterotic effects in breeding material, indicating the use of these parental lines for the development of hybrids.

Among the seed parents utilized in the current investigation, the lines that appeared to be desirable general combiners for multiple traits of which the line CMS 17 A showed desirable direction for volume weight, head diameter, seed yield plant^{-1}, test weight and stem diameter. Another well performing line, CMS 103 (B) was found to exhibit desirable *GCA* effects for days to 50% flowering, plant height, head diameter, seed yield plant^{-1} and hundred seed weight. Among the testers, RHAGMU755 appeared to be desirable general combiner for days to 50% flowering, stem diameter, plant height, head diameter, test weight, oil content and hundred ml volume weight. (Table 2a and 2b)

The present task of developing hybrids is to maintain the yield level of KBSH-44 (National check) and oil content near or above that of KBSH-53. The hybrid CMS 335 A x RHA 95 C 10,displayed highest standard heterosis of 197.91 over KBSH-44 followed by CMS 17 A x RHA 95 C 10 (158.91) and CMS 597 A x RHA GMU 756 (104.3) (Table 3). The hybrid combination CMS 335 A×RHA 95 C 10 (14.99 %) expressed the highest significant positive heterosis followed by the hybrids CMS 597 A × RHA GMU 756 (13.64%) and CMS NDCMS 2A × RHA GMU 756 with 11.33% over the check KBSH-44 for oil content (Table 3). In the future the same hybrids shall be tested for their superiority by large scale testing under multilocation and multi season trials.

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Table 1. Analysis of variance for seed yield and yield attributing traits

Source of variation	Df	Days to 50% flowering	Plant height (cm)	Stem diameter (cm)	Head diameter (cm)	Seed yield plant^{-1} (g)	Volume weight (g/100ml)	Hundred seed weight (g)	Oil content (%)
Replication	1	38.05 **	38.82**	0.31	2.91	6.57**	1.96*	1.61**	3.77
Treatments	89	25.30 **	1837.53 **	0.32	7.99 **	253.55**	53.56**	1.54	11.55**
Parents	17	8.77**	1015.15**	0.06	8.42 **	72.94**	54.45**	1.36	8.69**
Lines	11	11.09**	554.16 **	0.04	4.36 **	61.86**	46.61**	0.52**	9.26**
Testers	5	5.35	1187.20**	0.05	2.49 **	4.19**	79.82**	0.52**	6.68**
Lines *vs* Testers	1	0.50	5225.82**	0.32	82.73**	538.57**	13.79**	14.83**	12.50**
Parents *vs* Crosses	1	11.25**	112567.50**	8.87**	167.50**	8793.69**	1547.27**	11.08**	157.55**
Crosses (C)	71	29.46**	474.86**	0.26	5.64 **	176.52**	32.31**	1.44**	10.17**
Error	89	0.51	8.96	0.2	3.4	0.78	0.38	0.01	7.87

* Significant at P=0.05 ** Significant at P=0.01

Table 2a: Estimates of *gca* effects of seed parents based on male sterility inducing cytoplasm

Lines	Seed yield/plant	Test weight (g)	Volume weight	Oil content
CMS 17 B	8.63 **	0.58 **	5.43 **	-1.82 **
CMS 56 B	-4.16**	-0.023	0.592 **	1.54 **
CMS 58 B	-2.56**	-0.64 **	-1.89 **	-2.39 **
CMS 59 B	-3.96 **	-0.45 **	-3.23 **	-1.75 **
CMS 103 A (B)	3.83 **	0.23 **	-2.38 **	-1.58 **
CMS 103 A (R)	-2.09 **	0.48 **	1.95 **	1.93 **
CMS 275 B	-2.40 **	-0.23 **	-0.517 **	0.51 **
CMS 335 B	3.78 **	-0.42 **	-0.76 **	1.74 **
CMS 597 B	4.49 **	0.098 **	0.73 **	1.79 **
CMS 850 B	-9.42 **	0.11 **	0.196	1.26
CMS 911 B	1.49 **	-0.17 **	0.097	1.66 **
NDCMS 2B	2.38 **	0.43 **	-0.219	-0.90 **
S. Em±	0.51	0.04	0.25	1.21
CD at P=0.05	1.7	0.16	0.83	1.5
CD at P=0.01	1.2	0.12	0.57	1.4

* Significant at P=0.05 ** Significant at P=0.01

Table 2b: Estimates of *gca* effects of testers

Testers	Seed yield/plant	Test weight	Volume weight	oil content
RHA GMU 755	-0.56**	0.22 **	0.88 **	0.41 **
RHA GMU 756	-1.60 **	0.042	0.251 *	0.80 **
RHA GMU 762	-1.20 **	-0.26 **	0.43 **	0.172 **
RHA GMU 763	-0.237 *	-0.27 **	1.96 **	0.50 **
RHA-278	0.79 **	-0.40 **	-1.90 **	-1.65**
RHA 95 C 10	2.81 **	0.67 **	-1.62 **	-0.24 **
S. Em±	0.14	0.02	0.18	0.07
CD at P=0.05	0.29	0.05	0.35	0.15
CD at P=0.01	0.38	0.06	0.47	0.27

Table 3. Per cent heterosis over standard checks KBSH-41, KBSH-42, KBSH-44 and KBSH-53 for seed yield and yield attributing traits

Hybrids	Seed yield/plant				Oil content			
	KBSH-41	KBSH-42	KBSH-44	KBSH-53	KBSH-41	KBSH-42	KBSH-44	KBSH-53
CMS 335A×RHA 95C10	72.75**	142.59**	197.91**	309.8**	9.15**	25.49**	14.99**	4.73**
CMS 17 A×RHA 95C10	50.14**	110.83**	158.91**	256.21**	5.11**	20.84**	10.73**	0.85
CMS 911A×RHA GMU 755	28.56**	20.41**	33.18**	43.90**	9.06**	12.89**	11.71**	9.47**
CMS 58 A×RHA GMU 755	11.25**	56.23**	91.85**	163.95**	-12.10**	1.06	-7.40**	-15.66**
CMS NDCMS 2A×RHA GMU 756	14.35**	7.35**	18.75**	28.29**	8.68**	12.50**	11.33**	9.09**
CMS 103A (B) ×RHA GMU s756	18.11**	65.86**	103.68**	180.23**	3.69**	19.21**	9.24**	0.51
CMS 103A (B) ×RHA GMU 762	-43.17**	-20.15**	-1.95	34.90**	-10.17**	3.27**	-5.37**	-13.81**
CMS 597 A×RHA GMU 756	16.80**	64.02**	104.3**	177.12**	7.87**	24.01**	13.64**	3.50**
CMS 56 A×RHA GMU 762	-20.62**	11.47**	36.89**	88.43**	5.15**	20.89**	10.78**	0.9
CMS 59 A×RHA -278	-1.75	37.97**	69.43**	133.40**	12.85**	0.19	-8.19**	-16.38**

Toward improvement of oil content in safflower (*Carthamus tinctorius* L.)

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Safflower is one of the humanities oldest crop but world wide comparatively a minor crop limited in distribution because of environmental factor and spiny nature of the crop. More or less Day neutral crop but thermo-sensitive so grown as a *rabi* crop It has got phenotypic plasticity of plant population i.e. variation in plant density changes structure and branching maintaining same yield levels. Safflower, a multipurpose oilseed crop Seed - cooking oil, bird seed Petals - natural dyes (Carthamin) and medicinal use (herbal tea). However in India safflower is manly grown for its premium Oil. The oil content off ruling varieties viz, A1, PBNS -12, Bhima, Phule Kusuma and SSF-708 is around 28-3o% and hence scope for increase the oil content. India import oil more than 60% percent of its annual Requirement. In important to make effort toward the increasing oil production by improving the oil content.

MATERIAL AND METHODS

The development of safflower varieties with high yield and high oil content was the main breeding objective. Accordingly the crossing programme was started from beginning of AICRP on Safflower at Solapur. The crosses, F_1 and further segregating generations the material evacuation was done by using Pedigree method. The varieties were screened in Station Multilocation AIVT AVT-I and AVT-II trials in corresponding years. The Finely statistically superior entries as per Panse and Sukhate (1985) for seed and oil yield were released for cultivation

RESULT AND DISCUSSION

Improvement in Seed and Oil yield: Initially the safflower genotype SSF-708 has been evolved from the cross Nari-2XJSI -99.The genotype after 6 segregating generations tested in university as well as All India coordinated trials.The entry recorded seed yield of 1376 kg/ha which was 19.57 % higher over check Phule kusunma (1107kg/ha) and over Bhima (1130kg/ha) with oil content 22.44%.. On the basis of Superiority in seed and oil the entry was released for cultivation in 2008. ((Shinde et al 2012),

Further the improvement in seed and oil content another genotype SSF-1371 was developed and identified for all India zone-1 for cultivation in 2019. The entry was evolved from cross (Bhima x NARI-44). On the basis of pooled mean the entry SSF-13-71 (1999 kg/ha) recorded 9.84% higher seed yield over the national check A1 (1820 kg/ha) and 17.47 % over the check PBNS-12(1702 kg/ha in Zone-I. However, SSF-13-71 (591 kg/ha) recorded 14.98 % & 18.67 % higher oil yield over the National check A1 (514 kg/ha) and PBNS-12 (498 kg/ha) respectively in Zone-I. The average oil content of SSF-13-71(Bhima x NARI-44) is 29.2 % which was higher than check entry A1 (27.2 %). (Anonymous 2016-17to 2018-19).

Another variety SSF-16-02 (Selection from GMU-2757) was developed and identified in 2020-21for higher seed as well as oil yield. The SSF-16-02(2058 kg/ha) recorded 10.05% higher seed yield over the national check A1 (1872 kg/ha) in coordinated trials conducted for three years. Further, SSF-16-02 (632 kg/ha) recorded 19.92 % higher oil yield over the National check A1 (527 kg/ha). The average oil content of SSF-16-02 is 30.55 % which was 2.61% higher than check entry A1 (27.94%). (Anonymous 2017-18to 2020-21)

Improvement in Oil content and Oil yield: The entry SSF-12-40(Bhima x A1) was developed and identified for cultivation inZone-1in 2019. The average oil content of SSF-12-40 is 32.9 % which was4.9 % higher than check entry A1 (27.92 %). The seed yield was at par with the checks, however, SSF-12-40 (565 kg/ha) recorded 19.21 % & 13.23 % higher oil yield over the National check A1 (473 kg/ha) and PBNS-12 (498 kg/ha) respectively in Zone-I. (Anonymous 2016-17 to 2018-19)

As result of further improvement in Oil content, the entry SSF-15-65 (Bhima x GMU-2724) was developed and identified for cultivation in 2020-21. The average oil content of SSF-15-65 is 34.60 % which was higher by 7% than check entry A1 (27.76 %). The SSF-15-65(575 kg/ha) recorded 25 % higher oil yield over the national check A1 (460 kg/ha) in Zone-I. However for seed yield of SSF-15-65 (1665 kg/ha) is at par with national check A1 (1654 kg/ha) in Zone-I. %). (Anonymous 2017-18to 2020-21).

In the oil improvent program implanted at AICRP safflower Solapur there is achievement in oil content from 30% to 34.6%. Now the varieties having higher seed yield and higher oil yield are available. It is possible to harvest more oil from the limited area which will help to increase the oil production to greater extent.

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Table 1. Summary Oil yield data of Coordinated Varietal Trials Oil yield (kg/ha)

Year of testing	No. of trials/ locations	Proposed variety SSF-13-71	National Check 1 (A1)	Zonal Check 2 PBNS12
IVT-I 2016-17	9	666	606	553
AVT-I&II 2017-18	7	589	521	520
AVT-II 2018-19	4	426	297	333
Weighted Mean	20	591	514	498
Percent increase over			14.98	18.67

Table 2. Summary of Coordinated Varietal Trials Oil yield (kg/ha) and oil content (%)

Year of testing	Oil yield (kg/ha)		Oil content (%)	
	SSF-16-02	A1(NC)	SSF-16-02	A1(NC)
2017-18(IVT)	635	567	31.0	28.80
2018-19(AVT-I)	626	507	30.0	26.80
2019-20 (AVT-II)	634	497	30.67	28.23
Weighted Mean	632	527	-	-
Percent increase over	-	19.92	30.55	27.94

Table 3: Summary Oil yield (kg/ha) and oil content of Coordinated Varietal Trials, Zone-I

	Oil yield (Kg/ha)			Oil Content (%)		
Year of testing	SSF-12-40	A1(NC)	PBNS12(NC)	SSF-12-40	A1(NC)	PBNS12(NC)
1st year 2015-16	455	375	411	31.07	26.36	28.20
2nd year,2016-17	694	575	586	34.7	28.9	30.3
3rd year, 2017-18	592	513	537	32.8	28.5	29.4
Weighted Mean	564.5	473.54	498.54			
%increase over	-	19.21	13.23	32.86	27.92	29.3

Table 4. Summary of Coordinated Varietal Trials -Oil yield (kg/ha) and Oil Content (%), Zone-I

Year of testing	Oil yield (kg/ha)		Oil Content (%)	
	SSF-15-65	A1(NC)	SSF-15-65	A1(NC)
2017-18(IVT)	601	515	34.60	28.60
2018-19(AVT-I)	570	409	33.60	26.20
2019-20 (AVT-II)	544	439	35.64	28.23
Weighted Mean	575	460	-	-
Percent increase over		25.0	34.61	27.76

Safflower (*Carthamus tinctorius* L.) based cropping systems productivity with modified agronomy in the background of broad bed and furrow land configuration

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ABSTRACT

Soil moisture specific agronomy for safflower based cropping systems is essential to enhance crop productivity as well as cropping system productivity. Soybean (ND) with 4 rows/BBF x 100% RDF (P through SSP) + *Rhizobium* - safflower with 3 rows/BBF x 100% RDF + *Azotobacter* + PSB is the best combination for saturated level of profile soil moisture.

Profile soil moisture availability during cropping period is one of the constraints influencing safflower based cropping systems productivity (Padmavathi and Virmani 2013). Greengram-safflower and soybean-safflower are the important safflower based cropping systems. Broad bed and furrow land configuration facilitates planting of safflower under zero tilled conditions after harvest of *kharif* crop. Development of soil moisture specific agronomy in terms of plant population and fertilizer is required to enhance crop/cropping system productivity.

MATERIALS AND METHODS

The field experiment was conducted during 2020-21 in deep Vertisols under rainfed conditions at IIOR-ICRISAT farm in broad bed (1.2 m) and furrow (0.3 m) method of land configuration (BBF) in deep Vertisols with three safflower based cropping systems *viz.* greengram (Var. WGG-42)-safflower and soybean (normal duration Var. JS-335)-safflower and soybean (short duration Var. JS-93-05)-safflower. Four rows of *kharif* crop were grown on each broad bed and furrow with a row to row spacing of 30 cm. In each cropping system, safflower (Var. TSF-1) was tested with 6 treatment combinations ((two levels of plant geometry (2 rows/BBF; 3 rows/BBF) and three IPNM (integrated plant nutrient management) levels (control, 50% RDF + *Azotobacter* + PSB, 100% RDF + *Azotobacter* + PSB)) in split plot design with two replications. The amount of rainfall received during cropping period was 1385 mm (June to February). During *rabi* (October to February) it was 387 mm.

RESULTS AND DISCUSSION

Safflower productivity did not differ significantly when preceded either with greengram or soybean (ND or SD), however the system productivity of soybean (normal duration)-safflower was significantly the highest. Safflower productivity and system productivity were the highest with 3 rows/BBF x 100% RDF + *Azotobacter* + PSB.

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Impact of *kharif* crops, plant geometry and IPNM on safflower productivity (kg/ha)

Treatments	Safflower seed yield	Safflower equivalent yield
Cropping system		
Greengram-safflower	1452	1902
Soybean (ND)-safflower	1519	2679
Soybean (SD)-safflower	1445	2285
C.D ($p\leq0.05$)	NS	285
Plant geometry x IPNM		
3 rows x control	1300	2117
3 rows x 50% RDF + *Azotobacter* + PSB	1550	2367
3 rows x 100% RDF + *Azotobacter* + PSB	1918	2735
2 rows x control	1100	1917
2 rows x 50% RDF + *Azotobacter* + PSB	1420	2237
2 rows x 100% RDF + *Azotobacter* + PSB	1543	2360
C.D ($p\leq0.05$)	316	340
Interaction	NS	NS

Penetration behaviour of reniform nematode, *Rotylenchulus reniformis* on resistant and susceptible genotypes of Castor, *Ricinus communis*

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ABSTRACT

Penetration behavior of reniform nematode on nematode resistant (JC-12) and nematode susceptible (48-1) genotypes of castor was studied. Results showed that higher number of nematodes was attached to the roots of 48-1 than JC-12 as average root population of 48-1 and JC-12 were 60.3 and 9.8 respectively at four weeks after inoculation. Lowered nematode reproduction was observed on roots of resistant genotype (JC-12) as average number of eggmasses at 7, 14, 21 and 28 days after inoculation were 2.8, 5.0, 8.0 and 9.8. Corresponding values of susceptible genotype (48-1) were 38.3, 42.3, 46.3 and 60.3.

Keywords: Castor, Penetration, Reniform nematode, Resistance, Reproduction, Susceptibility

Castor is an economically important non-edible oilseed crop grown in tropical and sub-tropical regions of the world and India is the leading producer of castor sharing 65% of world castor growing area (0.75 million ha) with more than 85% of world's castor production (1.2 million tonnes) (FAOSTAT, 2019). Several biotic and abiotic factors account for our country's lower average productivity (1600kg/ha). Reniform nematode, *Rotylenchulus reniformis* is one among the major biotic factors affecting castor crop. This polyphagous, semi-endoparasite attacks numerous cultivated crops and yield loss estimates by Jain *et al* (2007) indicated that in castor, this nematode inflicts monetary loss to the tune of Rs. 180 million (13.93%). Interaction of the nematode with wilt pathogen, *Fusarium oxysporum* f. sp. *ricini* aggravates wilt incidence. Evaluation of various castor inbred lines, hybrids etc., under ICAR-AICRP on Castor, identified inbred line JC-12 developed by Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur as resistant to reniform nematode (Giribabu, 2014). Our objective is to study the penetration behavior of reniform nematode on resistant (JC-12) and susceptible (48-1) genotypes of castor.

MATERIALS AND METHOD

Plant materials: JC-12, reniform nematode resistant inbred line, and 48-1, susceptible line were selected for this study based on these genotypes' response under pot experiment conditions.

Methodology: Seeds of JC-12 and 48-1 were sown in plastic pots (500ml) filled with sterilized red soil, sand and vermicompost in the ratio of 2:1:1. Two weeks after sowing the seedlings were inoculated with freshly hatched second stage juveniles (J_2s) of reniform nematode @ circa 1000 J_2s / plant. Plants were harvested at 7, 14, 21 and 28 days after inoculation and the root nematode population was enumerated. Each treatment was replicated five times and the experiment was arranged in completely randomized design.

RESULTS AND DISCUSSION

Results showed that infective young females preferred to infect and penetrate the roots of susceptible genotype, 48-1. This was evident as average number of nematodes attached to the roots of 48-1was 60.3, which was six folds higher when compared to its counterpart, JC-12 (9.8) at four weeks after inoculation. At one week after inoculation, average number of nematodes attached to the roots of resistant and susceptible genotypes was 2.8 and 38.3 respectively. The same trend was observed in subsequent weeks. At two weeks after inoculation, the values were 5.0 and 42.3 respectively. At three and four weeks after inoculation, number of eggmasses attached to the roots of JC-12 and 48-1 were 8.0 and 46.8 and 9.8 and 60.3 respectively. Thus, it was concluded that JC-12 supports only 10% of population supported by its susceptible counterpart, 48-1. Nature of nematode resistance in JC-12 was governed by many genes, as QTL mapping using a linkage map consisting of 1,090 SNP markers resulted in the identification one QTL each on chromosome-6 and chromosome-8, linked to resistance (Poornima Kumari *et al*., 2022).

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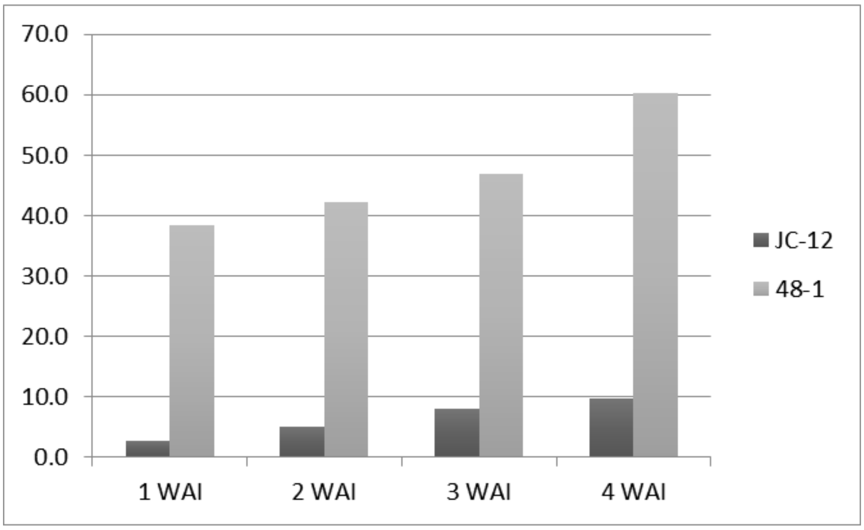

WAI – Weeks after inoculation

Fig.1. Number of eggmasses attached to the roots of resistant and susceptible genotypes of castor inoculated with reniform nematode, *Rotylenchulus reniformis*

Geographic specificity of infestation of phytoplasma in weeds and sesame as revealed *by 16S rRNA* gene based detection

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ABSTRACT

Nested PCR based study and analysis of the sequences of 16SrRNA fragment clones derived from the DNA isolated phyllody affected as well as healthy leaves of sesame crop and the weeds growing in the same fields showed that the prevalent strain of phytoplasma belonged to *Candidatus Phytoplasma aurantifolia* of 16SrII-D group. This study showed that the phytoplasma causing phyllody infects other weed plants and thus provides a hint to the continuum in the availability of the pathogen infecting sesame crop.

Keywords: Nested PCR, Phyllody, 16SrRNA, Sequence analysis

Bacteria without cell walls known as phytoplasmas are known to spread illness among hundreds of plant species around the world and are pathogens of both insects and plants (Liefting et al., 2004). While not all phytoplasma-infected plant species exhibit disease symptoms, infected plants typically exhibit signs including virescence, phyllody, yellowing, witches broom, leaf roll, and generalised decline (Bertaccini et al., 2022) in hosts including commercially significant food, fibre, forage, fruit, and ornamental plant species. Phytoplasmas have been recently assigned to a novel candidate taxon, 'Candidatus Phytoplasma' (IRPCM Phytoplasma/ Spiroplasma Working Team – Phytoplasma Taxonomy Group, 2004). 'Candidatus Phytoplasma' are delineated primarily on the basis that strains within a candidate species share at least 97.5 % sequence identity within their 16S rRNA gene, with new branches being constantly identified (Wei et al., 2007). An initial identification of the phytoplasma using sequencing of the 16S rRNA is very crucial and could give a preliminary idea about the species being prevailing in a particular region. In this study, we have used the nested PCR based stratification to identify and infer phytoplasma infecting sesame and the weeds growing in the same fields as sesame crop.

MATERIALS AND METHODS

Genomic DNA was extracted from leaf samples (the midrib and veins) of three symptomatic and three asymptomatic phyllody affected sesame crops from different regions like Hyderabad, Gujarat, Madhya Pradesh, Tamil Nadu and from phyllody affected weeds like *Cleome*, *Physalis* and *Parthenium* using CTAB (Cetylmethylammonim bromide) method. The detection of phytoplasma was achieved through PCR amplification using phytoplasma specific universal 16S rDNA primers P1/P7 (Deng and Hiruki, 1991), followed by nested PCR with primer pair R16F2/R2n (Gundersen and Lee, 1996). The 1.2Kb fragment obtained was cloned in T/A vector and transformed *E. coli* DH5α. Five positive clones were sequenced and the analysis of sequences was carried using NCBI-BLASTn tool from NCBI and the similarities were checked using CLUSTAL Omega multiple sequence alignment tool.

RESULTS AND DISCUSSION

Positive clones obtained were further confirmed with PCRs and restriction digestion. Five positive clones from each cloning attempt were sequenced with the M13 primers present in the vector. Initially the analysis was carried out with sesame clones. The sequences obtained were trimmed of the vector sequences and were aligned into a contigs using online bioinformatics software (https://www.bioinformatics.nl/cgi-bin/emboss/merger) and the contigs of 1244 bases were obtained. Sequence homology (by BLASTn analysis) revealed that this isolate was highly similar to *Candidatus Phytoplasma aurantifolia* isolate OS-KACh-AB with 99.92% identity with 100% query cover. Virtual RFLP analysis using online software (https://plantpathology.ba.ars.usda.gov/ phytoplasma.html) (Wei et al., 2007) revealed that the 16S rDNA F2nR2 fragment was identical (similarity coefficient 1.00) to the reference pattern of 16Sr group II, subgroup D (GenBank accession: Y10097). It revealed that the phytoplasma strain of IIOR belonged to 16SrII-D subgroup and not 16SrI-B group (as reported for the strain isolated by Delhi University). The sequence similarity of this isolate (P-IIOR) with two known Phytoplasma isolates causing sesame phyllody in India (P-IARI isolate GKP-1 isolated at IARI, New Delhi (GenBank: KF728959.1) and P-Hyd (Sequence ID: KP297862.1) deposited by HCU, Hyderabad]. This analysis clearly indicated that P-IIOR showed similarity to *Candidatus Phytoplasma aurantifolia* and belonged to 16SrII-D. Percentage identity matrix revealed that P-IIOR showed more similarity to *Candidatus Phytoplasma aurantifolia* isolate OS-KACh-AB and P-Hyd (99.92%) of 16SrII-D subgroup and less similarity to P-IARI (90.36%), strain that belonged to 16SrI-B subgroup (Table 1). Similar studies of 16S rDNA sequences with clones obtained from other sesame samples as well as from weeds growing along in sesame crop showed that there were similarities among the phytoplasma infecting the plants growing in together (Table.2).

Thus, the present study showed that the phytoplasma infesting sesame and some weeds growing along with sesame crop in the same area belonged to similar species of *Candidatus Phytoplasma aurantifolia*. The wide host range of the phytoplasma infecting sesame crop provides a clue regarding the continuum in the supply of inoculum of this obligate pathogen to the sesame crop. Therefore, further molecular studies to identify the pathways that effect the induction of phyllody in crop plants would help to develop strategies to reduce the incidence in commercially important crop production.

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Table 1. Percentage identity matrix among P-IARI, P-IIOR, and P-Hyd isolates of Phyllody phytoplasma

	P-IARI	P-IIOR	P-Hyd
P-IARI	100.00	90.26	90.36
P-IIOR	90.26	100.00	99.92
P-Hyd	90.36	99.92	100.00

Table.2. Sequence similarities of phytoplasma16SrDNA isolated from weeds and sesame

Plant Name	NCBI BLAST similarity	Similarity with P- IIOR
Cleome (weed)	Cleome phyllody (KC295291.1)	98 %
	Candidatus phytoplasma aurantifolia (ON 975020.1)	
Parthenium (weed)	*CP aurantifolia* (ON 975020.1)	95%
Physalis minima (weed)	*CP aurantifolia* (ON 975020.1)	98%
Sesame B1 (Tamil Nadu)	*CP aurantifolia* (ON 975020.1)	93%
Sesame RT-351 (Madhya Pradesh)	*CP aurantifolia* (ON 975020.1	99%
Sesame VS-19-036 (Gujarat)	*CP aurantifolia* (ON 975020.1)	99.83%
Sesame G1 (Gujarat)	*CP aurantifolia* OK625583.1	99%
Sesame- MSC-66 (Gujarat)	*CP aurantifolia*	98%
Sesame (IIOR)	*CP aurantifolia*	100%

Prospects of genome-editing in oilseed crops

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ABSTRACT

Genome editing (GE) has opened up new vistas for precise trait manipulation in different crops. The other main attractions of GE has been the production of transgene free trait manipulated plants even though the GE involves a genetic transformation step to introduce the GE machinery into the plant cells. This enables better social acceptability of the genome edited plants and already in many countries including India, the edited plants with SDN-1 (site directed nuclease – class I) strategy have been exempted from the purview of regulations by statutory bodies (such as GEAC in india) that monitor and regulate the release of genetically modified organisms. Among the several tools of GE that have been discovered and harnessed, CRISPR/Cas9 has been the most efficient and widely used. CRISPR/Cas9 mediated GE has been demonstrated and adopted in oilseed crops already. However, there are limitations and bottle necks such as amenability of the crop for *in vitro* genetic manipulation and the availability of functionally validated gene models for trait manipulation, which are limiting application of GE widely in oilseed crops. We discuss here the prospects of GE in oilseed crops.

Keywords: CRISPR/Cas9, Genome editing, Oilseed crops, Transformation

The ever-growing demand for vegetable oil has necessitated a surge in the production of oilseed crops. Unfortunately, productivity is often hindered by biotic and abiotic stresses and the non-availability of resistance source in the primary gene pool makes it difficult to achieve desired results through conventional breeding approaches. Also, this approach is in not only time consuming but also it is not possible to completely remove the linkage drag associated with trait transfer. This is due to the lack of genetic variability for certain traits, such as stress tolerance, as well as the time required for selection and the realization of a suitable genetic assemblage from the segregating populations. To overcome these obstacles, alternate approaches must be adopted. Genome editing (GE) technology provides a viable solution, allowing for precise modifications to the genome with minimal genetic perturbation in the shortest time. This technology has already been successfully implemented in a variety of crops including oilseeds.

Among different genome editing tools, CRISPR/Cas9 has revolutionized the pace of plant biology research and made precise plant genome editing a reality, transforming the field into an attractive and competitive one in a very short time. This technology has been used to manipulate agronomic traits in many crops, and the introduction of various versions of CRISPR/Cas9 with subtle but effective modifications has opened up novel ways of genome manipulation, such as base editors, prime editors and frame editors (Nakade *et al*. 2022). As the field continues to evolve, more crops and traits are being brought under its fold of benefits. However, there are specific requirements to adopt genome editing approach in crops, including: (i) genome sequence information; (ii) functionally characterized target gene(s); (iii) a DNA transfer method; (iv) suitable expression systems, and (v) a suitable regeneration system, preferably a genotype independent one, to obtain edited plants from the transformed cells.

The deciphered genome sequence of oilseed crops such as Soybean (Glycine max), Rapeseed (*Brassica napus*), Peanut (*Arachis hypogaea*), Palm oil (*Elaeis guineensis*), Sunflower (*Helianthus annuus*), Coconut (*Cocos nucifera*), Cottonseed (*Gossypium hirsutum*), Linseed (*Linum usitatissimum*), Sesame (*Sesamum *indicum*), Camelina (*Camelina sativa*), Castor bean (*Ricinus communis*), Safflower (*Carthamus tinctorius*), and *Jatropha curcas*, provides a great platform to choose the target gene sequences. Among the limitations of genome-editing in oilseed crops, the most significant bottleneck is the genetic transformation and in-vitro regeneration of callus cells. To overcome this obstacle, researchers have recently developed a plant tissue culture (PTC)-free genome-editing technique that involves the *de-novo* microinjection of developmental regulators and the use of viral vectors into meristematic cells of the plants already expressing the Cas9 gene (Vaikuntapu *et al.* 2020).

Allele mining, phenotypic analysis of chemically induced, T-DNA, and transposon -mutants, map-based cloning of QTLs, candidate gene-based phenotyping, transgenics - both silencing and overexpressing types, transcriptome studies, pathway analysis, and other techniques are just a few of the methods being used to determine the function of genes and their role in trait development. This information can be used to identify target genes for manipulation through gene editing, allowing for the development of new and improved traits (Vaikuntapu *et al*. 2022).

Based on the literature available across all crops and the specific research objectives of oilseed crops, Figure 1 illustrates the possible target traits and genes that could be edited. Basic functional genomics studies have provided ample evidence to use these specific genes for trait manipulation in oilseed crops. This information provides a valuable insight into the potential of oilseed crops and the possibilities for further research. Thus the scope of applications of GE in oilseed crops is immense and to harness the benefits of GE, efficient genetic transformation protocols are to be developed and the lessons and cues from successful examples in other systems are to be adopted. The efforts should fructify in genome edited oilseed crops that address the unresolved issues in oilseed crops.

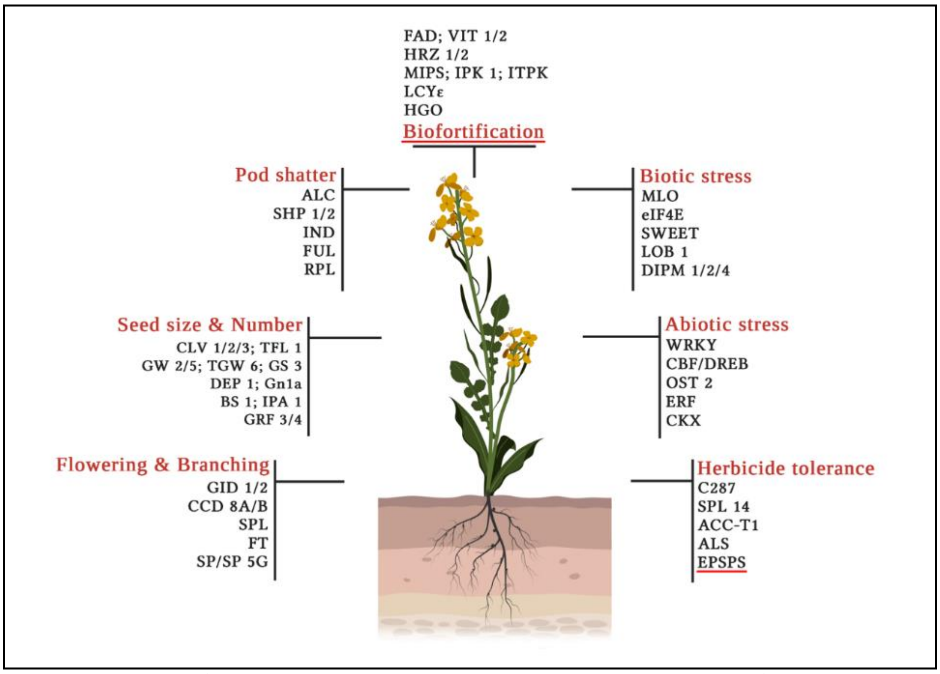

Figure 1: Promising traits and probable gene targets for editing by CRISPR/Cas in oilseed crops. RPL, Replumless; FUL, Fruitfull; IND, basic helix-loop-helix gene Indehicent; SHP 1/2, MADS-box genes Shatterproof 1/2; ALC, Alcatraz; EPSPS, encodes 5'enolpyruvylshikimate 3-phosphate synthase; ALS, acetolactate synthase; ACC-T1, acetyl-coenzyme A carboxylase; SPL 14, Squamosa Promoter Binding-Like 14; C287, C287 mutant of acetolactate synthase; CKX, cytokinin oxidase/dehydrogenase; ERF, ethylene responsive factor; OST 2, Open Stomata 2; CBF/DREB, C-repeat/DRE binding factor/ Dehydration Responsive Binding Element; WRKY, encodes transcription factors; DIPM 1/2/3, DspE-interacting proteins of Malus 1/2/4; LOB 1, Lateral Organ Boundaries 1; SWEET, sugar will eventually be exported transporter; eIF4E, eukaryotic translation initiation factor 4E; MLO, Mildew Resistance Locus O; HGO, homogentisate dioxygenase; LCYε, lycopene epsilon-cyclase; ITPK, inositol triphosphate kinases; IPK1, inositol-1,3,4,5,6-pentakisphosphate 2-kinase 1; MIPS, myo-inositol-3-phosphate synthase; HRZ 1/2, hemerythrin motif-containing really interesting new gene (RING)- and zinc-finger protein 1/2; VIT 1/2, Vacuolar Iron Transporter 1/2; FAD, fatty acid desaturases; CLV 1/2/3, Clavata 1/2/3; TFL 1, Terminal Flower 1; GW 2/3, Grain Weight 2/5; TGW 6, Thousand-Grain Weight 6; GS 3, Grain Size 3; BS 1, Big Seed 1; GRF 3/4, Growth Regulating Factor 3/4; DEP 1, Dense And Erect Panicle 1; Gn1a, Grain Number 1a; GID 1/2, Gibberellin Insensitive Dwarf 1/2; IPA 1, Ideal Plant Architecture 1; CCD 8A/B, carotenoid cleavage dioxygenase 8A/8B; SPL, Squamosa Promoter Binding Protein-like; FT, Flowering Locus T; SP, Self-Pruning; SP 5G, Self-Pruning 5G; Picture created by Biorender.com. (Modified and adopted from Vaikuntapu and Kumar, 2022)

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Impact of adoption of technologies in castor farming during *kharif* season in Southern Telanagana Zone

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ABSTRACT

Castor crop during *kharif* season is often caught by vagaries of monsoon like delay in onset of monsoon and prolonged dry spells or even failure of monsoon on the other hand the crop may also severely affected by *botryotinia gray rot* at flowering/capsule stage in the event of incessant rainfall coupled with high relative humidity. To overcome these problems researchers have developed high yielding hybrids like ICH-66 and PCH-111 in traditional castor growing areas of Telanagana state. In addition to the hybrids, adoption of improved technologies increased levels of productivity. The research and on-farm demonstrations carried out in Telanagana during *Kharif*, 2018 to 2020 proved that, whole package/improved technology demonstrations were resulted in increased seed yield up to 36% in intercropping of castor with pegionpea and 39% with whole practice as compared to farmers practice.

Castor crop cultivate any type of soils provided with proper drainage. Soils slightly acidic in reaction are preferred, however saline soils are unsuitable to grow castor. On the other hand highly fertile soils may favour excessive vegetative growth resulting in prolonged flowering and maturity period all of which may adversely affect the seed yield. Castor is a preferred crop in sub-marginal and marginal lands which are characterized by shallow depth, low water holding capacity and poor soil fertility in the region owing to its excellent rejuvenating capacity and genetic potential. It is mostly grown under rainfed conditions during kharif season (June to September) in dry land tracts of South and Eastern India in general and in Telangana in particular. However, in view of incidence of Botryotinia gray mold, occurrence of frequent dry spells and less scope for life-saving irrigation due to meager water resources and consequent reduction in economic yields during *kharif* season in Telangana (Ramanjaneyulu *et al.*, 2013). Further, many farmers started moving towards cultivation of remunerative alternate crops viz., Bt-cotton and Maize on a large scale. Decline in area and production of castor has become a great cause of concern for growers, scientists and policy makers. Considering wide array of uses of products and by products of castor, enhancing productivity of castor is imminent. Hence, PJTSAU has developed several crop production and protection technologies besides releasing high yielding and wilt resistant hybrids.

MATERIALS AND METHODS

Front Line demonstrations were conducted to show the production potential and profitability of the crop under the close supervision of scientists of the Regional Agricultural Research Station, Palem.
The area under each demonstration was 0.40 ha. Field days and training programmes were also organized at the demonstration site to provide the opportunities for other farmers to witness the benefits of demonstrated technologies. The critical inputs were duly supplied to the farmers and data were collected from the FLDs farmers and were analyzed to compare the yield of farmers' field and FLDs.

RESULTS AND DISCUSSION

The scientists of AICRP on Castor, RARS, Palem, Nagarkurnool (Dist), Telanagana state, India have developed and promoted following agronomic package of practices for *Kharif* castor for reaping higher yields.

Technologies for increasing the castor productivity:

- Life saving irrigation + top dressing with fertilizer application during Drought/prolonged dry spell.
- Adoption of intercropping castor + pigeonpea 1:1 ratio due to more additional net returns over sole castor.
- Selective mechanization.
- For gray mold, prophylytic spraying of propiconazole @ 1 ml/lit or Carbendazim @ 1 g/lit or followed by top dressing with 20 kg urea+10 kg MOP/acre.

The above technologies were demonstrated to the farmers through capacity building training programmes.

Impact of adoption of technologies, intercropping (Castor+redgram 1:1) gave additional net returns of Rs. 15562/ha over sole castor and whole Package Demonstrations. The FLDs conducted over the years at various locations on whole package in castor had shown 39% increase in yield as compared to farmers practice with additional net returns of Rs. 13694/ha. The B:C ratio was 1.17 and 0.71 with improved technology (IT) and

Farmers' practice (FP) plots, respectively (Kumar Naik *et al*., 2015).

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Table 1. Productivity and profitability of component technologies demonstrated through frontline demonstrations on castor.

Year	Mean seed yield (kg/ha)		Increase in seed yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Net returns (Rs./ha)		Additional net returns (Rs./ha)	B: C ratio	
	IT	FP		IT	FP	IT	FP	IT	FP		IT	FP
Castor+ pigeon pea (1:1)												
2018	1297	805	37	28201	26225	43921	27277	13767	2613	11154	1.56	1.04
2019	1338	784	38	26958	25280	45842	26819	17257	2840	14417	1.71	1.06
2020	1283	847	34	28201	26225	49501	29415	21832	5125	16707	1.88	0.57
Mean	1311	816	36	27580	25753	47672	28117	19545	3983	15562	1.80	0.82
Whole Package Vs Conventional practice												
2019	1042	667	36	30668	30863	36042	24508	5375	-6355	11728	1.18	0.79
2020	885	510	42	28793	28744	33142	19400	4349	-9345	13694	1.15	0.62
Mean	964	589	39	29731	29804	34592	21954	4862	-7850	12711	1.17	0.71

IT=Improved technology; FP=Farmers' practice

Dynamics of export potential of ICAR-IIOR mandate crops vis-à-vis groundnut, soybean and rapeseed mustard

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ABSTRACT

In the last two decades six oilseeds crops *viz.,* castor, linseed, Niger, safflower, sesame and sunflower (IIOR mandate crops) on an average contributed only 15 per cent area and rest of the oilseeds *viz.,* groundnut, soybean and rapeseed and Mustard together contributed 85 per cent area of total oilseeds. However, on an average for the last two decades the contribution of these six crops towards exports is 19 per cent and per cent in terms of export quantity and 36 per cent in terms exports value. In the last QE 2021-22 these six crops contributed 30 per cent and 44 per cent respectively. Thus, despite their relatively little contribution to area and output as compared to other oilseeds, IIOR mandate crops have strong export potential. It also underlines the necessity of stronger marketing chain development for these six oilseeds, as well as the need for area expansion, in order to reinforce and grow their contribution to exports.

India is one of the leading producers of oilseeds in the world, and its diverse agro-ecological features are conducive to the cultivation of nine annual oilseed crops. It has been observed for the past two decades IIOR mandate crops *viz*., castor, linseed, Niger, safflower, sesame and sunflower decreased drastically over the last two decades. However, the other oilseeds viz., groundnut, soybean and rapeseed and mustard majorly contributing to the area with a constant increment. The present study aims to determine whether declining production and area of IIOR mandate crops impeding oilseed exports.

MATERIALS AND METHODS

Data on area, production of nine oilseed crops for the last 20 years (2002-03 to 2021-22) has been downloaded from Tilhantec-OSIS. Oilseeds exports data (2002-03 to 2021-22) was obtained from EXIM databank, DOC, GOI. Percent contribution for each quinquennium ending (QE), over all compound growth rates were computed for the two groups with respect to area, production and export quantity and export value (incl. seed, oils and its fractions, oil cake and meal, etc.,).

RESULTS AND DISUSSION

Contribution of two groups of oilseeds towards oilseeds area, production, exports for the four quinquenniums of the last 20 years (2002-2003 to 2021-22) are computed and presented in Table 1. Perusal of Table 1 shows that area and production of six oilseeds crops (IIOR mandate crops) decreased gradually from 22.5 (QE 2006-07) to 11.7 % (QE 2021-22) and 13.0 to 8.1% respectively. Overall compound annual growth rate also indicated the same that area decreased about four per cent and about half per cent decrease in production every year. Whereas the export quantity and value of these crops has been increased from 12.3 to 29.4 % and 29.6 to 44.4% respectively. The same was revealed by overall CAGR of exports, increasing by seven percent in quantity and thirteen per cent in value every year.

In contrary, there is a gradual increase in contribution of area by other three oilseeds (groundnut, soybean and rapeseed & mustard (Others). It has been increased from 78% in QE 2006-07 to 85% in QE 2021-22 with CAGR of 1.3%. Similarly, production also increased from 87% from 90 % with CAGR of 3%. But contribution towards exports quantity is decreased from 87.7% to 70.6 % and export value from 70.9% to 55.6% for respective QEs.

Thus, the study indicates that despite their relatively little contribution to area and production as compared to other three oilseeds, IIOR mandate crops have strong export potential. Also underlines the necessity of stronger marketing chain development for these six oilseeds, as well as the need for area expansion, in order to reinforce and grow their contribution to exports. The area expansion needs proper futuristic crop planning for enhancing the production there by the export potential.

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Tilhantec-OSIS: https://icar-iior.org.in/tilhantec-osis-comprehensive-oilseeds-data-solution

Table 1: Per cent contribution of IIOR mandated crops and others towards Area, Production, Exports (Quantity) and Exports (Value) (2002-03 to 2021-22)

	IIOR Mandate Crops				Others*			
	Area	Production	Exports (Quantity)	Exports (Value)	Area	Production	Exports (Quantity)	Exports (Value)
QE 2006-07	22.5	13.0	12.3	29.1	77.5	87	87.7	70.9
QE 2011-12	19.7	12.1	13.7	28.8	80.3	87.9	86.3	71.2
QE 2015-16	15.6	11.1	23.7	36.2	84.4	88.9	76.3	63.8
QE 2021-22	11.7	8.1	29.4	44.4	88.3	91.9	70.6	55.6
Over all	**14.9**	**10.1**	**19.3**	**36.7**	**85.1**	**89.9**	**80.7**	**63.3**
CAGR (%)	-3.8	-0.5	6.6	13.1	1.3	2.9	-1.3	8.2

*Groundnut, Soybean and Rapeseed & Mustard

Bio - chemical and Bio - physical basis of resistance to leafhopper and thrips in castor

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ABSTRACT

Among the 8 genotypes screened, RG 1068, ICI-RG2661-7-5-1-7, ICI-RG2661-16-2-2 was found to be resistant to leafhopper with lowest leaf hopper population of 0.0 numbers/ 3 leaves/plant with hopper burn grade of 0. Among the accessions, thrips population was lowest in RG 22 (3.2 No/spike), RG 3198 (7.30 No. / spike). The remaining entries and the check entries recorded moderate thrips population which ranged from 12.30 to 24.60 numbers/spike

Keywords: Accessions, Castor, Genotypes, Thrips and Leafhopper

Castor (*Ricinus communis Linn)* is an important industrially valued non – edible oilseed crop. The average productivity is low (309 kg/ha) in Tamil Nadu where the crop is cultivated mostly as rain fed with low input management. The biotic stresses mostly the thrips were major reasons for low yields of castor cultivated during *Kharif* season. Thrips are suspected to cause withering of emerging spike or drying up of newly formed capsules besides making plant stunted in case of severe infestation. The seed yield loss due to thrips was found to be 12.2 %. Similarly fusarial wilt in castor causes highest yield loss in various life stages of castor plant, during flowering phase it causes 77 % yield loss and during 63 % yield loss during 90 days old crop and 39 % yield loss during secondary branch forming stages (Pushpavathi et al, 1998). Therefore, a combined application of effective insecticides and fungicides is a practical necessity for effective control and highly economic way of saving spraying cost.

Keeping in view, the present study was undertaken with effective and recommended insecticides at recommended rates to find their efficacy on thrips and fusarial wilt of castor as well as the compatibility of the test insecticides and fungicides.

MATERIALS AND METHODS

For studying the mechanism of resistance against leafhopper, totally 16 accessions were sown on 13.09.2018 for confirmation of reaction of promising accessions to leafhopper and thrips. Each entry was sown in a 6m row. The evaluation was done under at high pest pressure along with check entries (DPC-9, DCS-107, DCH-177, DCS-9, 48-1 and DCH-519) were sown. Observations of leafhopper population along with hopper burn grade and number of thrips/spike and leaf were recorded for screening. After screening castor accessions to leafhopper and thrips, one resistant and susceptible lines each for leafhopper and thrips were taken up for studying the biochemical basis of resistance. The biochemical analysis of leaf samples were carried out at Department of Post Harvest Technology Centre, TNAU, Coimbatore. In which important biochemical parameters (Carbohydrate, Protein, reducing sugars, phenol and tannin) were analyzed from four leaves sampled from each castor accession *viz.*, RG 22(Resistant), M574 (susceptible) for thrips and RG1068 (Resistant) and RG 3477 (susceptible) for leafhopper

RESULTS AND DISCUSSION

Lowest (3.10 thrips/spike) of *R syriacus* was observed when castor accession RG22 having high phenol and tannin content 406.30mg/100g and 533.22 mg/100g respectively. Whereas castor accession with low phenol (326.53mg/100g) and tannin content (410.23.32) recorded highest (21.0 thrips/spike) of R *syriacus* in M574. Lowest (31.0 thrips/spike) *R syriacus* was observed when castor accessions RG22 having high carbohydrate, protein and reducing sugars content of 4.03%, 8.34% and 2.96% respectively. Whereas castor accession with low carbohydrate (2.45%), protein (5.01%) and reducing sugars(0.92%) recorded highest (21.0 thrips/spike) *R syriacus* in M574.Lowest (0.0 leafhopper/3leaves/plant) *E flavescens* was observed when castor accessions RG1068 having low carbohydrate, protein and reducing sugars content of 2.20%, 5.25% and 1.10% respectively. Whereas castor accession RG 3477 with high carbohydrate (3.99%), protein (8.22%) and reducing sugars (3.87%) recorded highest (35.15 leafhopper/3leaves/plant) *E flavescens.*Minimum (7.30 thrips/spike) of *R syriacus* was observed in castor accession RG22 with shorter leaf length, shorter width and dark green colour leaf and maximum (24.60 thrips/spike) thrips population was recorded in M574 with higher leaf length, leaf width and light green leaves. Minimum (7.50 leafhopper/3leaves/plant) of *E flavescens* was observed in castor accession RG1068 with longer leaf length, width and yellowish green colour leaf and maximum(35.15 leafhopper/3leaves/plant) leafhopper population was recorded in RG3477 with shorter leaf length, leaf width and light green leaves. The findings are in conformity with Amudhan et al., 1999; Vijaykumar et al., 2009, where it was reported that the Gall midge *Orseolia oryzae* (Wood-Mason) resistant rice genotypes revealed higher levels of total phenol.

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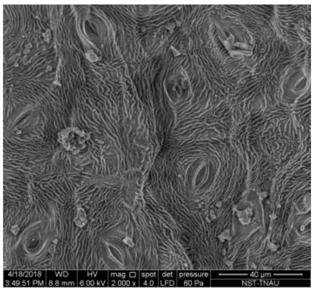
Table 1. Preference of leafhopper and thrips to castor accessions in relation to biochemical component of castor leaves

Insect pest/ Biochemical parameters	Thrips resistant (Thrips No. /spike) RG22	Thrips susceptible (Thrips No. /spike) M574	Leafhopper resistant (Leafhopper/3leaves/plant) RG1068	Hopper Burn Grade	Leafhopper susceptible (Leafhopper/3leaves/plant) RG3477	Hopper Burn Grade
	3.10	21.0	0.0	0	34.15	3
Carbohydrate (%)	4.03	2.45	2.20		3.99	
Protein (%)	8.34	5.01	5.25		8.22	
Reducing sugars (%)	2.96	0.92	1.10		3.87	
Phenol (mg/100g)	406.30	326.53	310.96		493.64	
Tannin (mg/100g)	533.22	410.32	453.00		564.20	

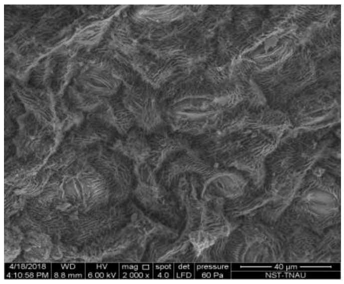
Table2. Preference of leafhopper and thrips to castor accessions in relation to biophysical component of castor leaves

Parameters	RG22		M574		RG1068		RG3477	
	Tender	Middle	Tender	Middle	Tender	Middle	Tender	Middle
Leaf length(cm)	5.5	10	7	14	5.2	9.5	5.6	7.0
Leaf width (cm)	4.0	6.5	4	11	5.0	7.5	4.0	4.5
Leaf colour	Dark green		Light green		Yellowish green		Light green	

SEM images of RG 3477 (Susceptible line to leafhopper)



SEM images of RG 1068 (Resistant line to leafhopper)



Effects of substituting soybean meal with safflower meal on the performance and meat yields in broiler chicken

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ABSTRACT

The main objective of this study was to evaluate the effects of utilization safflower protein concentrate (SPC) as a replacement for soybean meal (SBM) on performance and meat yield sin broiler chicken. The results of the present study suggest that SPC can be included in broiler diet up to 50 % of SBM protein without affecting the growth and meat yields.

Keywords: Alternative feed, Broiler chicken, Protein concentrates, Safflower

The poultry sector is the fastest-growing and most flexible of all livestock sectors. It occupied a leading role among agricultural industries in many parts of the world. Soybean meal (SBM) is the most extensively used protein source in poultry diets. However, with erratic supply, increasing demand and rising costs, SBM alternatives are being preferred (Rama Rao *et al.*, 2006; Rama Rao *et al.*, 2008). Our study evaluated the performance and meat yields of broilers when fed safflower seed as an alternative to SBM at two different inclusion levels.

MATERIALS AND METHODS

Safflower seed protein concentrates (SPC) were prepared from deoiled and dehulled safflower seeds. Broiler chicken (Cobb 430 Y) were raised in battery brooders.The experiment was conducted with 3 treatments and 10 replications. In each replication, six birds were placed. A standard control diets were prepared with maize-SBM as per the broiler strain recommendations. The SBM was replaced with SPC at two concentrations (50 and 100% replacement of SBM) in iso-caloric and iso-nitrogenous diet. Body weight gain, feed intake, and food conversation ratio (FCR) were recorded at weekly intervals up to 6 weeks. At the end of 42d one bird from each replicate was slaughtered to study the meat yields which were expressed as g per kg pre-slaughter live weight of the respective bird.

RESULTS AND DISCUSSION

The efficacy of SPC was tested in the broiler chicken diet during winter at ICAR-Project Directorate on Poultry (ICAR-PDP), Hyderabad (2021). Results showed no significant ($p > 0.05$) difference in body weight gain and FCR at 50% SPC level. However, at 100% dose, a significant increase in FCR, decrease in feed intake and weight gain were observed (Table). Meat yields (Table) were significantly reduced at 100% SPC compared to the control. It was concluded that safflower meal could be included up to 50% of SBM of the broiler diet without affecting these parameters.

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Table. Performance and meat yields of broilers fed SPC as substitute for SBM (42d of age)

Treatment	Performance			Meat yield (g/kg live weight)				
	BWG, g/b	FI, g/b	FCR	RTC	Breast	Liver	Fat	Gizzard
SBM100%	2037^{a}	3634^{a}	1.784^{b}	721.6^{a}	243.3^{a}	18.68^{ab}	14.55^{b}	16.33
SPC50%+SBM50%	1976^{a}	3467^{ab}	1.755^{b}	704.0^{b}	233.1^{a}	17.48^{b}	15.64^{ab}	16.68
SPC100%	1688^{b}	3323^{b}	1.976^{a}	697.3^{b}	216.0^{b}	19.57^{a}	17.61^{a}	17.07
P	0.000	0.008	0.000	0.001	0.004	0.096	0.082	0.761
N	12	12	12	12	12	12	12	12
SEM	32.84	42.50	0.022	2.908	3.592	0.398	0.570	0.400

SBM: Soybean meal; SPC: Safflower Protein Concentrates; BWG: Body weight gain: FI: Food Intake; FCR: Food Conversion Ratio

Variation in oil and oil quality parameters in Niger germplasm

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ABSTRACT

Niger (Guizotia abyssinica (L.f) Cass) germplasm from 800 accessions were analysed for oil and quality parameters. Significant variation was found among genotypes. The oil content ranged from 15.73% to 49.64%. Palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid were detected in the analysed samples. Linolenic acid was the predominant fatty acid.

Keywords: Fatty acid, Niger, oil content

Niger (Guizotia abyssinica (L. f.) Cass) is an oilseed crop grown in Ethiopia and India. It is an economically important edible oilseed and belongs to the Asteraceae family. The seed contains about 40% oil with a fatty acid composition of 75-80% linoleic acid, 7-8% palmitic and stearic acid, and 5-8% oleic acid (Getinet and Teklewold 1995). Indian varieties contain 25% oleic acid and 55% linoleic acid (Nasirullah et al. 1982). The meal remaining after oil extraction is free of toxic substances but contains more crude fibre than most oilseed meals. The seeds of the plant are used as a source of edible oil by tribal and rural populations in India and Ethiopia.

MATERIALS AND METHODS

Oil content was analysed by using a nuclear magnetic resonance spectrometer (NMR MQC -5 analyzer) according to the modified method of Yadav and Murthy, 2006. The fatty acid profile was determined using an Agilent 7890B gas chromatograph (GC) equipped with a flame ionisation detector (FID) and an auto-sampler. Peak separation was performed on an Agilent Technologies DB-225 capillary column (diameter-320µm, length-30m, film thickness-0.25µm). The carrier gas was nitrogen set to a constant gas flow of 5 ml/min at an initial temperature of 160^0 C. 0.2 microliter of sample was injected at a split ratio of 20:1. Fatty acid composition was determined by identifying and calculating the relative peak area in percent using Agilent Open Lab software after the GC run.

RESULTS AND DISCUSSION

A total of 800 Niger accessions were analysed for oil content, which ranged from 15.73% (IC-417201) to 49.64% (BMD-37). Linoleic acid was the predominant fatty acid with a maximum of 68.73% in accession IC -0211055 and a minimum of 31.67% in accession IC -0564781. The average linoleic acid content was 51.76%. Accessions with high oleic acid (□70%) were not found in the studied samples. The highest oleic acid content was 56.6% found in accession IC -0564781, and the lowest in JNS-28 with 16.69%. The average oleic acid content was 33.39%. The highest palmitic acid was found in accession IC -0305870 with 9.99% and the lowest was in accession IC -0567374 with 5.66%. The average palmitic acid content was 8.28%. The maximum stearic acid was observed in accession IC-0262620 with 8.12% and the minimum was in accession IC-0564781 with 3.87%. The average stearic acid content was 6.23%. The maximum linolenic acid was 1.91% in accession IC -0585545 and minimum of 0.04% in accession IC -0262534. The average linolenic acid content was 0.32%. The identified accessions can be used in breeding programmes to improve oil content and quality parameters.

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Alternate row mulching optimizes soil temperature and water conditions and improves groundnut yield in rainfed farming

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ABSTRACT

Half mulching coverage within alternate rows (HM) increased soil temperature in the early growth stage and prolonged time of warming compared with full mulching coverage within all rows (FM). Moreover, the magnitude of the warming effect in the early stages under mulching conditions was greater than that of cooling effect in the late stages.

Drought is the main factor that restricts the high yield of groundnut in dryland systems in northern Karnataka. Water consumption during the growing period is 2–3 times the rainfall amount of the same period, which often causes seasonal drought. Maintaining effective preservation and use of natural rainfall is a key solution to improving *kharif* groundnut production and water use efficiency in this region.

MATERIAL AND METHODS

Pervious season straw mulching allows for effective water storage in rainfed groundnut production. Finding a suitable straw mulching model that facilitates groundnut growth was the objective of this study. A 2-year field experiment was conducted to investigate the effects of two straw mulching patterns (FM, full coverage within all the rows; HM, half coverage within alternate rows) and two mulching rates (4.5 and 9.0 t ha^{-1}) on soil moisture, soil temperature, pod yield and water use efficiency (WUE) of *kharif* rainfed groundnut in northern Karnataka (UAS, Dharwad), with no mulching (M0) as the control.

RESULTS AND DISCUSSION

Results showed that mulching increased the soil water storage in all growth stages under high mulching rates, with a stronger effect in later growth stages. Water storage under the HM model was greater in later stages than under the FM model. Soil water content of HM groups was higher than that of FM groups, especially in surface soil layers. Evapotranspiration decreased in mulched groups and was higher under high mulching rates. Aboveground biomass during each growth stage under the HM model was higher than that under M0 and FM models with the same mulched rate, leading to a relatively higher pod yield under the HM model. Mulching increased WUE, a trend that was more obvious under HM 9.0 treatment. Warming effect of soil temperature under the HM pattern persisted longer than under the FM model with the same mulching rates. Accumulated soil temperature under mulched treatments increased, and the period of negative soil temperature decreased by 9–12 days under FM and by 10–20 days under HM. Thus, the HM pattern with 9.0 t ha^{-1} mulching rate is beneficial for both soil temperature and water content management and can contribute to high yields and high WUE for groundnut wheat production in Northern Karnataka under rainfed condition.

CONCLUSION

The highest pod yield and water use efficiency were recorded in HM under 9.0 t ha^{-1} of wheat. Despite the positive effects of mulching on yield increase, the HM pattern was more favourable to groundnut growth, soil temperature and water efficiency.

Strategies for development of climate resilient and high yielding hybrids and varieties in castor (Ricinus communis L.)

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ABSTRACT

Castor yields depend not only on nature of sex expression but also resistance to biotic and abiotic stress. Changing climatic conditions like temperatures and rainfall patterns are adversely affecting sex expression pattern in parents and thereby seed quality and yielding ability of castor cultivars. Mutational breeding approaches are the best for generating desirable variability in pistillate lines. S-type pistillate lines containing dominant and epistatic genes for pistillateness and temperature sensitive recessive genes for the expression of Interspersed staminate Flowers (ISFs) are the most suitable pistillate lines. Male parent with the presence of both male and female flowers in each of the basal 3-6 whorls even under cooler temperatures are feasible to ensure pollination during hybrid seed production and also optimum maleness in castor cultivars. Diverse strategies are required for the development of parents, hybrids and varieties for rainfed and irrigated conditions.

Castor (*Ricinus communis* L.), a member of *Euphorbiaceae* family (2n=20) earns a specific place in oilseeds scenario as successful annual, commercial, non-edible and industrial oilseed crop. During 2021-22, the total castor production was 17.60 lakh tonnes from an area of 8.0 lakh ha with a productivity of 2200 kg/ha. Castor is a drought tolerant crop and is amenable for cultivation under both rainfed and irrigated conditions in tropical and sub-tropical India. Performance of castor hybrids is highly influenced by the environment. In the context of climate change, there are changes in temperature, relative humidity, rainfall pattern, dry spells and biotic stresses causing increased cost of production coupled with adverse effect on seed quality and castor yields. Aberrant diurnal and high temperatures are causing increased maleness in castor hybrids; heavy and continuous rainfalls leading to incidence of *Botrytis* disease even in Gujarat; Intermittent and long dry spells (>15 days) causing incidence of dry root rot in peninsular India and sucking pests (thrips, leafhoppers, myriad bugs and whiteflies) across castor growing areas. Expression of Interspersed Staminate Flowers (ISFs) and/or reversion in the pistillate (female) lines due to temperature changes during hybrid seed production has also been adversely affecting quality seed production and thereby resulting in rejection of nearly 30% hybrid seed lots in India (Manjunatha *et al*., 2020). Hence, there is a need to revise and refine the breeding approaches and strategies in castor improvement programmes to increase castor yields and profitability as a commercial crop in India. Genetic variability and nature of castor genetic resources provides for ample scope to develop climate resilient and high yielding hybrids and varieties in castor.

Mutational breeding is an appropriate strategy for developing diverse pistillate lines as there are fewer natural and diverse genetic sources with stable pistillateness (Lavanya *et al*, 2000). The sequential bearing of racemes/spikes in castor has considerable bearing on sex expression. The basic sex forms in castor are monoecious (M), pistillate (P) and sex revertant (R). Among the three systems of pistillateness (N, S and NES types), S-type is the most suitable for the development of stable pistillate lines in the context of climate change. Dominant and epistatic genes govern the pistillateness (femaleness) in S-type lines and these genes does not allow reversion to monoecious nature even in the context of >32^0C and diurnal range of temperatures >10^0C. These S-type lines also contain temperature sensitive recessive genes for ISFs (male flowers on the spikes) and hence they remain pistillate in favourable temperatures (15-30^0C) and produce ISFs under unfavourable temperature conditions (>32^0C and/or >10^0C diurnal range). Production of ISFs results in selfing of pistillate (female) lines in hybrid seed production plots and thereby affecting the quality of hybrid seed lots. However, there is genetic variation for the genes controlling ISF production. Some pistillate lines like IPC-30 (derived by mutation of VP-1) recorded 0-1 ISFs even up to tertiary orders across four locations (SK Nagar, Junagadh, Hyderabad and Bengaluru) while some pistillate lines like DPC-9 and M-574 recorded >5-10 ISFs in primary spike itself. Thus evaluation and selection of S-type pistillate lines in different locations with varying temperatures provides an ample opportunity for the selection of the most stable pistillate lines, which help reduction of ISFs in hybrid seed production plots and thereby enhances its purity and reduces cost of hybrid seed production. Some S-type pistillate lines like VP-1 and SKP-84 produce sex reversals with 80-90% maleness on the spikes, resulting in very poor hybrid seed quality. These type of pistillate lines needs plant to progeny evaluation and selection of plants without sex reversal genes. Evaluation of pistillate lines in SK Nagar, Junagadh, Hyderabad and Bengaluru indicated that the Bengaluru location is the ideal location for hybrid seed production in castor as there were no ISFs expressed in pistillate lines up to tertiary orders.

Castor germplasm has significant variability in duration, branching, spike length, seed weight etc for the development of diverse male lines. Generally male lines containing both male and female flowers in each of the basal 3-6 whorls are the most appropriate rather than those containing only male flowers in entire whorls (bunches of male flowers) on spike. Male lines with high branching nature and sufficient pollen production ability even in low temperatures (10-30^{0}C) and no pistillate tendencies are most appropriate. Evaluation and selection of male lines in high temperatures (>32^{0}C) help selection of male plants with optimum maleness and provides enough scope for expression and rogueing of segregants with high or 100% maleness in nucleus/breeder/ foundation seed production plots. This is very essential as hybrids derived from male lines/rogues with high maleness (>20% of spike length containing only male flowers) generally (not always) have tendency for high maleness causing low yields in hybrids.

Synchronization of flowering in parents is very essential for ensuring quality hybrid seed production in castor. Sequential branching nature and 3-5 node number variation in the plants of female and male line results in extended time (days) of flowering of plants with in each parent, which ensures continuous supply of pollen and pollination. Female parent should never be early flowering than male parent in castor hybrid seed production. Early flowering (2-3 days) in male parent is preferable. Staggered sowing may not be feasible in castor in the context of unseasonal or unexpected rains causing delayed sowing, difficulty in weeding and intercultural operations, differential growth due to smothering effect of one parent on the other etc. Dwarf female with cup shaped and small leaves, longer spike and high branching, better seed weight and oil content are is desirable. Male line with elongated stem, high branching and better seed weight are desirable.

Distinct selection and evaluation strategies are to be adopted in castor improvement programmes for rainfed and irrigated conditions. For cultivation of castor in *kharif* in the peninsular India, hybrids/varieties need to be not only with shorter canopy, *Botrytis* disease resistant even in situations of continuous rainfall but also drought resistant with better seed weight and rejuvenation ability when moisture stress is relieved. It is generally observed that *Botrytis* incidence was low in genotypes like DPC-9 with no bloom on capsules, relatively hard pericarp and short spines. Very early hybrids, with node number (NN) <8 and days to 50% flowering (DF50%) < 40 DAS, are low seed yielding (< 218 g/plant) and may not be suitable for sustainable cultivation under rainfed conditions. Early hybrids with high seed yielding (>220 g/plant, NN 8-11, DF50% 40-45 DAS) with short stature and less canopy, better seed weight (>30g per 100 seeds) and drought tolerance are suitable for rainfed conditions. It is very much possible to develop high yielding (387 to 450 g/plant) early hybrids having lesser canopy with 14-16 NN and DF50% of 48 DAS, for their successful and sustainable cultivation in irrigated conditions of Gujarat and Rajasthan (Manjunatha *et al* 2020). Thus, it is possible to develop high yielding early castor hybrids having short plant stature suitable for both rainfed and irrigated conditions, to meet the emerging needs of the farmers in the changed social and agroclimatic conditions.

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Herbicide-tolerant sesame (*Sesamum indicum* L.) genotypes: Identification and prospects for molecular characterization

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ABSTRACT

Weed is a major menace in the early seedling establishment stage and hand-weeding is an uneconomical practice in sesame crop production. Herbicide-tolerance in sesame empowers chemical method of weed control in sesame. In the present study, three genotypes each of the tolerant and susceptible lines, identified under field condition, were screened under controlled condition, using a completely randomized design (CRD), for their differential responses to pendimethalin application at field dosage (750 g/ha). Nucleotide sequences of both target and non-target sites for the herbicide reported in other plant species were used for fetching sesame orthologues and molecular analyses were performed using *in silico* approaches. Herbicide-tolerant sesame genotypes *viz*., IC132558, IC131953, and IC1500445, identified in this study help not only understand the underlying molecular mechanism(s) but also serve as germplasm resources useful in breeding herbicide-tolerance in sesame.

Keywords: Herbicide tolerance, Pendimethalin, Sesame genotypes

Among herbicides, pre-emergence herbicides are highly effective in controlling weeds (Dong et al, 2021) in the early stage of seedling establishment in crop species, including sesame (*Sesamum indicum*, L.), as germination-to-seedling establishment stage of the crop phenology is slow and therefore a long process. Pendimethalin is one of the pre-emergence herbicides that kills weeds by inhibiting seedling growth (Sherwani et al, 2015) and may adversely affect crop plants also. This necessitates identification of herbicide tolerant genotypes and unravelling the molecular mechanism that is pre-requisite and vital for herbicide-tolerant sesame breeding. In this context, the present investigation was undertaken to identify pendimethalin herbicide-tolerant sesame genotypes under field condition and to confirm their differential response under controlled condition *vis-à-vis* susceptible genotypes. Further, *in silico* analyses and molecular docking were performed towards deciphering molecular mechanism(s).

MATERIALS AND METHODS

Pre-emergent herbicide Pendimethalin 30 EC was sprayed @ 750 g/ha in the field where a panel of 120 sesame genotypes were sown for raising in three replications using alpha lattice design and the recommended package of practice. Eighty susceptible genotypes were completely knock-out, and 40 tolerant genotypes survived till maturity. The representative tolerant and susceptible lines were screened for the herbicide response under controlled conditions using a completely randomized design (CRD). Mean data was recorded for germination percentage, days to germination, shoot length, root length and shoot-to-root ration was computed for 150 individual seeds and seedlings of all genotypes. As an illustration the data for 6 genotypes is given in Table 1. Target region (TR) and non-target region (NTR) reported in other plant species were used to get sesame orthologs and molecular docking was performed using *in silico* analyses.

RESULTS AND DISCUSSION

An herbicide tolerant sesame genotype is a boon for economical and effective control of weeds using chemical methods (Bright, 1992). A pre-emergence herbicide pendimethalin shows herbicidal activity by inhibiting seedling growth (Sherwani et al, 2015). Sesame genotypes susceptible (IC132410, IC204843, and IC5004408) and tolerant (IC132558, IC131953, and IC1500445) to pre-emergence herbicide pendimethalin showed differential seedling growth response when screened under controlled conditions (Table 1). Mean germination percent in both susceptible and tolerant genotypes ranged between 95 and 100 in the absence of pendimethalin, whereas it was 12-13 among susceptible and 51-71 among tolerant genotypes in the presence of the herbicide. In terms of days taken to germinate after sowing, there was no difference between susceptible and tolerant genotypes as well as between herbicide treated and non-treated, suggesting that herbicide-tolerance was not by way of avoidance (i.e., delayed germination till the degradation of pendimethalin). Further, pendimethalin-treated genotypes showed lesser shoot and root lengths than their untreated counterparts. However, the shoot-to-root ratio ranged from 5.2 to 2.0 in the case of untreated genotypes while that of treated was 0.70 to 1.4. It is intriguing to note that in all the tolerant genotypes the ratio was less than or equal to one, possibly due to more stunting of shoot growth than the root growth, suggesting that less-hindered root growth was quintessential for *in vivo* detoxification of the herbicide. Analyses of target region (TR) and non-target region (NTR) through molecular docking (data not shown) supported the laboratory observations. Herbicide-tolerant sesame genotypes *viz*., IC132558, IC131953, and IC1500445, identified in this study help not only understand the underlying molecular mechanism(s) but also serve as biological resources useful for breeding herbicide-tolerance in sesame.

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Table 1: Germination and seedling growth response of three representative sesame genotypes susceptible and tolerant to pendimethalin herbicide.

Genotypes	Control					Herbicide treatment				
	GP* (%)	DAS#	Mean@ Shoot Length (mm)	Mean@ Root Length (mm)	Shoot$ to Root ratio	GP (%)	DAS	Mean@ Shoot Length (mm)	Mean@ Root Length (mm)	Shoot$ to Root ratio
Susceptible										
IC132410	95	6	28	14	2.00	13	6	7	10	0.70
IC204843	96	5	25	12	2.09	13	5	7	5	1.40
IC500408	100	6	22	6	3.67	12	6	7	5	1.40
Tolerant										
IC132558	98	8	26	5	5.20	51	8	5	5	1.00
IC131953	96	9	27	10	2.70	68	9	5	5	1.00
IC1500445	98	9	25	9	2.78	71	9	6	7	0.86

Note: *Germination percentage (Mean values of 150 observations); #Days after sowing (Mean values of 150 observations); @Mean values of 150 observations recorded 20 days after sowing; $Mean of derived values

Growth and physiological response of canola (*Brassica napus* L.) to interactive effect of temperature, moisture and nitrogen stresses under controlled environment

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Present atmospheric limits growth of C_3 crop plants, which show response to elevated CO_2 via reduced photorespiration and enhanced photosynthetic rates thereby increased growth and yield. Global research on plant responses to raising atmospheric CO_2 has primarily focused on C_3 species, advancing our understanding of processes underlying C_3 plant acclimation and response. Therefore extensive research has been conducted to project the potential impacts of global warming on agriculture productivity through laboratory by using crop and global climate models. Canola is one of the world's most important oilseed crops and the most profitable commodity for Canadian farmers. As a C_3 cool season crop, it is more susceptible to heat stress than other C_3 and C_4 field crops (Wu and Ma, 2018). High temperature significantly changes the rate of plant metabolic processes that ultimately reduces biomass accumulation and grain formation. A field study in Eastern Canada reported that seed yield reduced as much as 40% in 2012 due to severe heat and drought stress over normal years (Ma and Herath, 2016). High or warm temperature has been shown to induce the floral sterility or pollen abortion and shorten seed filling duration and subsequently reduce inflorescence size in canola plants. Even high temperature could alter the partitioning of photoassimilates to roots and suppress root growth extension or change root system architecture. Late seeded canola plants often produced a smaller root system, due to higher temperature and or drought stress encounters during the crop development. Keeping these facts trial was conducted under controlled condition to know the response of canola to drought stress, elevated CO_2 and temperature.

METHODOLOGY

A pot culture experiment was conducted in 2022 under controlled environment chambers at the Jamie Whitten Delta states Research Center, USDA-ARS Stoneville Mississippi laboratory. Treatments were arranged in a factorial CRD with temperature treatments as main plots allotted to each growth chamber, soil moisture as sub factor and N rate treatments as sub-sub factor were arranged randomly within each growth chamber. The average temperature in growth chambers were at respective day/night temperature of 35/18 (high temperature), 27/18 (moderate temperature) and 20/18 (Low temperature) until final biomass harvest. Two water stresses as sub plot were applied simultaneously with temperature stress by watering half of the plants to 100% of field capacity (FC) (no stress), and the remaining plants to 50% FC (high stress). Amount of water applied to each pot was decided based on pre-calculated FC of the dried soil and it's WHC. Water was applied to bring the water level of the pots to the desired level by individual pots moisture content recorded by sensor. For all the growth chambers RH was maintained at 70% throughout the crop period. For moisture stress were maintained upto end of the trial, N treatments were at the rate of 120 kg/ha (considered as sufficiency) compared with N free treatment. The treatments were repeated four times in each chamber. Canola variety 930 W round up seeds were planted at 25 mm deep. Three seeds were sown in each of the 4 PVC pots (15 cm dia and 30 cm height), filled with top soil and sand in 3:1 proportion. Before start of the trial, soil was analyzed for physical and chemical properties. Totally sixteen pots were moved to each of the three growth chambers (Model PGC 105, PERCIVAL Scientific, Perry, Iowa, USA). The position of the pots within each chamber was rotated at random on a weekly basis to avoid any potential light/temperature/water gradient within the chamber on plant growth. The seedlings were thinned to one per pot at two- to three-leaf stage, the plants were grown in three growth chambers for two weeks at 20/18^{o}C (day/night) prior to the application of temperature treatments. Chambers were set at 12/12-h as light/dark cycle. Photosynthetic photon flux density (PPFD) levels were maintained at 1500 µmol/m²/sat canopy height. At 6:00 (central time) it starts with 1000 µmol/m²/s raised at 500 µmol/m²/s increment and after 18:00 light level was zero in all the chambers. The transition time for raising temperature was three hours for all the chambers. Temperature in the canopy was monitored using double shielded, passively ventilated thermocouples at two locations within the growth chamber and was used to adjust the chamber temperature. The pots continued to receive watering to maintain the soil water at or near FC upto two weeks until moisture stress treatments were imposed. The soil water continued to be maintained at FC with no ponding for any stress treatment. For stress plants watering amount was reduced to 50% achieve a longer drying cycle until maturity. Soil moisture in each pot was measured by Watchdog 1000 series and

Waterscout SM 100 (Spectrum instruments Inc.) connected micro stations (1525). The weather variables temperature and RH were measured in each growth chamber at 15 min interval throughout the growth period using a combined temperature and humidity meter. Final biomass harvest was done at 43 days after sowing. The experiment was run once only with the assumption that the well-controlled experiment is repeatable, and the fact that this type of controlled experiments are very costly. Wherever parameters were measured on all the plants, means were used for statistical analysis.

RESULTS

Results of the study showed that leaves area per plant, chlorophyll content, leaves DW, roots DW and total DW, root to shoot ratio N uptake and leaf chlorophyll fluorescence were significantly influenced by temperature stress (Table 1). These were greater in optimum temperature at 27^{o}C day and 18^{o}C at night. Further these were greatly reduced at high temperature 35/18^{o}C and 20/18^{o}C at day and night temperature respectively. Whereas leaves per plant, leaf thickness were not influenced by day and night temperature variation. Most of the canopy parameters were found non-significant by drought stress and well watered treatments except total Dry weight and N uptake. Similarly rate of N application was significant impact of canopy characters at early stage of canola except, leaf area, total dry weight and N uptake per plant. Total dry weight per plant was most significantly affected by interaction effect of temperature, water and N application. Results confirmed that canola is highly sensitive for high temperature, water and N stress during early part of the crop season.

Table 1. Canopy characteristics of canola influenced by drought stress, elevated temperature and nitrogen under controlled environment

	Leaves/ plant	Leaf area/ Plant	Total Chl Mg/g of leaf	Leaf thickness (mm)	Leaves DW (g)	Root DW (g)	Total DW (g)	Root: shoot	N uptake (g plant^{-1})	Fv/Fm
Temperature gradient (T)										
HT	5.05	345	0.92	6.63	3.31	15.87	05.83	0.137	0.33	0.72
MT	3.89	1,289	0.77	6.22	2.52	6.93	22.79	0.183	0.99	0.74
LT	4.72	728	0.43	5.64	6.91	4.60	11.52	0.210	0.66	0.67
CD@ 5%	NS	279	0.18	NS	2.74	6.69	2.11	0.046	0.10	0.04
Water stress (W)										
WW	4.52	767	0.68	6.46	4.50	9.50	11.43	0.187	0.60	0.71
DS	4.59	808	0.74	5.88	4.00	8.77	15.32	0.166	0.72	0.72
CD@ $%	NS	NS	NS	NS	NS	NS	1.72	NS	0.08	NS
Nitrogen rate (N)										
N120	4.34	879	0.84	6.09	4.47	9.48	14.00	0.162	0.90	0.69
N0	4.77	695	0.57	6.24	4.02	8.79	12.76	0.192	0.42	0.74
CD@5%	NS	395	0.14	NS	NS	NS	0.56	NS	0.08	0.03
Interaction										
T x W	NS	NS	NS	NS	NS	NS	2.99	0.065	0.14	NS
T x N	NS	NS	NS	NS	NS	NS	2.99	NS	0.14	0.05
W x N	NS	NS	NS	NS	NS	NS	4.22	NS	NS	NS
T x W x N	NS			NS					0.20	NS

HT- High temperature (35/18); MT- Medium temperature (27/18); LT- Low temperature (20/18)
WW- Well watered; DS- Drought stress; N120- nitrogen at 120 kg/ha: N0- Nitrogen free control

Phytochemical profiling and nematicidal activity of leaf extracts of *Tinospora cordifolia* against reniform nematode (*Rotylenchulus reniformis*)

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ABSTRACT

Reniform nematode, *Rotylenchulus reniformis* is an important nematode associated with castor influencing the productivity of the crop. Efficacy of the leaf extract of *Tinospora cordifolia* at different concentrations *viz*., 0.1, 0.5, 1.0, 2.0, 5.0, 10.0 and 20% against the nematode juveniles were evaluated *in vitro*. The extract, at 20%

concentration was recorded to be effective in the reduction of nematode juveniles to 93.8 per cent. The more active non-polar and medium polar compounds which are having melting point less than 200^{o} C were analysed by GC-MS. Eighteen compounds of the total extract were identified of which six compounds were reported to possess nematicidal properties.

Keywords: Nematicidal activity, Phytochemicals, *Tinospora cordifolia, Rotylenchulus reniformis*

Reniform nematode (*Rotylenchulus reniformis*) are the most important nematode species associated with the castor crop, which are one of the factors influencing the yield reduction of the crop. With increased awareness of possible deleterious effects of chemical pesticides, there is an increasing interest in non-chemical nematode management strategies. One of the possible alternatives is the use of biopesticides from plant origin. Current study was designed to evaluate the nematicidal effects of *Tinospora cordifolia* (leaves) in controlling reniform nematode (*R. reniformis*) and to assess the chemical composition of methanolic leaf extract of the plant possessing nematicidal properties.

MATERIALS AND METHODS

The leaves of *Tinospora cordifolia* were collected during the month of July from ICAR-IIOR farm, Rajendranagar, Hyderabad. The leaves were dried under shade and powdered into fine particles with equal quantity of methanol in Pestle and mortar. Then the leaves were kept on a rotary shaker for 24h at 120 rpm. The solution was filtered through muslin cloth and then through Whatmann no. 1 filter paper. The filtrate was evaporated at 40^{o}c in water bath to obtain the organic extracts of the leaf.

For maintenance and multiplication of pure culture of reniform nematode, *Rotylenchulus reniformis*, the soil was autoclaved at 15 psi pressure at 121º C for 30 min. The autoclaved soil was filled in the pots and castor seeds were sown in the pots. To the 30 days old seedlings, 4nd stage juveniles of nematodes were inoculated and the egg mass collected from the plant roots after 20-25 days of inoculation was allowed for hatching. From the hatched out juveniles, fourth stage juvenile was used for the mortality assay studies.

From the crude extract of *Tinospora cordifolia*, different concentrations *viz*., 0.1, 0.5, 1.0, 2.0, 5.0, 10.0 and 20% prepared by diluting with distilled water. Fourth stage juveniles of the nematode were suspended in sterile distilled water. This suspension was adjusted to contain the nematode juveniles of about 100 / 0.2 ml suspension. For mortality studies, 0.2 ml of nematode suspension was poured into 5 cm diameter Petri dishes containing 2 ml of diluted plant extract of each concentration. A control was maintained with only nematode juveniles. All the treatments were replicated four times in CRD. Dead juveniles were count under stereoscopic microscope after 12, 24 and 48 h exposure period and per cent mortality was assessed.

Methanolic extract of leaves of *T. cordifolia* were analysed for the presence of different compounds by GC-MS technique. GC-MS analysis of some of the potent volatile constituents present in the extracts was performed at The South India Textile Research Association (SITRA), Coimbatore (Tamil Nadu), India. GC analysis of the extracts was performed using a GCMS (Make: Agilent Model :CH-GCMSMS02, 8890 GC System, 7000 GC/TQ) equipped with a DB-5MS fused silica capillary column (30 m length × outside diameter 0.25 mm × internal diameter 0.25µm) and gas chromatograph interfaced to a Mass Selective Detector (MS-DSQ-II) with Mass Hunter software. For GC-MS detection, an electron ionization system with ionization energy of -70eV was used. Helium gas was used as a carrier gas at a constant flow rate of 1ml/min and the sample injected was 2µl; Injector temperature 250°C; Ion source temperature 200°C. The oven temperature was programmed from 50 °C at 1 min hold time Run time : 1 min; 5 °C / min 120 °C hold 1 min Run time 16 mins; 10 °C / min 210 °C hold 1 min Run time 26 mins ; 10 °C / min 280 °C hold 5 mins Run time 38 mins . Total GC run time was 38 min. The relative percentage of the each extract constituents was expressed as percentage with peak area normalization. The identity of the components in the extract was assigned by comparison of their retention indices and mass spectra fragmentation patterns with those stored on the computer library and also with published literatures. Per cent mortality data was subjected to statistical analysis using the factorial completely randomized design statistical package. The critical differences in main effects *i.e.* compounds, concentrations and days as well as in their interactions were tested at P = 0.05 %.

RESULTS AND DISCUSSION

The results, after 48 h of exposure, revealed that all the concentrations of the leaf extract caused significant mortality of *R. reniformis* juveniles when compared to control. The percentage of mortality ranged between 29.8 and 93.8 %. Among the different concentrations tested, 20% concentration exhibited highest per cent mortality (93.8) followed by 10% (85.0) and 5% (76.0) as compared to control (Table 1). The present report was in accordance with the results of Meena *et al.* (2010), Khan (2019) and Das *et al*. (2011) where they explored the efficacy of different botanicals against nematodes and reported the mortality of nematodes with the botanical extracts and powder against nematodes *in vitro*.

Mortality recorded by *T. cordifolia* leaf extracts are in accordance with the potential secretion of their metabolites as represented in Fig. 1. In GC-MS analysis, 18 compounds were identified of which 6 were reported with nematicidal properties (1, 2-Benzenedicarboxylic acid, bis (2-methylpropyl) ester; Hexadecanoic acid, methyl ester; Dibutyl phthalate; Methyl stearate; Phthalic acid and Octadecadienoic acid) (Table 2) (Hooks *et al*., 2010; Kumar *et al*., 2017).

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Table 1 Effect of *T. cordifolia* leaf extracts on the juvenile (J_4) mortality of *R. reniformis*

Concentration	% Mortality (48 HAT)
0.1	29.8
0.5	34.0
1	44.5
2	49.3
5	76.0
10	85.0
20	93.8
Control	2.0
C.D. (p< 0.05)	6.73

Table 2 Chemical composition of *T.cordiofolia* leaves with nematicidal properties

Compound name	Retention Time (min)	Area %
1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester	7.54	4.52
Hexadecanoic acid, methyl ester	10.31	2.47
Dibutyl phthalate	11.74	2.39
Methyl stearate	22.76	9.55
Phthalic acid	28.57	38.26
Octadecadienoic acid	13.98	5.47

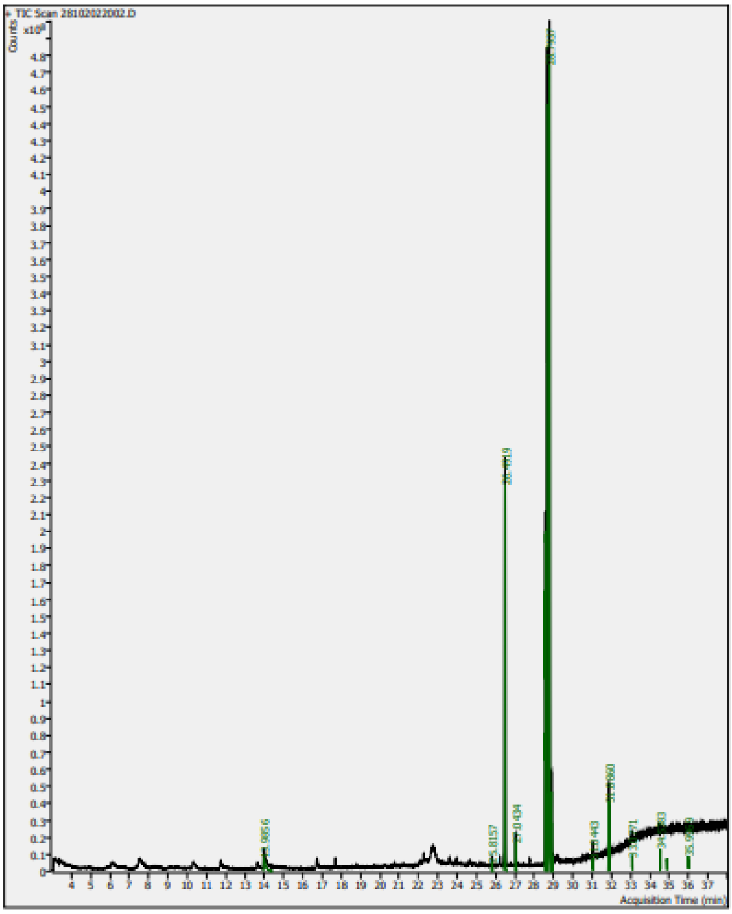

Fig. 1. GC-MS chromatogram of active methanol extract

Query based information system for safflower germplasm accessions

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ABSTRACT

Safflower (*Carthamus tinctorius* L.) Germplasm Information System (SGIS) was developed to retrieve the germplasm data based on different queries selected. It is web-enabled interface for the selective retrieval of accessions with desired characters, and also for retrieval of all the information for the selected genotype. It contains information on both qualitative and quantitative descriptors. The user can select a particular character or combination of characters to obtain information of that particular accessions.

Keywords: Catalogue, Germplasm accessions, PHP, Safflower, XAMPP

Assembly of germplasm representing the genetic diversity in a crop species is a prerequisite for its effective study, conservation and utilization for crop improvement. The Germplasm Management Unit of safflower at ICAR-Indian Institute of Oilseeds Research is the repository for 7022 accessions of safflower germplasm from 56 countries. All these genotypes have been characterized for 39 morphological and quantitative characters for description of these accessions. But searching of germplasm accessions will be difficult as it contains information of large number of accessions. To ease this difficulty, we have developed searchable query based sunflower germplasm catalogue with the objective of facilitating an easy and rapid retrieval of information on germplasm accessions.

MATERIALS AND METHODS

The safflower germplasm data collected from IIOR germplasm unit and compiled in excel. The data is stored in MySQL database as tables and integrated with PHP (Hypertext PreProcessor). Database server XAMPP was used to run the PHP code and installed.

RESULTS AND DISCUSSION

Using login credentials provided to the breeders, they can enter in to the SGIS. The breeder has different options to choose the different modes of data representation depending on their need. Search option is meant for searching the desired accession with their numerical value of its desired characters. It includes search by country of origin, by GMU number, by descriptors. Under core subset searching by GMU number it will give all 39 morphological and quantitative characters information. All the output can be exported to excel by selection that option.

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Lynn Beighley & Michael Morrison. Head First PHP & MySQL

Few snap shots of safflower germplasm catalogue.

Policy Initiatives for enhancing domestic availability of vegetable oils in India

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ABSTRACT

Oilseeds, the backbone of several agricultural economies from classical times assume a prominent role by providing access to nutrition through protein and oil to humans and livestock beside usage in the industrial sector and also a life line for providing livelihood and employment to those involved in the processing sector. The country which evidenced self-sufficiency in oilseeds during early nineties and ultimately gained the status of the world's largest importer, with import of 14.28 million tonnes during 2021-22. e Compound Annual Growth Rates (was used to assess the performance of annual oilseeds during 2000-01 to 2020-21. It was evidenced that the CAGR was positive for all the components. The power of technology operational at the farm level, paved way for sustained production, which is due to the technology outputs from the NAREES/AICRP on oilseeds besides the driving forces initiated by the Government of India. For further reducing import dependency, policy instruments eviz. Seed production, technology assemblage, linkages and convergence, providing incentives, promoting PM-FME.

\ Oilseeds, the backbone of several agricultural economies from classical times assume a prominent role by providing access to nutrition through protein and oil to humans and livestock beside usage in the industrial sector and also a life line for providing livelihood and employment to those involved in the processing sector. Majority of the edible oil comes from these crop enterprises. With its rich agro-ecological diversity, India is indeed blessed to cultivate nine annual oilseed crops. The country which evidenced self-sufficiency in oilseeds christened the "Yellow Revolution" during early nineties of the previous millennium could not be sustained during the present millennium, and ultimately gained the status of the world's largest importer, with import of approximately 14.28 million tonnes, with an exchequer of Rs14153 crore during 2021-22 (Import during the current financial year ending December, 2022 is 10.09 million tonnes an at exchequer of Rs. 11328 crore. (DGCIS, Kolkatta).This suggests that the demand-supply gap of the country's requirements are met through imports causing severe imbalance in the b alance of trade situation of the country.
An attempt is made in this paper to examine the performance of the growth of annual oilseeds in India during the present millennium and suggest appropriate interventions for enhancing the domestic availability of vegetable oils in the country.

METHODOLOGY

The secondary data from published sources (DACNET, DGCIS, and MOPSI) form the Alma matter for the study. The data pertains to the present millennium (2000-01 to 2021-21). The Compound Annual Growth Rates (CAGR) was employed in the present approach to assess the performance of the annual oilseeds crops for the period 2000-01 to 2020-21

Compound Annual Growth Rates (CAGR) was employed to examine the performance of the growth in area, production and productivity of the annual oilseeds (using the exponential time trend equation Y=a Bt. the CAGR is calculated as $(e^{B}-1)$ X 100 as suggested by Dandekar (1980).

RESULTS AND DISCUSSION

It can be observed from Figure 1 that the CAGR was 2.69, 2.07 and 0.61 per cent for production, yield and area respectively and were significant at one per cent level for the annual oilseed crops.

It can be evidenced that although the CAGR for area was 0.61 per cent indicating mild acceleration in terms of expansion of area under oilseeds, the country evidenced sustenance in the oilseeds production primarily, due to accelerated growth rate evidenced in productivity at 2.07 per cent. In fact, the average production during the the last five years (2016-17 to 2020-21) was 32.68 million tonnes with a sticky area of 26 million hectare suggesting that yield (technology) was the single largest contributor to the production.

It is appreciable to observe that during this period, when the country evidenced rapid strides in the per capita consumption of edible oils which more than doubled (9.5 to 19.4 kg in 2000-01 and 2020-21 respectively), due to a platter of reasons including reduced import duty and tariff structure; changing life styles, ever increasing per capita income, performance of the annual oilseeds sector during this period had showed signs of resilience, although the growth in area was around 0.61 per cent. This suggests, that the power of technology in terms of yield per ha operational at the farm level, paved way for sustained production, which is due to the technology outputs from the NAREES/AICRP on oilseeds besides the driving forcesinitiated by the Government of India to give a boost to the domestic production of annual oilseeds through various schemes initiated and being operationalised.

A snapshot of the Net domestic availability, imports, per capita availability of edible oils is furnished in Table 1 below. In India during the present millenium. It can be observed from the table that during the last five years ending 2021-22, despite increase in per capita consumption, rise in population, the import dependency has shown of slight decline with quantities hovering around 13-14 million tonnes during the above period.

To keep the momentum of reducing the import dependency through increased domestic availability of vegetable oils in the country, it is imperative that policy instruments are indeed warranted at this juncture to be created / strengthened in this direction. Some of the key policy requirements that require immediate attention increase the farm level productivity based on the study are summarized below:

- Developing a robust mechanism for creation of seed hub in annual oilseeds towards ensuring the timely availability of quality oilseeds to the farming community is very important and essential. The private players should be involved in seed production and in the seed chain of the oilseed crops.
- Convergence / Multi-Institutional approach of both public and private in technology assemblage and output marketing
- Linkages and strengthening the FPO's with end to end solutions
- Incentives for cultivation of oilseeds towards diversification
- Special purpose vehicle for giving fillip to oilseeds in Bundelkhand and North Eastern Region
- Favourable policy ecosystem for startups/ entrepreneurs in value chain of oilseeds
- Emphasis on promoting Micro Food Processing Entreprises (PM-FME) under the Atmanirbhar Bharat Abhiyan.

CONCLUSIONS

It can be concluded that the acceleration in the growth rate of productivity enabled for sustained production of annual oilseed in India during this millennium. Signs of reduced import dependency evidenced during the last five years is to be geared up for further reducing dependency through policy instruments encompassing seed production, technology assemblage, linkages and convergence, providing incentives, promoting PM-FME.

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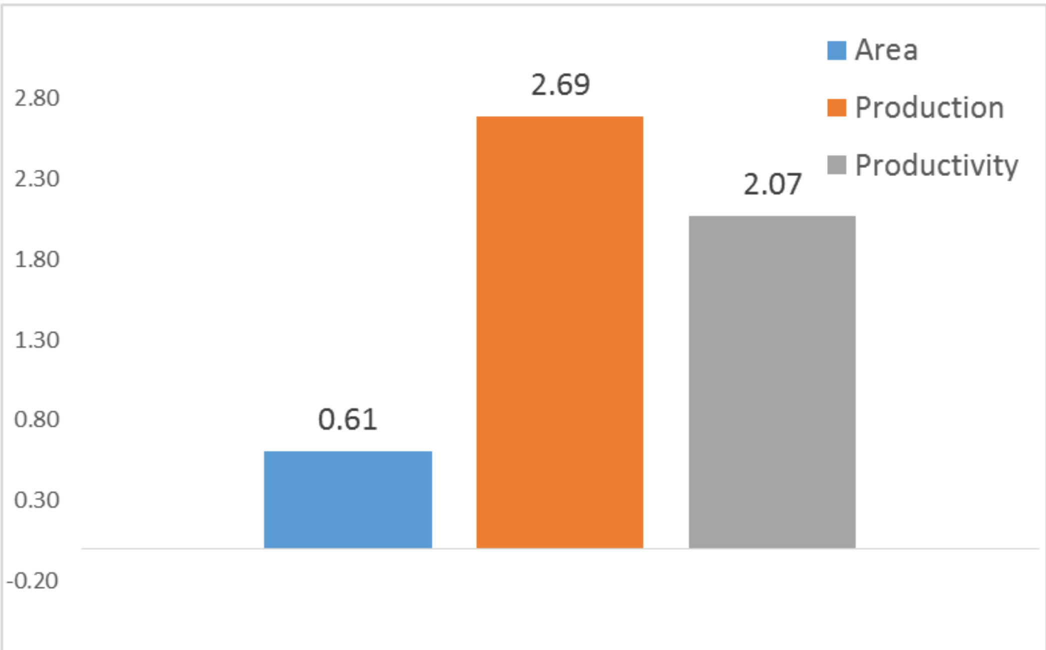

Figure 1: Compound Annual Growth Rate of annual oilseeds in India (2000-01 to 2020-21)

Table: Net domestic availability, imports, per capita availability of edible oils in India

Year	Population (billion)	Net domestic availability (mill. tonnes)	Import of edible oils (mill. tonnes)	Total Consumption (mill. tonnes)	Import Dependency (%)	Per Cap. Availabilty (kg/annum)
2000-01	1.06	5.5	4.18	9.68	40	8.2
2005-06	1.15	8.32	4.29	12.6	34	10.6
2010-11	1.23	9.78	7.24	17	43	13
2015-16	1.31	8.64	14.85	23.5	63	17.7
2016-17	1.32	10.1	15.32	25.4	60	18.2
2017-18	1.34	10.38	14.59	24.8	59	19.5
2018-19	1.35	10.35	15.57	25.92	60	18.1
2019-20	1.37	10.66	13.42	24.08	56	19.2
2020-21	1.39	11.16	13.45	24.61	55	19.7
2021-22	1.4	11.44	14.28	25.72	55	19.9

Fatty acid profiling of dark brown sesame (*Sesamum indicum* L.)

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ABSTRACT

Sesame is considered to be the oldest of oilseed crops having chemical composition of 42-63% oil, 22-25% protein, 13.5% carbohydrate and 5% ash. The fatty acid content of sesame oil contains oleic acid (43%), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%) contributing towards 96% of total fatty acid. The present investigation was carried out to study the total fatty acids composition in 200 sesame accessions. Results revealed that certain amount of variation has been observed among the accessions for oil content and fatty acid composition in the accessions.

Keywords: Fatty acid, Oil content, Oleic acid, Linoleic acid, Sesame

Sesame is considered to be the oldest of oilseed crops. Bedigian (1981) suggested that Africa is the primary centre of origin, due to its broad genetic diversity, while India is considered to be the secondary centre due to its huge production of sesame seeds. Being a short-duration crop is suitable for multiple cropping system as a catch crop or sequence crop. Sesame seeds are small in size, ovate in shape, slightly flattened with a smooth surface and a vital source of different nutritional elements *i.e.,* Iron (Fe), Magnesium (Mg), Copper (Cu) and Calcium (Ca) and some important vitamins *viz.,* B1 (Thiamine) and E (Tocopherol). This oil is used in the pharmaceutical industry and ayurvedic preparations because of its medicinal properties.

Most of the researchers observed that lignans i.e., sesamin and sesaminol found in sesame seeds have an extraordinary antioxidant effect on the human body. Sesame oil has some oxidative stability and oxidative activity because of lignans (Wu, 2007). Besides a source of edible oil, sesame seeds have enormous significance in the food industry because of the flavor and stability of the oil. The fatty acid content of sesame oil contains oleic acid (43%), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%) contributing towards 96% of total fatty acid (Elleuch et al., 2007). Keeping the above facts in view, the present experiment was formulated to carry out the study of total fatty acids composition in 200 sesame accessions.

MATRIALS AND METHODS

The present experiment was conducted to evaluate two hundred dark brown sesame (*Sesamum indicum* L.) accessions collected from Project Co-ordinating unit (AICRP on Sesame & Niger) for oil content and fatty acid composition. Oil content was determined by Soxhlet procedure and the fatty acid composition i.e., Oleic acid, Linoleic acid, Lionlenic acid, Palmitic acid and Stearic acid were determined by Gas chromatography.

RESULTS AND DISCUSSION

The experimental results revealed that certain amount of variation has been observed among the accessions for oil content and fatty acid composition. The Oil content ranged from 22.09% to 52.63% with average value of 42.10%. The accessions EC-334960 (52.63%), SI-995 (51.36%), G-41 (51.24%), EC-334994 (51.07%), EC-334992 (50.96%), IS-321 (50.89%), S-0481 (50.43%), ES-75 (50.39%), G-2 (50.11%), SI-1033 (50.05%), ES-75-4-84 (50.01%) were identified as promising accessions for oil content. Similar results were observed by Thakur et al.

(2017), Kurt (2018), Khayambashi and Asadi- Gharneh (2020), Morris et al. (2021).

The nutritional quality of ideal edible oil seeds is determined by low content of saturated fatty acid (palmitic acid and stearic acid) and high level of long- chain unsaturated fatty acids (oleic acid, linoleic acid, linolenic acid) and absence of very long-chain unsaturated fatty acid (eicosanoic acid and erucic acid) (Bhunia et al.(2015)).

Among unsaturated fatty acids, oleic acid is the essential fatty acid and varied from 26.78% to 64.03% with mean value of 42.90% and the accessions G-23 (64.03%), EC-335011-A (57.35%), IS-972 (54.67 %), IS-145 (53.79 %) and ES-560 (50.92) were identified as promising accessions for Oleic acid content. Linoleic acid ranged between 25.92% and 61.44% with average value of 42.62%. The accessions BC-303427 (61.44 %), SI-2123 (57.65 %), Nitamtpur-1 (56.73%), EC-3349989 (53.83 %), IS-503 (53.14%) identified as promising for linoleic acid. Linolenic acid ranged from 0.08% to 2.74% with average value of 0.48%. The accessions Tilohana (2.74%), G-6 (2.59%), G-8 (2.31%), G-10 (1.68%), ES-75 (1.59%) were identified as promising accessions from linolenic acid. Palmitic acid varied between 6.34% and 12.29% with mean value of 9.01%. Stearic acid ranged from 3.32% to 8.25% with average of 5.00%. Similar results were observed by Guimarães et al. (2013), Bhunia et al. (2015), Thakur et al. (2017), Kurt (2018), Khayambashi and Asadi- Gharneh (2020), Morris et al. (2021).

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Factors affecting *agrobacterium*-mediated transformation in castor (*Ricinus communis* L.)

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Castor (*Ricinus communis* L.) of the Euphorbiaceae family has been an important oilseed crop for genetic transformations, particularly *Agrobacterium*-mediated transformation. Many factors influence *Agrobacterium*-mediated transformation, including bacterial strains, cell density, plant growth regulators, antibiotics, explant, explant genotype, light, and temperature. The available information on this topic was summarized, and prospects for improving transformation efficiency were discussed.

EXPLANT

Despite the fact that plant cells' totipotency allows for the use of various plant parts as explants, such as embryonic cultures, immature embryos, meristems, shoot apices, root cotyledons, seed derived callus, and leaf blades, only a few will be amenable to transformation. Mature seeds and embryo axes are used as explants in castor for transformation in most of the studies. Cell death, tissue browning and necrosis following agrobacterium infection influences the survival of the transformants. Embryo axis is mainly used for castor transformation for insect resistance with transformation efficiency of 1.4% (Sujatha and Sailaja (2005) and for salt tolerance with transformation efficiency of 2.8-5.9% (Patel *et al*., (2015). Explant wounding has a significant impact on transformation efficiency by exposing the actively dividing cells of the explant to competent agrobacterium cells, allowing for easy entry and infection by removing the physical barrier. An enzymatic method is also used to wound the explant by using pectinase (1-2%) in castor, which was toxic to the explant and resulted in the death of the meristem and shoot cultures. The release of phenolic compounds at wounded site allows vir gene activation. Dedifferentiation and rapid proliferation of cells at the site of injury of the explant, allows plant cells to survive agrobacterium infection, heal, and promote growth for transformant regeneration. P-caumaric acid, ferulic acid, o-coumaric acid, syringic acid, and cinnamic acid are the phenolic compounds released by castor when wounded, but acetosyringone was used in co-culturing media for efficient induction of vir genes.

AGROBACTERIUM STRAIN

The agrobacterium strain is an important factor influencing transformation efficiency. For transformation. In castor, *agrobacterium* strains EHA105 and LBA4404 with GUS or GFP gene as a reporter gene with kanamycin and hygromycin as a selectable marker were used in transformation studies (Sujatha et al., 2004). The optimum cell density of the bacterial culture plays a major role in increasing the transformation efficiency. It was further influenced by Agrobacterium strain, cell viability, plant species, explant used and co-culturing period. It is found that that the optimum density is OD_{600} i.e. 0.6 for both *Agrobacterium* strains EHA105 and LBA 4404 in many crops. The EHA105 strain with a bacterial density of $2X10^8$ showed optimum transient *gus* expression at 30 min of co-culturing in castor.

CO-CULTURING MEDIA COMPOSITION

The co-culturing medium is critical in *Agrobacterium*-mediated transformation because it contains all of the necessary nutrients and minerals for the growth of the explant and Agrobacterium, acting as an overall energy source. The medium's composition varies depending on the plant species, explant, and bacterial strain, as each has different nutritional requirements such as optimum P^H, growth promoting factors, and hormones. Co-culturing of embryo axes in MS basal media with 3% sucrose, 0.8% agar, and 5.8 P^H found to be more efficient. While the mature seedlings were suspended in Winan's medium during transformation (Sujatha et al., 2005)

ANTIBIOTICS

Antibiotics are used to suppress the growth of susceptible cells, such as agrobacterium, and to prevent contamination after the co-cultivation period. Because long-term exposure can result in the death of the explants, antibiotics are used to distinguish transformed plants from untransformed plants. For selection, antibiotics such as Amphotericin B, Ampicillin, Tetracylin, carbencillin, neomycin, cefotaxime, hygromycin, and kanamycin are used, and one or two genes are incorporated in plasmid vectors as selectable markers in agrobacterium prior to co-culturing with explants. In this case, the concentration of the antibiotic in the selection medium is very important in the selection of the transformed plants.

PLANT GROWTH REGULATORS

Plant growth regulators enhances the frequency of transformation in both stable and transient integration by activating cell division and dedifferentiation. Since castor is a recalcitrant crop, identification of best hormonal combination for efficient regeneration after transformation is crucial. Pre-culturing of explant in TDZ (thidiazuron) helps in inducing organogenesis of explant in recalcitrant crops like castor. Cytokinin, BA (6-Benzylaminopurine) is used for adventitious shoot formation in most of the studies. Embryo axes cultured with 0.1mg-1 BA for shoot induction followed by 0.5mg-1 TDZ and 3 cycles of 0.5mg-1 BA for shoot and meristerm proliferation in castor (Sujatha *et al.,* 2004)

GROWTH CONDITIONS

Generally, co-culturing in dark are preferred to preserve the endogenous hormones and preventing the accumulation of the phenolic compounds and also found that dark pre-treatment subsequently increased the shoot regeneration in cotyledonary node explants and developed thin vascular tissue, cell walls which enhanced the transformation. The effect of light and photoperiod varies in the transformation in different crops and explants. In castor, the co-cultivation is done under 16/8 hr photoperiod by cool white fluorescent lamps with 30umol $m^{-2}s^{-1}$ light intensity. The process of transformation is thermo-sensitive and temperature plays a key role in regeneration and transformation. Since the optimal temperature for T-DNA transfer varies with the type of explant and Agrobacterium strain involved in transformation, hence it has to be evaluated for the particular strain and species of explant respectively. The *GUS* reporter gene was used to study transient expression with 19℃ – 32℃ temperature range for transformation and found that 19℃ was reported as optimal for transfer of T-DNA. In castor, the temperature range 26℃-28℃ and 28℃ was optimal for transformation. $P^{H\ is}$ an important factor which influences the expression of vir genes and T-DNA transfer. Generally acidic P^H is preferred and PH 5.8 was proved best for the co-culturing.

CONCLUSIONS

Stable and transient *agrobacterium* mediated transformation in castor is difficult due the recalcitrant nature of the crop. For increasing the transformation efficiency, thorough understanding of the major factor like agrobacterium strain, co-cultivation time and media with effective inducers, selective agents and efficient regeneration protocol is required.

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Benefits of farmers' collectivization through FPOs: A case study of Chinnakodur FPO

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ABSTRACT

The collectivisation of producers, especially small and marginal farmers, into producer organisations has globally emerged as one of the most effective pathways to address various challenges in agriculture. Chinnakodur FPO was nurtured and handhold by ICAR-IIOR. Necessary capacity building was done and a pragmatic business plan was developed. The FPO has made a turnover of more than Rs.35 lakh during the first year and poised to develop into a self-sustainable corporate entity.

Keywords: Business plan development, Equity grant, FPOs

Farmer Producer Organisations are membership-based organisations with an objective to develop and deploy the aggregation mechanism of farmers with common interest agree to pool their resources together to form a group, jointly deal with various issues of farming; be it credit, input sourcing, deployment of farm technology and good agricultural practices, post-harvest handling or onward sale of agricultural produce. The collectivisation of producers, especially small and marginal farmers, into producer organisations has globally emerged as one of the most effective pathways to address various challenges in agriculture.

MATERIALS AND METHODS

A bench mark survey was conducted in Chinnakodur mandal, Siddipet, Telangana State comprising of 10 villages and resource inventory of the villages on major crops, varieties grown, input utilization, output marketing, potential for crop diversification, value addition and business opportunities were collected. For mobilizing the membership in the FPOs, personal contacts, small group meetings, focussed group discussions and local leader were used. The Chinnakodur Mandal Farmer Producer Mutually Aided Cooperative Society Ltd. (chinnakodur FPO) was registered on 01.09.2021. After sufficient members (750 farmers) were mobilized, baseline data were collected from each member by personal interview method through a semi-structured interview schedule. The business plan was developed in consultation with the expertise available in the ICAR and other institutes. ICAR-IIOR has facilitated in getting the required licenses (seed, pesticide and fertilizer) for doing business by the FPO and in procuring the equity grant. Capacity building programmes for office bearers and members were organized by ICAR-IIOR in collaboration with various agencies.

RESULTS AND DISCUSSION

The business plan for the FPO included the following activities *viz*., input aggregation, output marketing, foundation seed production of groundnut varieties (Girnar 5 and Kadiri Lepakshi), certified seed production of paddy and crop diversification during *rabi* season, capacity building of farmers in oilseed crops and bee keeping in oilseeds. The economics of these activities indicated that the FPO has earned a profit of more than rupees nine lakhs during the first year itself, which clearly indicated the potential benefits of collectivization of farmers.

Farmers were also convinced to take up sunflower during *rabi* season instead of paddy. ICAR-IIOR has conducted a series of trainings on sunflower production and provided sunflower hybrids DRSH-1 and KBSH-78 from UAS, Bengaluru. The Institute also facilitated in procuring seed from private seed firms (Siri seeds and Nuziveedu seeds). Thus, IIOR could managed to supply sunflower seed to FPO at reasonable price during the times of acute seed shortage and private companies were selling at exorbitant price. A training programme on bee keeping in sunflower crop for developing complete value chain of sunflower in the village and bee keeping was taken up by entrepreneurs. This has created lot of confidence among farmers on the activities of the FPO and role of IIOR and resulted in crop diversification with sunflower in around 1500 acres. One of the crucial determinants for the sustainability of FPO is institutional support, new market linkages, adoption of agricultural best practices, and providing the managerial skills to the farmers (Gurpreet Singh et al. 2018). All these aspects were taken care in the Chinnakodur FPO. Lack of government support and credit facility were the major constraints that the farmers perceived in the functioning of FPOs (Sudip Kumar Gorai, 2020).

The Chinnkodur FPO has developed a strong platform and is ready to further extent its activities due to the infusion of equity grant of Rs. 15.0 lakh from GoI. The FPO is in the process of developing a custom hiring centre for offering mechanized services, paddy processing centre and oil expeller unit for value addition. ICAR-IIOR will facilitate in branding the products of the FPO to build a self-sustainable corporate entity.

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Table 1. Economics of FPO during the first year (October 2021 to December 2022)

Activity	Quantity (kg)	Purchase price (Rs.)	GMR (Rs.)	Profit (Rs.)
Input aggregation				
Sunflower hybrids				
DRSH-1	660	1,98,000	4,95,000	2,97,000
KBSH-78	200	6,50,00	1,50,000	85,000
Siri-33	1000	5,50,000	7,50,000	2,00,000
Swathi	500	2,75,000	3,75,000	1,00,000
Fertilizers				
	1,06,700	12,07,891	13,06,050	98,158
Plant protection chemicals				
	72.5 litres	56,658	65,320	8,662
Output marketing				
Groundnut				
Girnar-5 (0.50 acre)	1000	60,000	1,10,000	59,000
Kadiri lepakshi (2 acres)	4000	2,40,000	3,20,000	2,34,500
Total		25,87,549	35,71,370	9,18,820

Strategic approach under ICT for farmer empowerment

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NEED OF ICT'S

In spite of successful research on new agricultural practises concerning crop cultivation majority of farmers not getting upper bound yields due to several reasons. Therefore there is a need to propose a cost effective frame work for a agricultural information dissemination system to disseminate expert agricultural knowledge to the farming community in order to improve crop productivity. It aims to provide expert advice which is crucial to the Indian farmer to harvest different kinds of crop varieties based on the demand in the world market. According to above instruction establish the relationship between the information technology and computer related services with the farmers who are working hard in their farm.

INFORMATION AND COMMUNICATION TECHNOLOGIES- ICT'S

ICTs is a umbrella term includes devices, networks, services and applications. These can range from cutting edge Internet-based technologies and sensing tools to other technologies that have been around for much longer, such as radio, telephones, mobile phones, television and satellites as well as various services like and applications associated with them, such as videoconferencing and distance learning.

NEED OF ICT'S IN AGRICULTURE

It can initiate new agricultural and rural business such as e-commerce, real estate business for satellite offices, rural tourism, and virtual corporation of small-scale farms. It can support policy-making and evaluation on optimal farm production, disaster management, agro-environmental resource management etc., using tools such as geographic information systems (GIS). It can improve farm management and farming technologies by efficient farm management, risk management, effective information or knowledge transfer etc., realizing competitive and sustainable farming with safe products. For example, farmer has to make critical decisions such as what to plant? When to plant? How to manage pests? While considering off-farm factors such as environmental impacts, market access, and industry standards. IT-based decision support system (DSS) can surely help their decisions. It can provide systems and tools to secure food traceability and reliability that has been an emerging issue concerning farm products since serious contamination such as chicken flu was detected. It can facilitate rural activities and provide more comfortable and safe rural life with equivalent services to those in the urban areas, such as provision of distance education, telemedicine, remote public services, remote entertainment etc. Empowerment of Stakeholders (Government Officials, Research, Education & Extension Scientists, farmers and other service providers such as Community Information centers. Development of Knowledge Management, Decision Support and Advisory Systems to strengthen Extension services and also used for Farmers Redressal system. Efficient management (Development, Conservation, allocation and utilization) of resources.Improved productivity and profitability of farmers through better advisory systems.

ICT INFRASTRUCTURE SENARIO IN INDIA

India's ICT sector contributes over 13 percent to India's GDP. About 1.25 billion digital identity numbers issued to citizens (as of June 2020).India's television industry grew about 12 % from $8.8 billion in 2017-18 to $10 billion in 2018-19. At the end of 2019, there were about 298 million households in India, and about 197 million households had television sets (66.12%). India has the 2nd largest telecom network in the world in terms of subscribers. India has emerged as the 2nd largest manufacturer of mobile handsets in the world. India imported over $2.2 billion in computer and electronic equipment from the U.S. in 2017. The ICT market is reach $191 billion in FY2020 and is projected to grow to $350 billion by 2025.

ACTS & RULES GOVERNING ICT SECTOR IN INDIA

- The Indian Telegraph Act, 1885
- The Indian Wireless Telegraphy Act, 1933
- Indian Telegraph Rules, 1951
- National Telecom Policy, 1994
- Telecom Regulatory Authority of India Act, 1997
- New Telecom Policy, 1999
- The Information Technology Act, 2000
- Boradband Policy, 2004
- National Telecom Policy, 2012
- Indian Telegraph Right of Way Rules, 2016
- National Digital Communications Policy, 2018

WHY SOCIAL MEDIA?

Social media are web-based tools of electronic communication that allow users to personally interact with others individually or in groups for the purposes of exchanging information, sharing thoughts and opinions, influencing and facilitating decision-making by creating, storing, retrieving and exchanging information in any form (text, pictures, video, etc.,) by anyone in the virtual world. These are digital networks that are used to share and discuss user generated information - opinion, video, audio, and multimedia. Social media is not about what each one of us does or says, but about what we do or say together, worldwide, to communicate in all directions at any time by any possible digital means. Social media is basically digital technologies facilitating communication of user generated content through constant interaction. Accessibility of social media through mobile phones and the scope of mass-personal and mass-self communication makes it a popular platform among the masses to share ideas and increase linkability and content sharing across multiple platforms.

FACEBOOK

Facebook is the most used social media platform in the world with more than 1.87 billion monthly active users on the site (we are social, 2017). And this means an immense potential for extension professionals. A few examples where Facebook is being used as an extension tool by individuals, professional networks, and extension organizations are given below.

(1) Livestock Information and Market Centre: This is aFacebook group of livestockfarmers, extension personnel, scientists, local leaders, market functionaries, and consumers in the Indian state of Tamil Nadu to share information related to livestock production and management, marketing, etc.

TWITTER

Microblogging site Twitter is one of the most popular social media platform globally with 320 million users. On a social context, it has been one of the major catalysts used for creating public opinions and for organizing people into groups. In agriculture too, it is one of the most used platform and some of the examples are as follows:

(1) **e-Agriculture**: e-Agriculture is a global community of practice, where people from all over the world exchange information, ideas, and resources related to the use of information and communication technologies (ICT) for sustainable agriculture

(2) **YPARD (Young Professionals for Agricultural and Rural Development):** It is an international movement by young professionals for agricultural development. It is a global network of professionals.

(3) **AgChat:** AgChat Foundationis a community of volunteerswith collaborative mission ofconnecting consumers andproducers to help initiate abetter understanding of thefarming process and thefarmers' condition.and rural development.

YOUTUBE

YouTube, a video sharing platform, is the third most visited website in the world. A total number of 3.25 billion videos are watched on the website each month and more than half of the views are from mobile. Many individuals, organizations, and networks are leveraging its advantages. Few agriculture related YouTube channels in India and abroad are given below:

(1) **KISSAN KERALA**: It is an integrated, multi-modal Agriculture Information System for Kerala. Conceptualized, implemented and managed by Indian Institute of Information Technology and Management - Kerala (IIITM-K), Kissan Kerala videos to entertainment videos. The videos are made to create awareness about life on farm, various agricultural operations and start a conversation about agriculture with the rest of the community. The channel has 121,994 subscribers and a total of 43,529,553 views on the videos. It provides several ICT enabled agricultural information services to the farming community. Information services are provided through multi-modal delivery platforms like online services, television program, mobile based information services, touch screen kiosks etc. With 43,261 subscribers and more than 27 million views, this channel provides telecast quality informative videos on agriculture, animal husbandry, fisheries and allied topics.

(2) **GREEN TV**: It is India's first premier agriculture television channel aiming to provide news updates of news and analysis on topical issues of national and international importance in agriculture. The channel also analyze Saharan Africa since 2008. As of June 2016, it has reached over 1 million individuals across 13,592 villages through 4,426 videos, which showcase and demonstrate best practices. As many as 574,222 viewers have adopted one or more of the best practices promoted through these videos and YouTube is one of the popular platforms of sharing the videos.

BLOGS

Blogs contain detailed information on specific topics. They create and facilitate in-depth discussion on any issue through comments from the readers. With increased popularity, many blog competitions are also organized worldwide for rural youth to encourage them start a discussion about farming. Even organizations like World Bank, Food and Agriculture Organization (FAO) and International Food Policy Research Institute (IFPRI) have their own blogs not just to discuss issues but announce their new publications like policy papers, working papers, and reports and so on; communicate summaries of important publications; and to increase awareness and discussion on important issues related to agriculture and rural development.

WHATSAPP

A messenger app for smartphones, it is an internet based messaging platform that supports text, audio, video, pdf and various other forms of files. Real time video chatting has also been integrated recently, making it more popular among users. Currently there are more than one billion users of the app in 180 countries. Though initially used for personal messaging, it is gaining more popularity among agricultural professionals and practitioners to share information, which is aided by the group messaging feature. There are few hundred thousand WhatsApp groups created for agricultural extension and advisory services in India.

ICT in Agriculture: Connecting Farmers to Knowledge, Networks & Institutions

ICTs provide a forum to reach masses easily and to make global and local information easily accessible to the stakeholders.Information dissemination in agriculture is cost effective, time saving and speedy through ICT. Agriculture experts are the key component in the whole process of disseminating information to the farmers. Mobile telephony has emerged as the foremost choice of the majority of the urban and rural people. Mobile phones were found as the most widely accessed tool among the farmers for accessing agriculture-related information particularly for the marketing of produce. Researchers also reported that mobile phones were the most used ICT tool and highly accessible by the farmers. It was found in a comparative study that the livestock farmers of Uttar Pradesh, who were using ICT-based information made significantly better decisions on various livestock practices as compared to ICT non-users. Further, few studies reported that the ICT based initiatives helped farmers of MP, UP &Tamil Nadu, in reducing transaction cost while acquiring information and transactions in input and output markets.

ICT PROJECTS

WARANA 'WIRED VILLAGE'**:**

Objectives

To make available agricultural, market and educational information in local languages. To provide information on Govt. schemes. To create a database of villagers on various socio-economic aspects. To establish GIS to 70 villages. To simplify operations of the Sugar Co operative.

Benefits of the Project

Increased efficiency of Sugarcane growing and harvesting as time is saved in administrative transactions. To increase Transparency of payments. One visit to the Kiosk – Saves 2-3 days. Fertilizer stocks are now smaller and better managed.

ITC’s e-Choupal – A Private Sector Initiative:

It was Launched in June 2000, now the largest initiative among internet-based interventions in rural India. Initially, a few soybean growing villages of Madhya Pradesh state of India were selected for them pilot phase of the project. Real-time information and customised knowledge enhance farmer’s ability to take decisions and align their farm output with market demand. Aggregation of the demand for farm inputs from individual farmers gives them access to high quality inputs from established and reputed manufacturers at fair prices. As a direct marketing channel, virtually linked to the ‘mandi’ system for price discovery, ‘e-Choupal’ eliminates wasteful intermediation and multiple handling. Thereby it significantly reduces transaction costs. 'e-Choupal' services today reach out to over 4 million farmers growing a range of crops - soyabean, coffee, wheat, rice, pulses, shrimp –35,000+ villages linked through 6,100 ‘e-Choupals’ across 19 states.

Services provided: Along with telephony and email, video conferencing software is bundled with the basic kiosk operations. Offering services to learn computer-based applications through online modules. It Works as an agricultural consultant in terms of offering advices. In the area of health care too, n-Logue has set up operation by using internet-based video conferencing for the doctors to see the patients. It also offers services pertaining to e-governance with services like holding land records, online application forms, payments of various utility bills, etc.

Sustainability: n-Logue derives its revenue mainly in terms of usage revenues from the kiosk operator. The kiosk operator pays n-Logue a sum per month which is shared between N-Logue and the Local Service Provider. The kiosk operator breaks even over a period of 6-8 months and recovers the initial investment over a period of 3 years. N-Logue has thus built a self-sustaining model which has profitability as its core business strategy.

ICT-DIGITAL AND MOBILE APPLICATIONS
APPLICATION OF ICT IN PEST
MANAGEMENT: e-SaAP

Electronic Solutions against Agricultural Pests (eSaAP), an ICT dedicated for crop health management system developed at UAS Raichur in association with Tene Agricultural Solutions Pvt. Ltd., Bengaluru. The project initiated in 2013 in Chikkaballapur and Ramanagar districts in Karnataka. It was developed on an Android platform which was an offline solution that exchanges data with the cloud server under any telecommunication network. It has a unique image & voice-based diagnostic architecture, a mechanism to capture field data and is updated remotely. Temporal and spatial information gathered out of crop-pest surveillance for quicker requirement-based management actions to be disseminated.

LAND RECORD COMPUTERISATION (BHOOMI)

Bhoomi is an online database & viewing system for management andaccess of land records for Karnataka launched in 2000. The main objective of the programme is 'to develop a modern, comprehensive and transparent land records management system in the country, with the aim to implement the conclusive land-titling system with title guarantee, which will be based on four basic principles single window to handle land records, Mirror principle- which refers to the fact that cadastral maps mirror the ground reality, Curtain principle- which indicates that the record of title is a true depiction of the ownership status, mutation process is automated and happensautomatically following the registration, and the reference to past records is not deemed necessary. Title insurance- which guarantees the title for its correctness, and indemnifies the title holder against loss arising on account of any defect therein.

PROJECT GYANDOOT:

It is a low cost rural intranet project based on e-governance started in the year 2000 in Dhar, MP that aim is to harness ICTs to improve governance at village, block and district levels. Project linked around 35 kiosks with district HQ. Kiosks include a networked computer, printer, Software in Hindi & touch screen applications designed to encourage maximum utilization and access by rural farmers. Gyandoot provides many information services to the farmers like best practices related to agriculture, prices of agricultural produce in different markets, ask the Expert. It also act as provision of a database that stores information regarding the best practices for crop cultivation. Online registration and provision of land records, information and application formats for rural development schemes.

PUSA KISHI APP– OVERVIEW:

It was launched on 21 March, 2016. It was developed to realize the Dream “LAB to LAND” and help farmers to get Information about technologies developed by IARI. With the use of the PUSA Krishi application, farmers can get easy solutions to their problems in their farm fields and help of this app farmers will get information about weather and accordingly they can take measures to save crops. PUSA Krishi app offers information related to new varieties of crops developed by ICAR, resource-conserving cultivation practices as well as farm machinery and its implementation. Scientists support farmers from time to time with new technologies.

FARMERS' PORTAL:

It was launched in 2015 is an endeavour to create '***one stop shop'*** for meeting all informational needs relating to Agriculture, Animal Husbandry and Fisheries sectors production, sale/storage. Farmer get all relevant information on specific subjects around his village/block /district or state through the Map on Home page. Block level details related to soil fertility, storage, insurance, training, etc. are available in an interactive map. Information delivered in the form of text, SMS, email and audio/video in local language he or she understands. Farmers will also be able to ask specific queries as well as give valuable feedback through the Feedback module specially developed for the purpose. Users can also download farm friendly handbook, scheme guidelines, etc.

e –NAM (NATIONAL AGRICULTURE MARKET):

E-NAM or the e-trading platform launched on April 2016, a Pan-India electronic trading portal that nets the prevailing APMC Mandis for making a united national market for agricultural commodities. E-NAM operate via the online portal that is linked to the states' Mandis (Wholesale markets). Over 90 Commodities Including Staple Food Grains, Vegetables and Fruits. Some key points related to e-NAM- GOI offering grant of Rs.30 lakhs to participating mandis, 'Farmer helpline services' 24×7 to help about portal. Small Farmers' Agribusiness Consortium (SFAC) is the lead promoter of e-NAM. SFAC through open tender selects a Partner to develop, operate, and maintain the NAM e-platform.

E-SAGU:

It was launched in 2004 by International Institute of Information Technology (IIIT) Hyderabad, funded by Media Lab Asia. E-sagu tested on 5,000 farms in 35 villages in more than six districts of Andhra Pradesh. It Uses medium of digital photos of farmers 'fields to provide expert advice. Photographs are captured every 15 days by a local coordinator employed by e-Sagu. E-Sagu experts at main center examines photos and provide advice which is sent back to the local coordinator. An advice is provided on a regular basis (typically once a week) from sowing to harvesting in around 24–36 hours. In case of pests and diseases requiring urgent treatment, the advice is sent via SMS directly to the farmers and the coordinator.

AGROPEDIA:

It was originally titled "Agropedia Indica", Agropedia is an online knowledge repository for information related to agriculture in India launched in 2009 by IIT Kanpur with NAIP funding. It is a Collaborative project of seven consortium partners' viz. ICRISAT- Hyderabad, NAARM- Hyderabad, IIT Kanpur, IIT Mumbai, GBPUAT- Pantnagar, UAS- Raichur and IIITM-Kerala. It provides knowledge models for different crops developed on agropedia provide general idea about all the aspects of crops and specifically about each crop. It provides interaction platform though forum and blogs.

KISAN SHUVIDHA APP:

It was l*aunched in 2016 by Hon'ble PM*. It was d*eveloped by C-DAC for Ministry of Agriculture and Farmers Welfare GOI*. It provides information regarding Weather - daily weather report, forecast for 5 days, Extreme weather alerts. Dealers - Name, Mobile & Address of Seeds, Pesticides, Fertilizer & Farm Machinery are provided. Market Prices - rates of various crops in different mandies are provided. Plant Protection - Crop specific information on pest management. If crop is not normal, farmers can upload a photo & send it to experts for advice. Agro Advisories - advisories from experts regarding activities to be undertaken and precaution to be taken staring from sowing to harvesting. Contact KCC - This option provides facility to speak to Kisan Call Centre Soil Heath Card - option gives information about Soil Health Card, so that farmers can use fertilizer and pesticides judiciously having regard to minerals available in a particular land/farm. Cold Storage and Gowdowns - information & contact details of warehouse and cold storage available in the district.

IFFCO Kisan Sanchar Limited: Green SIM, 2008

Green SIM card for farmers is an initiative of the IFFCO Kisan Sanchar Ltd (IKSL). IKSLisajointventureofIFFCOandAIRTEL. IKSL provides voice-based agricultural information in regional languages to empower rural farmers.Farmers with Airtel "Green SIM" have access to value added services which include daily agri- voice messages (weather, crop/animal husbandry advice, market prices, government schemes etc) and an agri-helpline.

TATA CONSULTANCY SERVICE_m-KRISHI:

It was launched in 2012 in 3 districts of Tamil Nadu. Farmers get answers to queries related to agriculture, such as advice on use of fertilizers, pesticides and growth hormones and also provides up-to-date weather and market information through SMS. Currently, nine crop protocols, cotton, wheat, rice, and soybean are on m-Krishi.

KISAN RATH (APRIL, 2020):

Kisan Rath mobile app facilitates farmers, FPOs and traders for transporting Agriculture & Horticulture produce. Allows posting requirements of part-load as well as full-load. App interfaces with major transport aggregators and also allows individual transporters to register their vehicles and provide services to farmers and traders. Kisan Rath - which will bring together 5 lakh trucks and 20,000 tractors on mobile platform for transporting farm produce to markets from farm gate. Primary transportation would include movement from Farm to Mandis, FPO Collection Centre and Warehouses etc. Secondary Transportation would include movement from Mandis to Intra-state & Inter-state mandis, Processing units, Railway station, Warehouses and Wholesalers etc.

DAIRY INFORMATION SYSTEM KIOSK (DISK):

- The E-Governance Centre of the Indian Institute ofManagement (IIMA) and NDDB initiative
- It has two major components -DISK- application running at the society level that could be provided Internet connectivity and DISK software maintain databases of members, their cattle, AI, veterinary, feed and other service transactions in addition to the daily milk transactions.
- Dairy Portal at the district level serving transactional and information needs of all members and staff in the district cooperative structure
- Dairy Portal gas two-tier architecture, with database software hosting and maintaining the data and the web server delivering static as well as dynamic the contents

LIVESTOCK GURU:

Tamil Livestock Guru is a touch screen technology, whichprovides guidance on animal health and husbandry issues. Touch screen option, rather than a keyboard was often easier by illiterate users. Here Content displayed by livestock species. After choosing species of interest, user can choose modules from Feeding, Housing or Disease.Within each disease module, all of the learning information proceeded in the same sequence: Causation, Symptom, Treatment and Prevention.

FISHER FRIEND:

Qualcomm India, TATA Indicom, Astute and MSSRF have started a joint initiative called“Fisher Friend” in 2009. Mobile application which provides vital real-time information to fishing community’s whenand where they need it the most, at mid-sea. Relevant information on wave height, speed & direction, potential fishing zones, news provided in local language. Mobiles allow fishermen, to get timely price information and decide the best place to land and sell their daily catch.

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CONCLUSION

It concludes that under certain conditions, information and communication technologies (ICTs) can significantly enhance poor people’s human and social capabilities and have a positive impact on their well-being. ICTs can enhance poor people’s individual and collective agency strengthen their existing individual or community assets and enhance their informational capabilities. ICTs receive meaning only if people use and enact them for specific purposes and if local communities can exert control over their use by interpreting and appropriating them for their specific socio cultural realities. Direct impact of ICT programs on people’s well-being is the personal empowerment of the most marginalized groups, such as indigenous women, whereby the newly acquired ICT capabilities provide women with a sense of achievement, significantly strengthening their self-esteem. The role ICTs play in enhancing people’s well-being remains significantly limited by the broader structural barriers of extreme poverty and social exclusion of poor communities.

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A pilot study on kernel germination to enhance planting material production in oil palm

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INTRODUCTION

At present, only five oil palm seed gardens are actively involved in DXP seed production in India with cumulative capacity of 10-12 lakh germinated seeds in a year. The National Mission on Edible Oils (NMEO) – Oil Palm has targeted to increase area under oil palm to 10.0 lakh hectares by 2025-26 from the present level of 3.50 lakh hectares. For this, nearly 975 lakh oil palm seedlings are required (Reddy, 2020). Further, conventional method of seed dormancy breaking and germination is an energy and time consuming process and produces only 40-50% quality germinated seeds. Increase in germination can facilitate to enhance planting material production with same level of seed production. Hence, an alternate method was attempted to germinate oil palm kernel to improve germination.

MATERIALS AND METHODS

The oil palm DXP bunches from five palms were de-pericarped and seeds were collected. The kernel from fresh seeds were obtained by mechanical removing the endocarp (shell) and soaked in water for 3, 5 and 7 days and studied the imbibition rate. After hydration, seeds were de-operculated (removal of operculum) and kept for germination @ 25°C in germination paper. Seed viability was studied using Tetrazolium (TZ) test (AOSA, 1970). At regular interval, germination percent (kernels with well differentiated radicle and plumule) was counted. The germinated kernels were categorized into small, medium and large based on length on embryonic axis and transferred to portrays and evaluated various growth parameters.

RESULTS AND DISCUSSION

The oil palm seeds have initial moisture level of 18.4% which was increased to 32.8% after 5 days of soaking. As per the oil palm seed standards, minimum of 22% moisture is necessary for seed germination. The imbibition in seed induces metabolic changes necessary for initiation of germination i.e. radicle protrusion. The initial viability (TZ test) of kernels was 95%. The germination percent was increased from 28% on 5 days after sowing (DAS) to 67% on 30 days after sowing. Further, tetrazolium test of ungerminated kernels after 30 days of sowing revealed that 73-93% kernals were still viable, which further widens the scope for improvement in germination. Protray studies indicated that 2 % mortality in small size germinated kernals - (0-3 cm) compared to medium (3-6 cm) and large size (>6 cm), where no mortality was recorded. Similarly, other seedling growth parameters like shoot length, root length, stem girth and shoot & root dry weight were also higher in medium and large size germinated kernals.

1.

CONCLUSION

In oil palm, de-operculated kernel germination can be used as alternate to conventional method of germination. The de-operculated kernel germination has several advantages like complete elimination of heat treatment to break dormancy, improved germination, energy and time saving. As these results are based on pilot study, needs validation in large scale at different seed gardens before adopting for commercial use.

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Importance of biodiversity in rhizosphere microbes for crop response and methods to assess the biodiversity

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ABSTRACT

Microbes play a vital role in influencing the quality and health of soil and plants. Several studies had led to understanding of diversity and structure in the plant rhizosphere: linking with Soil Microbial diversity to Modern Agriculture, amrita gupta et.al (2022); Influence of long-term fertilization on soil microbial biomass, dehydrogenase activity, and bacterial and fungal community structure in a brown soil of northeast, China Peiyu Luo et.al (2013). The microbial population has many applications and advantages which are determined only through Long term fertilizer studies. Some of the methods used for assessing the biodiversity of these rhizosphere microbes are: 16s rRNA sequencing, DDGE, TDGE, SEM, etc. Some advantages of rhizosphere microbes are improved crop yield, fighting climate change with minimal soil and environmental degradation, the protection of human health for current and future generations, macro and micro-nutrient cycling for optimum agricultural growth, higher crop yield, and also prevents land degradation. In this article we will study about importance of biodiversity of rhizosphere microbes and various methods to identify the microbial population.

Keywords: Long term fertilizer trials, PGPR, 16s ribosomal RNA, Rhizosphere microbes, etc.

In the early 1900's the studies based on rhizosphere microbes had started. The term rhizosphere was coined for the first time by L. Hiltner which was used to denote the area of intense microbiological activity in the soil which generally extends up to several millimeters from the root system of the plants. According to the scientists Balandreau and Knowles (1978) F.E. Clark [1949] and the rhizosphere is divided into 3 regions namely endorhizosphere, exorhizosphere and rhizoplane. Nowadays most of the agri-biotech techniques are focused on prioritizing crop commercialization and increasing the yield of crops for short term benefits without any foresight for sustainable development and natural balance instead of focusing on the ground level factor for improving the crop yield like the activity of soil micro-biome, which has led to facing many drawbacks like decreased nutrient composition of soil, soil erosion, soil acidification, recalcitrant xenobiotics, etc. The rhizosphere region has many positive impacts to the plants and some of them are: (a) the microorganisms catalyse the reactions in the rhizosphere and produce CO_2 and form organic acids that in turn solubilize the inorganic nutrients of plants. (b) Aerobic bacteria utilize O_2, and produce CO_2, therefore, lower O_2 and increase CO_2 tension that reduces root elongation, and nutrient and water uptake. (c) Plant growth regulators such as indole acetic acid, gibberellins, cytokinins, etc. are known to be produced by the rhizosphere micro-flora. (d) They influence phosphorus availability to plant through the process of mineralization and immobilization. However, when plant suffers from nutrient scarcity during summer in tropical areas the microorganism release the immobilized nutrients. Therefore, they act as sink between soil and plant roots in nutrient poor systems, and many more.

The biodiversity of rhizosphere microbes in a particular soil can be studied and developed only by using long term trials. Organic and inorganic fertilizers are primarily used to increase the crop yield, and in short-term fertilizer (STF) experiments, they have no major effect on microbial community (Crecchio et al. 2001; Marschner et al. 2001). However, in long-term fertilizer (LTF) experiments, they can affect the function, community structure, and population of soil microorganisms (Marschner et al. 2003; Cinnadurai et al. 2013). The LTF trials help us understand the complexity of the soil microbes when the test field is treated with different types and composition of fertilizers which may be organic or inorganic. According to majority of the LTF studies conducted in different countries with different soil, climatic, nutrient, and environmental conditions its collectively accepted that the diversity of the rhizosphere microbes present in the soil sample is always rich if the particular test plot has been treated with organic fertilizers, and contrary to the above claim the test plot which has been treated with inorganic fertilizers has a less complex and simpler diversity of soil microbes.

The information generated from various aforementioned studies and other theories numerous scientists and institutions have come forth in supporting facts, stating that rhizosphere microbes indeed play an important role in controlling the growth and development of the plants (both commercially important and wild varieties). So, in order to enrich the diversity of soil microbes many countries have started to support and increase the use and production of organic fertilizers which even though don't show any significant effect in the short term they are very helpful in the long term sustainable development of the crops and also help in increasing the yield of the crops.

Some of the applications of rhizosphere microbes are: They act as bio-control agents, inducers, stimulants, help in Induced systemic resistance (ISR), and can also be used on the commercial level as biofertilers, bio-pesticide.

MATERIALS AND METHODS

In general, biochemical (culture dependent) and molecular (culture independent) methods are used to assess the biodiversity of the rhizosphere microbes present in the soil.

Morphological identification such as cell shape, size, colour, flagella and gram staining are used to classify the microbes. Since only a very limited per cent of bacterial communities can be cultured, classification based on the morphological features are not enough to establish a detailed classification of bacterial communities in the soil.

There are also some other advanced molecular methods like shot gun sequencing, identification based on PCR, 16s rRNA , metagenomics, micro array based identification, etc. are used to assess the soil microbial biodiversity in recent decades.

Culture dependent method: here the microbial sample is inoculated into different culture mediums, in which each culture has different compositions to study the characteristics of the microbial population. It's a long and time consuming process. According to the scientific studies only 3% of the microbes found in soil can be cultured, so only few species or groups of microbes can be identified using these methods.

Culture independent method: in this method the rhizosphere microbial samples are not inoculated into any media but are characterised based on in silico analysis using bio-informatics studies and tools like SILVA, UNITE, NCBI, Kronatools, etc. The result is represented in the form of heat maps, venn diagrams, or krona charts which are designed on the basis of the bio-informatics studies.

But most frequently used method of identification for rhizosphere microbes is based on 16s ribosomal RNA of the microbes, through which 16s rRNA sequencing is done. The 16s ribosomal RNA is found in all the prokaryotes and has 9 hyper-variable(HV) regions(variable in every microbe) which plays a major role in taxonomic identification of the microbes along with other regions called as conserved regions(which are constant in all the microbes).

The most frequently used hyper-variable regions are V3 - V4 regions. But sometimes instead of choosing only the HV regions we sequence the whole sequence containing 1500bp or more, this method is called as shotgun sequencing. The primers used for this process differs based on the source organism from which 16s rRNA is taken from. This method is more prevalent then others as it has highest accuracy compared with other methods.

16S metagenomics approaches, OTUs are cluster of similar sequence variants of the 16s rRNA marker gene sequence. Every cluster is intended to represent a taxonomic unit of a species or a genus depending on the sequence similarity threshold. Typically, OTU cluster are defined by a 97% identity threshold of the 16S gene sequences to distinguish bacteria at the genus level.

Species separation requires a higher threshold of 98% or 99% sequence identity, or even better the use of exact amplicon sequence variants (ASV) instead of OTU sequence clusters.

CONCLUSION

In the early 1900's the studies based on rhizosphere microbes had started. The term rhizosphere was coined for the first time by L. Hiltner which was used to denote the area of intense microbiological activity in the soil which generally extends up to several millimeters from the root system of the plants.The biodiversity of rhizosphere microbes in a particular soil can be studied and developed only by using long term trials. The methods for assessing the biodiversity of rhizosphere microbes are biochemical (culture dependent) and molecular (culture independent) methods are used to assess the biodiversity of the rhizosphere microbes present in the soil and the culture independent methods are more favored as they can assess a wider range of soil micobes than the culture dependent method. Most commonly used method of identification these rhizosphere microbes is by 16s rRNA sequencing and followed by many others like DDGE, TDGE, SEM, etc. The 16s ribosomal RNA is found in all the prokaryotes and has 9 hyper-variable(HV) regions(variable in every microbe) which plays a major role in taxonomic identification of the microbes along with other regions called as conserved regions(which are constant in all the microbes). The most frequently used hyper-variable regions are V3 - V4 regions as they are best differentiating factor which help us in microbial identification.

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Methods	Remarks
Pyro-sequencing	It's a high throughput Sequencing technique does long reads by 454 sequencing which allows more frequent unambigous mapping to complex regions.
16s ribosomal RNA sequencing	It's the most highly preferred sequencing technique which focusses on then hypervariable regions to distinguish and identify the microbial population.
DGGE (denaturing gradient gel electrophoresis)	Type of gel electrophoresis based on the denaturing gradient of the sample DNA which helps us compare the sample gel result with the known bacterial DNA gel result.
TGGE (temperature gradient gel electrophoresis)	Type of gel electrophoresis based on the temperature gradient of the sample DNA which helps us compare the sample gel result with the known bacterial DNA gel result.
RFLP (restriction fragment length polymorphism)	The technique uses the simple restriction digestion of purified DNA from bacteria, and variation in the banding pattern in the digestion reveals the genetic diversity.
PCR (polymerase chain reaction)	The method is used for amplification of minute DNA sample by a several fold in a short period of time, which is used for microbial identification.

Is increasing MSP result in increasing area under annual edible oilseed crops?

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ABSTRACT

Oilseed crops are the second most important determinant of the agricultural economy, next only to cereals within the segment of field crops. The present study assessed the trend and relationship between MSP, CoC, area and productivity of oilseed crops. The data collected from secondary sources such as from DA&FW, CACP and frontline demonstration reports were used for analysis. The increase in Minimum Support Price (MSP) during 2017 to 2021 ranged from 73.3% in rapeseed -mustard to 29.5% in niger crop. The Cost of cultivation (CoC) has increased steadily for all the oilseed crops. The area under different oilseed crop increased except for sunflower (-6.0%), safflower (-21.9%) and niger (-50.8). The productivity for all the oilseed crops showed increasing trend.

Keywords: Area and productivity, Cost of cultivation, Minimum support price

India ranks first in the production of castor, second in groundnut, sesame, and linseed, third in rapeseed-mustard, and fifth in soybean, the productivity of oilseeds as a whole in India is low except in case of castor. Minimum Support Price (MSP) is a form of market intervention (Gill *et al.* 2017) by the Government of India (GoI) to ensure the producers against any sharp fall in farm prices which are announced at the beginning of the sowing season for certain crops on the recommendations of the Commission for Agricultural Costs and Prices (CACP). (Mahalle *et al*. 2018). MSP acts as instrument in reducing the exploitation of farmers by traders and hence, it is always suggested to provide remunerative prices to farmers for increasing the production.

MATERIALS AND METHODS

The secondary data on MSP, Cost of Cultivation (CoC), area and productivity of selected oilseed crops were analysed for the period 2017-2021. Based on the changes in the selected parameters during five year period the results were drawn. The data were analysed using percentages and improvement over the base year 2017-18.

RESULTS AND DISCUSSION

The MSP announced by the GoI has increased by 73.3% in rapeseed-mustard to 24% in groundnut during the five year period. The MSP has increased continuously during the period. The CoC also increased for all the crops during the same period ranging from 78.3% to 4.1%.

In spite of increase in MSP for seven oilseed crops, the area under sunflower declined marginally and the area under safflower and niger decreased drastically and for other crops the area increased (soybean (18.7), rapeseed-mustard (29.2) and groundnut (17.4)). The decline in area of safflower and niger can be attributed to the competitive crop such chickpea, *rabi* sorghum and *rabi* maize. The productivity of all the crops increased during the same period mainly due to the adoption of technology (fig 1).

In spite of continuous increase in MSP on oilseeds, commensurate increase in area is not observed. The major reasons may be the increased cost of cultivation and the actual procurement of oilseeds at MSP. Hence, creating awareness on low cost-no cost technologies for reducing CoC and proper marketing interventions are required to sustain the interest of farmers in oilseed crops.

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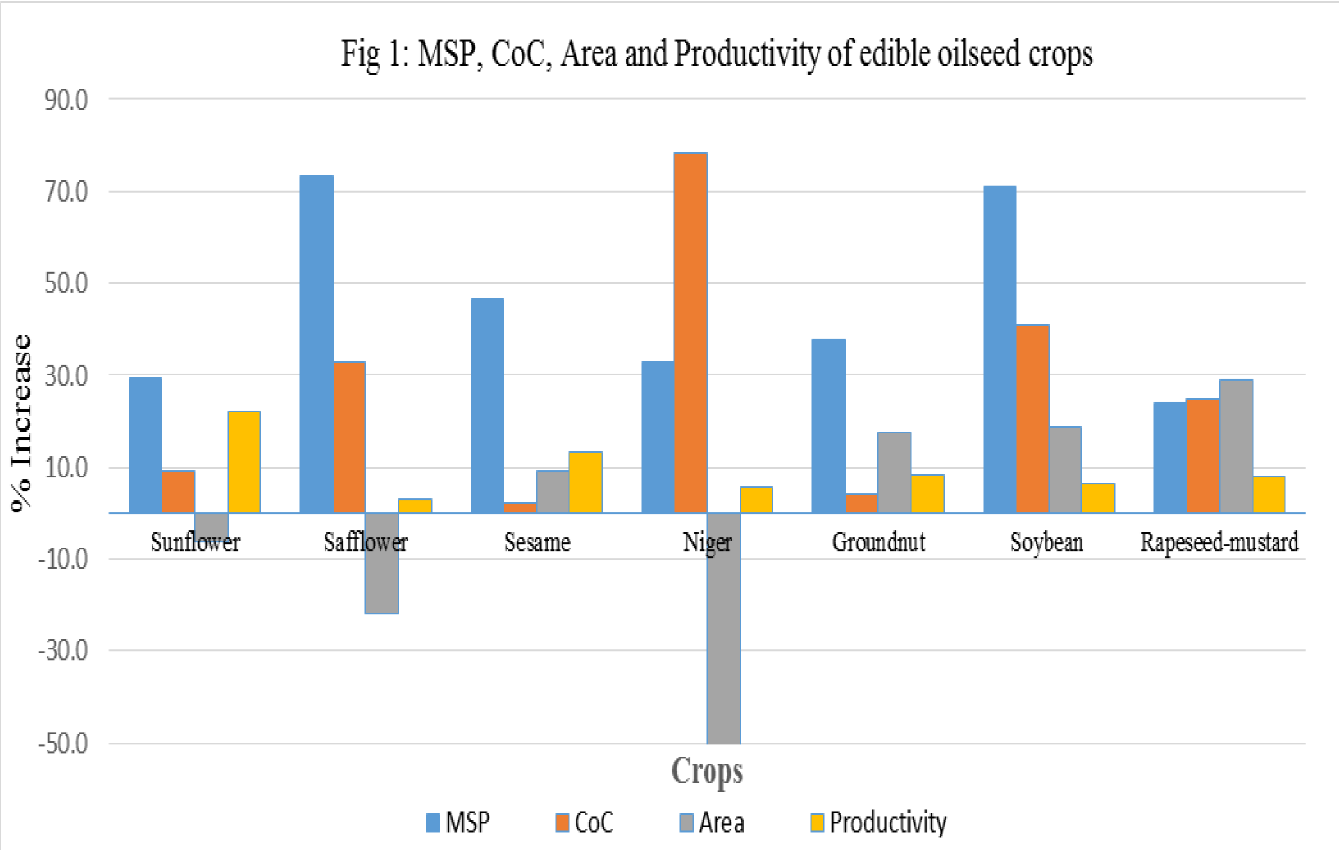

Exploring microbial symbionts for improving soybean production and soil carbon sequestration

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ABSTRACT

To meet UN 2030's agenda for Sustainable Development Goals (SDGs), the use of non-renewable bioresources is being campaigned globally to ensure food security and resource sustainability while minimizing environmental impact. Among oilseeds, soybean is the most important leading oilseed crop worldwide and being a high rich seed protein (40%) crop requires high N for its growth. Its requirement is largely met through biological nitrogen fixation (BNF) and to certain extent from native pool. BNF in soybean takes place via specific N fixing symbiotic bacteria (e.g., bradyrhizobia) inside the root nodules of the plant-soil rhizosphere (rhizobiome) wherein other microbes such as arbuscular mycorrhizal (AM) fungi are also actively involved in performing various soil functions. However, during crop growth, BNF activity is limited by number of environmental and ecological factors. Amongst all, drought and nutritional stress are the most limiting factors affecting the productivity of soybean. Hence to mitigate the adverse conditions, improve soil biological health and overall productivity there is need to have well adapted microbial symbionts such as super nodulating and moisture tolerant soybean rhizobia and AM fungi for sustaining the productivity of soybean.

Keywords: Arbuscular mycorrhizal fungi, Glomalin, Moisture tolerant soybean rhizobia,

Moisture stress tolerant soybean rhizobia

Drought is the most important factor limiting the activity of rhizobia during N-fixation and plant growth. Potential soybean bradyrhizobial strains were recovered from root nodules of higher trehalose accumulating soybean genotypes. After evaluation under stress (moisture stress in a gradient of polyethylene glycol-6000) the most symbiotic effective strains were identified based on 16S rDNA gene sequences. There were four bradyrhizobial species recovered from high trehalose accumulating genotypes mainly from PK-472. Among all potential rhizobial strains showed plant-growth promotion traits such as indole acetic acid (IAA) production, exopolysaccharide production (EPS), and phosphate solubilizing potential, siderophore, and proline. Amongst all, *B. daqingense* (D4A) strain has been found to be the superior strain in promoting nodulation, plant fitness and mitigating moisture stress in soybean. The strain *B. daqingense* found to be novel and was reported for the first time from Indian soil. The D4A strain has been validated for moisture stress mitigation under AICRPS. The compatibility with other PGP strains (Zinc and phosphate-solubilizing) to release as microbial consortia and its evaluation in field is in advance stage.

Managing AM fungi in improving soybean productivity and soil carbon sequestration

The AM fungi are the most common fungal association forming nearly with more than 80% of plant families of cultivated and wild plants including soybeans. The role of AM symbiosis in nutrient uptake, carbon mitigation, stress alleviation, soil aggregation and ecosystem stabilization has been widely recognized. AM fungi being obligate symbiont rely on host plant for carbon and colonization increases the carbon sink in the growing mycorrhizal roots. Significant yield enhancement through field application of AM fungal inoculum has been recorded in cereals, fruits, ornamentals and forest plants. The uses of native strains of AMF in sustainable plant production systems have been encouraged. Apart from growth promoting and several other attributes, AMF also helps in the soil structure improvement through aggregation. Soil aggregation is taking place through production of a sticky glycoprotein termed as 'glomalin' that stabilizes soil aggregates which contributes to soil carbon pool. These AM fungi can be mass produced on host plants in potting substrates utilizing organic wastes such as soybean hulls and natural plant growth hormones. This has been validated through AM-signature 16:1ω5cis phospholipid and neutral fatty acids. The AM signature lipids and glomalin has been analyzed in a long-term soybean-based cropping system consisting soybean-wheat/chickpea rotation and soybean-maize intercropping under organic and inorganic farming practices. Overall, higher values of C-pools and AMF biomass were obtained in organic/integrated practice and AM inoculation in soybean + maize intercropping plots had higher C-stocks (14.46 Mg C ha-1 yr^{-1}), glomalin stocks (2.37 Mg glomalin ha yr^{-1}), and AMF live-biomass (16:1ω5 PLFA and NLFA) compared to other practices. Glomalin made a significant contribution (about 15-18%) to soil organic carbon and hence both glomalin and AM signature fatty acids (16:1w5 PLFA and NLFA) can be used as potential indicator biomarkers for assessing the sustainability of soil and crop management practices for sequestering soil carbon without compromising crop yields.

Optimization and characterisation of solvent extracted *Simarouba glauca* oil

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ABSTRACT

Simarouba glauca of *Simaroubaceae Quasia* family is an evergreen tree which can serve many purposes. The trees of *Simarouba glauca* were firstly planted by National Bureau of Plant Genetic Resources in the research station at Amravati (Maharashtra, India) in 1966 and now it is grown in Orissa, Gujrat, Andhra Pradesh and Karnataka alongside Maharashtra. *Simarouba glauca* starts flowering after attaining the age of 6 to 8 years and its purple color fruits are having sweet edible pulp. The pinkish or yellowish kernels are 1.5 to 2 cm long and it undergoes colour change after ripening. The hard shell is removed manually from the kernels to get kernels which contain oil. All parts of tree are useful but kernel is the most useful part as it contains 60-70 % oil which can be easily bleached, refined, fractionated and deodorized. The *Simarouba* oil is useful for both edible and non-edible purposes. The oil obtained from the kernels of *Simarouba* has a decent demand for edible purpose which is available

by a trade name of Manteca vegetal "nieve" a company and oil is accepted by the consumers. It has good potential for edible oil over Vanaspati or for use as Cocoa butter as it contains high fat and fatty acid in the kernels, high content of Oleic and Stearic acids and moderate iodine.

Since last century, the solvent extraction has been applied for the extraction of oil and it has been proved to be very economical and easy for use. Though mechanical oil extraction equipment as well as processes are comparatively cheap and easily available, they cannot give near about 100 % oil yield, as their oil expression efficiency is below 70 %. So solvent extraction process is taken into consideration as it has the capacity for carrying out several extractions at a time and it is highly effective in recovering oil. In solvent extraction, it has been found that various parameters impact the extraction rate of oil, viz., extraction time, particle size of the sample kernels taken, the solid-solvent ratio, solvent type, nature of the oil, residence time, extraction temperature, kernel pre-treatment conditions, etc.

In literature, no work has been found on the optimization and characterization of solvent extracted *Simarouba* oil from *Simarouba* kernels with the help of processing parameters. Thus, the aim of this research is to observe the significance of the mentioned (independent) variables: extraction time, solid-solvent ratio, particle size for solvents such as n-hexane, acetone and ethyl acetate together with their interactions on the yield of *Simarouba* kernel oil and therefore, model and optimize the conditions for solvent extraction oil from a non-conventional kernels of *Simarouba glauca* using response surface methodology (RSM). Further, physicochemical characterization of the oil was carried out and functional groups of the oil obtained using solvents (n-hexane, acetone and ethyl acetate), were determined to note the effect of different solvents on the quality of the oil obtained.

Simarouba glauca kernel oil was extracted by using three solvents namely n-hexane, acetone and ethyl acetate. The factors considered for extraction of oil were extraction time (1-3 hours), soild-solvent ratio (0.05-0.25 g/ml) and particle size of grounded *Simarouba glauca* kernel (0.6-1.0 mm) and Box-Behnken design of RSM (Response Surface Methodology) was used for modeling of extracted oil. The effect of each factor (independent variable) on oil yield was discussed by using suggested model of R^2 values of 0.9974, 0.9873 and 0.9884 for n-hexane, acetone and ethyl acetate respectively. An optimization study by using genetic algorithm showed that the oil yield of 67.03 % would be maximum for n-hexane with extraction time of 3 hours, solid-solvent ratio of 0.05 g/ml and particle size of 0.636 mm. The physiochemical properties of extracted oil was satisfactory and there was no significant change in the behaviour of FT-IR spectrum for each of solvent.

Effect of foliar nutrition applied at different growth stages soybean [*Glycine max*] under rainfed condition

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ABSTRACT

A field experiment to study the effect of foliar nutrition applied at different growth stages of soybean [*Glycine max*] under rainfed condition was laid out in factorial randomized block design with three replications and total twelve treatments. The result revealed that apparent values of growth and yield parameters were influenced significantly due to different foliar sprays. However, significantly higher number of pods per plant, number of seeds per pod, seed yield and stover yield were recorded with 1.5% 19:19:19 remained at par with 1.0% 19:19:19.

Keywords: *Foliar nutrition, Growth stages, 19:19:19, Rainfed agriculture, Soybean*

Soybean oil has become the most important raw material for the production of biodiesel, which is fast supplementing fossil fuels, a boom in the bio-fuel industry (Caminiti *et al*., 2007). Under rainfed conditions when the availability of moisture becomes scarce, the application of fertilizeas foliar spray resulted in efficient absorption. Most of the time crop roots are unable to absorb nutrients, because of soil properties, such as high pH, heavy texture and in this situation, foliar application is better as compared to soil application.

Management strategies for improving soybean yield are most effective when you are able to identify the growth stage in which potential yield is affected. 19:19:19 is the best foliar fertilizer for crops like pulses, vegetables, paddy for green house cultivation, nurseries, and kitchen gardens and for all types of field crop. It contains 100% water soluble N, P and K in 19:19:19 ratio and it is free from salts like sodium and chloride and neutral in nature. Hence, it is 100% soluble even in hard water and gets fully and immediately absorbed by plants.

MATERIALS & METHODS

The experiment was conducted at the NARP Farm of College of Agriculture, Navsari Agricultural University, Bharuch (22° 42' N latitude, 73° 0' E longitude and 10 m above the mean sea level) during *kharif* season 2020 & 2021. The factors consisted of four level of foliar spray (foliar spray of water (control), 0.5 % 19:19:19, 1.0 % 19:19:19 and 1.5 % 19:19:19) and three levels of time of application (fourth trifoliolate, beginning pod and full pod).The soil of the experimental field was clayey in texture with low in available nitrogen (236 kg/ha), available phosphorus (25 kg/ha) and higher in available potassium (340.21 kg/ha) and moderately alkaline in reaction. Soybean variety was sown with row spacing 45 cm on 9th July and harvested on 29th Nov, 2020. Other cultural practices and plant protection measures were taken as per university recommendations.

RESULTS & DISCUSSION

Effect on growth

The data pertaining to the plant height, dry matter accumulation and number of branches is presented in Table 1. Foliar spray applied at 1.5% 19:19:19 (F4) being at par with 0.5% 19:19:19 (F2) and 1.0% 19:19:19 (F3) recorded significantly higher plant height (81.81 and 94.10 cm) at 60 DAS and at harvest, however result remained non significant at 30 DAS. However, in case of stage application, significantly higher plant height with fourth trifoliolate (T1) (80.93, 93.29 cm) which was at par with Beginning pod (T2) in case of 60 DAS and at harvest, however results remained non significant at 30 DAS. Significantly higher dry matter accumulation (24.62 and 40.71 g) was found with 1.5% 19:19:19 (F4) at 60 DAS and at harvest and being at par with 1.0 % 19:19:19 (F3), however result remained non significant at 30 DAS. While, significantly higher dry matter accumulation at 60 DAS and harvest (23.92 , 40.72 g) was recorded with fourth trifoliolate (T1) found at par with beginning pod (T2) however results remained non significant at 30 DAS. Number of branches per plant were observed significantly higher (5.93) with 1.5 % 19:19:19 (F4) being at par with 1.0% 19:19:19 (F3). Whereas in case of stage of application, significantly maximum number of branches per plant (5.75) were recorded with fourth trifoliolate (T1) and remained at par with beginning pod (T2).

Plant height at 60 DAS and at harvest, dry matter accumulation at harvest and number of branches per plant had significant results due to F x S interaction. The treatment combination F4T1 gave maximum values for these biometric observations. However it remained at par with F1T1, F1T2, F2T1, F2T2, F3T1, F3T2, F3T3, F4T2, F4T3 for plant height at 60 DAS and with F1T1, F1T2, F2T1, F2T2, F2T3, F3T1, F3T2, F3T3, F4T2, F4T3 in case of plant height at harvest. And F1T1 ,F2T1, F2T2, F3T2, F4T2, F4T3 for dry matter accumulation at 60 DAS and F2T1, F3T1, F3T2, F4T2 for dry matter accumulation at harvest and number of branches per plant.

This might be due to right concentration of nutrient with timely application that boosts the availability to plant and reflected in plant height, dry matter gained and increase in number of branches. Similar results were observed by Lodhi (2020) and Sharifi *et al.* (2018).

Effect on Yield attributes & Yield

The data pertaining to the yield attributes and yield of soybean as influenced due to foliar nutrition applied at different growth stages is presented in Table 1. Significantly higher number of pods per plant (99.57) were recorded with 1.5% 19:19:19 (F4) and remained at par with 1.0 % 19:19:19. While, lowest values (75.02) were observed under foliar spray of water (F1). While in case of stage of application, number of pods per plant of soybean with full pod (T3) (92.73) was found to be significantly superior over rest of the treatments and significantly maximum number of seeds per pod (2.61) with full pod (T3) being at par with beginning pod (T2). Significantly higher seed (1684 kg/ha) and stover (3078 kg/ha) yield were recorded with 1.5% 19:19:19 (F4) found at par with 1.0 % 19:19:19. While, significantly higher seed yield (1602 kg ha-1) and stover yield (2919 kg ha-1) were recorded at full pod (T3) being at par with beginning pod (T2) in case of stage of application.

The interaction effect of foliar spray and stage of application revealed that Number of pods per plant, seed yield, stover yield and oil content had significant results due to F x T interaction. The treatment combination F4T3 gave maximum values for these biometric observations. However it remained at par with F3T3, F4T2 for number of pods per plant and with F3T2, F3T3, and F4T2 for seed and stover yield. Foliar application of nutrient after flowering to pod development stages might have been easily absorbed and better translocated in the plant and maintained constant requirement of N at the reproductive stages of the crop. Similar results are observed by Dandge *et al.* (2019) and Chauhan *et al.* (2020).

On the basis of the field experiment, it can be concluded that foliar spray of 1% 19:19:19 applied at beginning pod or full pod stage should be done for getting profitable soybean production

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Table 1: Effect of foliar nutrition applied at different growth stages on growth and yield of soybean

Treatment	Plant height (cm)			DMA (g)			No. of branches/ plant	No. of pods /plant	Seed yield (kg/ha)	Stover yield (kg/ha)
	30 DAS	60 DAS	At har.	30 DAS	60 DAS	At har.				
Foliar spray (F)										
F_1	24.23	73.48	86.18	11.94	22.40	36.89	4.90	75.02	1384	2519
F_2	24.29	78.41	91.41	12.77	22.84	37.72	5.62	82.77	1444	2642
F_3	24.46	80.48	92.31	13.27	23.32	39.84	5.69	96.01	1618	2956
F_4	24.97	81.81	94.10	13.09	24.62	40.71	5.93	99.57	1684	3078
S. Em.±	0.56	1.50	1.55	0.37	0.47	0.76	0.09	2.02	39.51	75.85
C.D at 5%	NS	4.41	4.55	NS	1.38	2.22	0.28	5.91	115.8	222.4
Time of application (T)										
T_1	25.13	80.93	93.29	12.60	23.92	40.72	5.75	81.25	1406	2571
T_2	24.27	79.47	91.88	12.99	23.53	37.92	5.54	91.05	1589	2906
T_3	24.07	75.23	87.83	12.71	22.44	37.74	5.32	92.73	1602	2919
S. Em.±	0.49	1.30	1.34	0.32	0.41	0.65	0.08	1.75	34.22	65.68
C.D at 5%	NS	3.82	3.94	NS	1.19	1.92	0.24	5.12	100.3	192.6
F x T	NS	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. (%)	6.90	6.74	6.11	8.64	7.04	6.84	6.08	6.84	7.73	8.13

Effect of different legumes in castor relay cropping system

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ABSTRACT

In the scenario of conventional farming system, limited chances are available to cope with sustainability and productivity issues at the same time. Relay cropping may play a crucial role in tackling this concern, by increasing the sustainability with minimum tillage, continuous soil cover along with increase in land productivity. Lot of studies already reflected the benefits to crops sown after legume crop, so more emphasis was given in this study to directly relate the research towards a best choice of legumes for relay cropping in castor crop. With these thoughts this research was framed to study different legume-castor relay cropping systems *viz.*, greengram-castor, clusterbean (veg) - castor, blackgram-castor, cowpea-castor and sole castor (control). The results revealed that greengram-castor and blackgram-castor are the best identified relay cropping system for obtaining higher castor equivalent yield and monetary returns as per the three years of experimentation. However, the study also showed that legume-castor relay cropping gives more than two folds returns than sole castor.

Keywords: *Castor, Crop equivalent yield, Cropping system Legume sequence, Relay cropping,*

Relay cropping is a method of multiple cropping where next crop is seeded before harvesting of previous crop. With the use of short duration crops as preceding crops, relay cropping may be effective for efficient use of available resources, time, fertilizer, and soil conservation. In case of castor, Laxman and Maheswari (2017) observed occurrence of major pest's *viz.*, *Achaea janata* and *Spodoptera litura* comparatively more in early sown (last week of July) castor genotypes than late sown (last week of August) castor crop. These fall in the same way of recommending castor for late sowing after month of August for skipping from insect attack. Thus to capture the monsoon season before castor, we may introduce short duration crop during the month of June, using relay cropping system. This may help in ensuring sustainable use of natural resources and food security in the face of high population density especially for developing countries (Araya *et al.* 2010, Tsozué *et al.* 2015).

Presently farmers are hassled due to variation in rainfall patterns, poor soil health, cost of cultivation and the associated decline in crop productivity. Numerous factors like intensive tillage (Laudicina *et al.* 2015), soil erosion, compaction and organic matter depletion (Cerda *et al.* 2010), indiscriminate and overuse of pesticides and chemical fertilizers (Hussain *et al.* 2015), and reduced vegetation cover (Keesstra *et al.* 2015) are reported to trigger the soil degradation. Therefore, an experiment was framed to study the effect of legume-castor relay cropping system particularly to see it may help to recover the ongoing theme.

Legumes being the most complex suite of different resource-efficient technologies, which possesses the capability to improve soil quality, to increase net return, to increase land equivalent ratio, and to control the weeds infestation. Relay cropping of legume can improve the soil nutrient status, particularly N through biological nitrogen fixation and nutrient recycling (Hartemink *et al.* 2000, Tian *et al.* 2000). These are generally short duration crops and can easily fit to the castor sowing time, which is late *kharif* in relay cropping system. The main objective of the study was to determine the suitable and economically viable legume-castor relay cropping sequence under rainfed condition.

MATERIALS & METHODS

The experiment was carried out at College Farm, Navsari Agricultural University Bharuch, India (21.70 °N 72.99°E, elevation of 15 m above sea level) during *kharif* season of 2017, 2018 and 2019. The experiment included four different relay systems (greengram-castor, clusterbean (veg)- castor, blackgram-castor, cowpea-castor) and a control as sole castor treatment. The experimental framed in randomized block design with four replications. The varieties used were Castor- NAUCH 1, Greengram- GM 4, Cluster bean- Pusa Navbahar (Veg), Blackgram- GU 1, and Cowpea- GC 5, with recommended fertilizer dose of 20-40 N-P kg/ha for all the legumes and 120-25 N-P kg/ha for castor crop. All the legumes were sown on same date of sowing every year i.e. on proper arrival of monsoon in July and castor was sown in the first week of September. The harvest of all the legumes was completed at physiological maturity during last week of September while castor was being harvested in the month of March-April during all the three consecutive years.

To determine the suitable and economically viable legume-castor relay cropping sequence castor equivalent yields (CEY) were calculated using the price obtained under relay cropping system as compared to the price that could have been obtained under sole cropping.

$$CEY\ (kg/ha) = Castor\ yield\ (kg/ha) + \frac{Legume\ yield\ \left(\frac{kg}{ha}\right) x\ price\ of\ legume (Rs.)}{Price\ of\ castor\ (Rs.)}$$

RESULT AND DISCUSSION

The experiment of relay cropping of castor in legume crops was conducted during the year 2017, 2018 and 2019. Weather condition plays an important role on the growth and yield of any crop, especially in *kharif* season under *rainfed* situation due to variation in rainfall patterns. Although the sowing of preceding legume crops was done on the proper arrival of monsoon there was no failure of crop observed in all the three consecutive years of research. Also there was ample amount of moisture and rainfall during the September month too, so that castor crop also received good early growth and nearly no serious loss in plant stand was found during all the three years. Occurrence of major pest problems of castor, *Achaea janata* and *Spodoptera litura* are found comparatively less in late sown crop (Laxman and Maheswari, 2017) so no any severe incidences of diseases and pests were found in legume-castor relay cropping system during the entire crop growth period. Thus, it is expected that the variation observed in the experimental results were mainly due to the treatment effects only.

The results of the experiment revealed that castor equivalent yield was significantly influenced by different relay cropping treatments in all the three years of experimentation and in pooled results (Table 1). Greengram- castor relay cropping system gave significantly highest castor equivalent yield (kg/ha) during all the three consecutive years of study and remained at par with treatment blackgram-castor and cowpea-castor in all the three years but, cowpea-castor relay cropping failed to express its significance in pooled results. However, castor equivalent yield was 2.53, 1.88, 2.52 and 2.36 times more in treatments greengram-castor, clusterbean (veg)-castor, blackgram-castor and cowpea-castor, respectively over the sole castor treatment. This may be due to the effect of all legumes that benefited the castor crop by their naturally fixed nitrogen and litter fall that directly influenced the yield of castor and reflected in the castor equivalent yield. Punyalue *et al.* (2015) also observed similar results in maize + legume relay cropping systems with 24-53% enhanced maize grain yield compared with monocropping of maize and indicated that biological N fixation in legumes most likely contributed in enhancing the total aboveground nitrogen and grain yield as well.

The data regarding to cost of cultivation (Rs./ha), gross returns (Rs./ha), net returns (Rs./ha) and B:C Ratio of all the cropping systems is illustrated in Table 1 also showed much higher values as compared to sole castor treatments. The cost of cultivation for follow- castor was Rs.25159/ha and of all rest of the treatment was Rs. 47989/ha.

Maximum gross and net returns were obtained from legume-castor relay cropping systems as compare to sole castor. Amongst the pulse-castor relay cropping systems, greengram-castor gave the maximum gross as well as net returns followed by blackgram– castor. In case of net returns, higher net returns (Rs.182997/ha) were obtained from treatment greengram – castor relay cropping system followed by treatment blackgram– castor relay cropping system. Lowest net returns of Rs.66103/ha were observed in sole castor. However, net returns obtained were in treatments greengram – castor, clusterbean – castor, blackgram– castor and cowpea – castor over sole castor were 2.77, 1.87, 2.75 and 2.53 times more, respectively.

The B:C ratio also remained higher with greengram-castor (3.8) and blackgram-castor (3.8) followed by cowpea-castor (3.5). The lowest B:C ratio (2.6) was found in sole castor and clusterbean-castor. The results of benefit cost ratio directly make to notice that though the cost of cultivation of legume-castor relay cropping is nearly double that of castor sole, thenet monetary returns obtained from the legume-relay cropping system are also more as compared to their respective cost of cultivation. These results are in line with results observed by Bhanvadia *et al.* (2017).

Therefore from the three years of studying different legumes in castor relay cropping system it can be concluded that greengram or blackgram are the most suitable legumes for getting higher and profitable crop yields in legume-castor relay cropping system. In this relay cropping system, sowing of legumes *i.e.* greengram or blackgram may be done as on proper arrival of monsoon in last week of June or July and castor may be sown in the first week of September. Inappropriate choice of legume species and establishment dates may result in severe interspecific competition for light, water and nutrients and a subsequent yield loss in the main crop (Akanvou *et al.* 2002).

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Table 1 : Castor equivalent yield (CEY) (kg/ha) and economics of all the legume-castor relay cropping system

Treatment	CEY (kg/ha)				CoC (Rs./ha)	GR (Rs./ha)	NR (Rs./ha)	B:C Ratio
	2017	2018	2019	Pooled				
Sole Castor	2309	2215	2320	2282	25159	91262	66103	2.6
Greengram – Castor	5871	5850	5603	5775	47989	230986	182997	3.8
Cluster bean – Castor	4426	4413	4047	4295	47989	171813	123824	2.6
Blackgram– Castor	5818	5788	5648	5751	47989	230053	182064	3.8
Cowpea – Castor	5396	5522	5226	5382	47989	215265	167276	3.5
S.Em.±	159	170	126	88				
C.D. at 5 %	490	524	389	253				
C.V. %	6.7	7.2	5.5	6.5				

Influence of sowing windows on seed yield of soybean [*Glycine max* (L.) Merill] cv. JS-335

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ABSTRACT

The soybean seed production has been limited due to lack of supply of quality seed; this is because soybean seed is affected by field weathering and environmental condition during pre and post-harvest period and thus loses its viability in storage and cannot be stored from one season to next. Therefore, the present study was conducted during 2020-21 and 2021-22 to determine the soybean cv.JS-335 breeder seed production feasibility in three seasons. The result revealed that, maximum number of pods (60/plant), pod length (4.25 cm), number of seeds per pod (3.12), test weight (75 g) and seed yield per acre (10.50 q) were recorded when soybean was sown during kharif season followed by summer as compared to Rabi season.

Keywords: Oilseed, Sowing window, Soybean, Seed yield

Soybean is a major oilseed crop of the country covering an area of 6 million hectares. Owing to its high protein and oil composition lead to phenomenal spread of soybean cultivation in India. However, soybean seed reaches its maximum potential for seed vigour, but very sensitive and losses viability at physiological maturity. The viability of soybean seed is very short lived high sensitive to least mechanical damage as it has thin coat as compared to other field crops and is often reduced prior to sowings. This loss of viability is much more acute under tropical conditions like India. These environmental conditions make very difficult to produce the quality soybean seed and maintain its viability during storage. Such deteriorated seed is one of the basic reasons for low productivity in soybean (Dalvi, 2019). Therefore, the present study aimed to find out suitable sowing window for getting maximum seed yield through the supply of fresh, vigorous and viable seeds.

MATERIAL AND METHODS

The present investigation was carried at Breeder seed production unit, National Seed Project, University of Agricultural Sciences, GKVK, Bengaluru to study the effect of sowing windows on seed production feasibility of soybean cv. JS-335 during 2020-21 and 2021-22.

RESULTS AND DISCUSSION

The study revealed that the sowing window had significant effect on plant growth and seed yield in all the three seasons. The maximum number of pods per plant (60), pods length (4.25 cm), number of seeds per pod (3.12), test weight (75 g) and seed yield per acre (10.50 q) were recorded when soybean was sown during kharif season followed by summer (50, 3.18 cm, 3.10, 80 g and 9.10 q, respectively) as compared to Rabi season (45, 3.10 cm, 3.15, 74 g and 8.10 q, respectively). During rabi/summer season unfavourable environmental cconditions like temperature, rainfall, high incidence of pests and diseases, in addition to lesser irrigation facilities could be attributed reduced seed yield. Prabhakar *et al*. (2018) showed the suitability of kharif season on yield potentiality of soybean cv. JS-335. Similarly, (Dalvi, 2019) also concluded that the kharif is the best season for seed production of soybean followed by summer as compared to rabi season.

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Estimation of genetic variability and association analysis in sesame (*Sesamum indicum* L.)

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ABSTRACT

Sesame is well recognized for good quality edible oil due its high PUFA content, antioxidant properties, excellent nutritional and medicinal properties. The present investigation aims at analyzing the variability among promising parents and newly developed genotypes of sesame on the basis of 8 morphological characters. PCV exhibited a bit higher values but maintained a close relation with GCV for all the traits, indicating low G×E interaction. Additive gene action was prominent for the traits like no of capsules/plant, seed yield /plant, and primary branches/plant. Highly significant positive phenotypic correlation coefficient was observed between seed yield and its four attributes namely plant height, branches per plant number of capsules/ plant and 1000 seed weight.

Keywords: Correlation, GCV, Genetic variability, PCV, *Sesamum*.

Sesame (*Sesamum indicum* L.), known to be the most ancient oilseed crop in the world and well recognized for its excellent nutritional and medicinal properties is evidently domesticated in Indian subcontinent to its modern cultivated form. Improvement of sesame production is still hampered due to lack of promising variety with high yield and oil content. Assessment of genetic variability is an initial step in breeding programme where large variability among potential parents is always desirable. The present investigation was carried out to gather information on variability, heritability and genetic advance and to determine the association between yield and yield components in genotypes of sesame.

MATERIALS AND METHODS

Field experiment was conducted using 20 genotypes (Table 1) of sesame during the *Pre-kharif* season (summer), 2022 at Agricultural Experimental Farm, University of Calcutta Baruipur, South-24 Parganas, West Bengal. The sowings were done in first week of March, 2022 following Randomized Complete Block Design with three replications at the spacing of 40cm ×10cm. Data were recorded on five randomly selected plants from each genotype for the following parameters: plant height (cm), number of primary branches/plant, days to 50% flowering (days), capsule length (cm), number of capsules/plant, number of seeds per capsule,1000 seed weight (g), seed yield/plant (g).

RESULTS AND DISCUSSION

ANOVA for eight characters revealed that replications differed much for most of the characters. Treatments were significantly different from each other indicating high diversity.

The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) revealed that PCV was found to be greater than the GCV for all the characters studied (Table. 2), which reflected the role of environment in the expression of the observed traits. Iqbal *et al.* (2016) also reported similar finding earlier. Highest coefficients of variation (phenotypic) were exhibited by seed yield/plant (33.08), followed by no. of primary branches/plant (27.4), number of capsules/plant (27.26), 1000 seed weight (15.00), plant height (12.01), days to 50% flowering (11.71), capsule length (10.03), number of seeds/capsule (9.57).

Estimates of GCV showed a similar trend for the above mentioned traits. The phenotypic and genotypic coefficient of variation was high for number of capsules/plant, seed yield/plant. Higher genotypic coefficient of variation suggests that these characters are under the influence of genetic control. Therefore, these characters can be relied upon and simple selections can be practiced for further improvement. Traits with high heritability estimates can be utilized for genetic improvement as they have potential for large genetic determination (Vasline *et al*. 2000). The heritability estimates were found to be high for days to 50% flowering (86.51%), seed yield/plant (79.60%), capsule length (66.36%), number of capsules/plant (61.63%), which indicated that these characters were least influenced by the environmental effects and high capacity of the characters for transmission to subsequent generation. Similar findings were reported for one or more character in sesame (Tesfaye *et al*. 2021). The estimates of heritability (broad sense) include both additive and non-additive gene effect and its higher estimates in broad sense indicates that the trait is least influenced by environmental effects.

Correlation between plant characters and yield assume special importance in formulating a basis of selection. Highly significant positive phenotypic correlation coefficient was observed between seed yield and its four attributes namely plant height, number of branches/ plant, number of capsules/plant and 1000 seed weight (Iqbal *et al.* 2016 and 2018). Thus selection of any of these characters would lead to the improvement of seed yield/plant.

However, a few inter- relationships were consistently significant and positive namely number of capsules/plant with plant height and number of primary branches/plant, Thus selection for plant height would not only improve number of capsules/plant and number of primary branches/plant but also will improve seed yield/plant through correlated response. Thus the correlation studies highlighted the importance of the traits like plant height and primary branches per plant.

The present study suggested that the selection based on the characters, number of capsules/plant, number of seeds/capsule and 1000 seed weight would be effective for the development of sesame through breeding.

Genotypes: MT-75, NIRMALA, TKG-306, TKG-308, ATGHARA, CUMS 01, EC 84, EC 98, CUMS-19, EC 96, EC 114, EC 113, EC 112, IC 55, P2-23, P2-27 S, A-21, P2-22, SA-14, P-434

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Table 1. Components of genetic variability in sesame

Character	Range	Mean	G.C.V.	P.C.V.	H (%)
Days to 50% flowering	27-44.50	35.33	11.06	11.71	86.51
Plant height (cm)	60.38 -165.30	95.90	11.65	12.01	52.03
Number of primary branches/plant	1- 4	2.33	26.92	27.26	80.71
Number of capsules/plant	38-143	65.33	27.26	26.33	61.63
Capsule length (cm)	1.9-3	2.33	9.77	10.03	66.36
Number of seeds/capsule	49.66-72.66	60.05	9.06	9.57	51.09
1000 seed weight (g)	2.47-4.18	3.21	14.36	15.00	60.85
Seed yield/plant (g)	7.98-18.55	10.61	32.08	33.08	79.60

Evaluation of oil palm cross combinations under north East Indian condition

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ABSTRACT

The growth and yield performance of ten cross combinations, NRCOP-21 to NRCOP-30 which were planted in 2010 in randomized block design with 03 replications and 06 palms per plot at a spacing of 9m X 9m X9m were evaluated. The results reveals that the growth of the palms with respect to stem height and stem girth was non significant. Maximum number of leaves (23.26), female flowers (10.60), Fresh Fruit Bunches (10.43), highest sex ratio (0.74), bunch weight (13.46Kg) and yield (20.10 t/ha) were observed in NRCOP-22. From the results it is evident that the performance of NRCOP-22 is the best under North Eastern Indian conditions.

The oil palm (*Elaeis guineensis* Jacq.), a perennial oil yielding crop, produces 4 to 6 MT of palm oil and 0.4 to 0.6 MT of palm kernel oil per hectare per annum which is higher than any other oil seed crops. Realizing the potential of the crop in bridging the shortage in edible oil requirement in India, the cultivation of oil palm has got considerable attention from planners, researchers and farmers. The country has got potential of 2.8 million ha for cultivation of the crop against the present area coverage of 3.2 lakh ha. In India, edible oil demand in 2030 is expected to be around 34 million tonnes per annum. From the recent statistics, the gap between edible oil demand (25.38 million tonnes) and supply (10.5 million tonnes) stands at 14.88 million tonnes per annum in the country. Oil palm is the only suitable option to minimize the import substitution for filling the widening gap between domestic demand and production of vegetable oils in the country (Mathur, 2020). The global production of vegetable oils has made tremendous impact, of which progress made by palm oil, soybean, rapeseed and sunflower oil is worth mentioning. High yielding hybrids play an important role in increasing the yield and oil productivity in the oil palm (Jagadeesha *et al.* 2018). Superior planting materials (hybrids) could be a better option to meet worldwide demand for palm oil (Youmbi *et al*., 2015) Growth and yield of oil palm are hampered by factors such as soil type, location, climate variability, crop management and unadoptable germplasm (Corley and Tinker, 2003). Hybrid vigor is influenced by the environment (Chapman *et al.,* 2000), hence hybrids must be evaluated through multi location trials to determine their location specific suitability. In light of these factors, the current study was undertaken to identify a superior performing *tenera* hybrids (*dura* × *pisifera*) for the commercial cultivation in North Eastern States of India

MATERIALS AND METHODS

A set of ten *tenera* hybrids were evaluated at AICRP on Palms (Oil Palm), College of Horticulture and Forestry, Central Agricultural University (Imphal), Pasighat, Arunachal Pradesh, India. The experimental site experiences a consistent and high annual rainfall (3000-4500 mm) between Junes to September, high humidity, and a moderate environment (temperatures 15^0 C to 35^0 C). The experiment was laid out in a RBD design with ten *tenera* hybrid cross combinations (NRCOP-21 to NRCOP-30) developed by ICAR- IIOPR, Pedavagi, Andhra Pradesh, India and were planted during 2010 at a spacing of 9 m x 9 m x 9 m with three replications and 6 palms per plot. The recommended package of practice of 1200:600:1200 g N, P_2O_5, K_2O per plant per year and irrigation based on potential evapotranspiration were followed. The observations (growth characters, FFB yield and yield attributes) were recorded during 2018 to 2022 and were subjected to statistical analysis and interpreted

RESULTS AND DISCUSSION

Then growth of the palms with respect to stem height and stem girth was found to be non significant and statically at par in the entire cross combinations. Maximum number of leaves (23.26) was produced by the cross combination NRCOP-22 which was significantly higher than any other treatment. Minimum number of leaves (19.96) was produced by NRCOP-30 which was at par with NRCOP-29 and NRCOP-23. Maximum number of male flowers were produced by the cross combination NRCOP-30, NRCOP-29 and NRCOP-28. The minimum number of male flowers were recorded in the cross combination NRCOP-22 which was significantly less than other crosses except NRCOP-27, NRCOP-26 and NRCOP-24. Maximum number of female flowers (10.60) were produced by the cross NRCOP-22 which was significantly higher than the female flowers produced by other cross combinations and at par with NRCOP-26. Minimum number of female flowers (6.86) were recorded in the cross NRCOP-30. The sex ratio was recorded highest (0.74) in NRCOP-22 which was statistically at par with NRCOP-26. Sex ratio was recorded least (0.53) in NRCOP-30. Fresh Fruit Bunches (10.43) produced by NRCOP-22 was significantly higher than in any other cross combination except NRCOP- 26 where as the NRCOP-30 produced the least number of FFB (6.56) per palm. The average bunch weight (13.46Kg) in NRCOP-22 was significantly higher than other cross combinations except NRCOP-26, NRCOP-25 and NRCOP-30 the bunch weight was least (10.53Kg) in NRCOP-23. Highest yield was recorded in NRCOP-22 (20.10 t/ha) which was significantly higher the any other cross combinations. Yield was minimum (12.01t/h) in NRCOP-30.

From the results it is evident that the performance of NRCOP-22 is the best under North Eastern Indian conditions as compared to other cross combinations.

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Growth and yield of sunflower under different sources and levels of sulphur in irrigated light soils

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ABSTRACT

A field study was conducted to observe the effects of sulphur sources and levels on sunflower growth and yield. The sulphur levels were 0, 20, 40 and 60 kg S/ha through three sources viz., elemental sulphur, gypsum and ammonium sulphate. The values among the treatments for higher plant height (173cm) and grain yield (1888 kg/ha) were recorded with sulphur @ 40 kg/ha though gypsum as compared to other sulphur sources and levels.

INTRODUCTION

Sunflower is one of the most important oilseed crops containing high quality edible oil. Sulphur plays a predominant role in improving the grain quality of sunflower crop (Naser *et al*., 2012). Nearly 35 % soils of Siddipet district are deficient in available sulphur status. Hence it is essential to identify the optimum level of sulphur for maximum yield and oil content in the sunflower crop through suitable sources.

METHODS AND MATERIALS

The field experiment was carried out at Agricultural Research Station, Tornala, Siddipet during season 2020-21. The experiment was laid out in split plot design with 3 main treatments and 4 sub treatments using sunflower (DRSH-1) crop. The soil was non saline with EC of 0.25 dS/m, pH 7.25 neutral soil reactions, low in N 194.6 kg/ha and deficient in S 7.16 mg/kg. The experimental treatments consisted of four levels of S (0, 20, 40, and 60 kg S/ha) through three sources *viz*., elemental suphur, gypsum and ammonium sulphate.

RESULTS AND DISCUSSION

Application of sulphur to sunflower crop is essential in irrigated light soils to ensure good seed yield. Significantly taller plants (173 cm) and greater seed yield (1888 kg/ha) were recorded when sulphur @ 40 kg/ha though gypsum source compared to other S levels of 0, 20 and 60 kg/ha. This trend indicated that the response in seed yield was linear with the increasing level of sulphur (Usha Rani *et al.*, 2009). Application of sulphur @ 40 kg/ha through gypsum can be recommended for rabi sunflower due to enhanced growth and seed yield in irrigated light soils.

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Table 1. Effect sources and levels of S on yield and yield attributes of sunflower (Rabi, 2020-21)

Treatments	Plant height (cm)					Seed yield (kg/ha)				
	S1	S2	S3	S4	Mean	S1	S2	S3	S4	Mean
M1	156	157	161	164	159	1412	1600	1695	1788	1624
M2	148	170	173	163	163	1533	1857	1888	1728	1752
M3	150	162	168	171	163	1438	1718	1798	1872	1707
Mean	151	163	167	166		1461	1725	1794	1796	
	SE(m) (±)		CD (5%)			SE(m) (±)		CD (5%)		
M	0.38		1.53			7		28		
S	1.24		3.73			22		67		
S x M	0.76		6.55			14		118		
M x S)	1.90		5.78			37		104		

Main treatments: M1: Elemental sulphur, M2: Gypsum, M3: Ammonium sulphate
Sub treatments: S1: Control (without S application), S2: S @ 20 kg/ha, S3: S @ 40 kg/ha and S4: S @ 60 kg/ha

Management of rapeseed-mustard germplasm

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ABSTRACT

Brassicaceae family is of immense economic significance since human civilization. Over 3,700 species in 338 genera, with significant morphological diversity and uses has been reported in Brassicaceae. To meet the expanding need for rapeseed-mustard varietal improvement, the evaluation of the diverse genetic resources and dissemination of the information generated is a pre-requisite. A total of 31 trait specific rapeseed-mustard germplasm were developed and conserved at ICAR-DRMR, Bharatpur to use in mustard improvement programme.

Keywords: Brassica genetic resources, Rapeseed-mustard

INTRODUCTION

Crop Brassicas including six Brassica species, are distributed worldwide and consumed as vegetables, condiments, and edible oils. *B. juncea* and *B. rapa* are distributed predominantly in the warm sub-tropical regions, mainly in South-and South-East Asia, while B. napus and *B. rapa, B. carinata* is limited to cooler temperate regions in Ethiopia and northeast Africa, whereas B. nigra is grown in Europe and Asia. Other genera in Brassicaceae are valued for condiments (Sinapis, Eruca), vegetable (Eurca, Raphanus, Diplotaxis), industrial uses (Eruca, Crambe, Sinapis, Lepidium, Camelina, Thlaspi), and food/fodder (Orychophragmu, Eruca). Wild and related genera of Brassica species are reservoirs of novel genes which possess some traits of interest including genes for agronomic importance, biotic and abiotic stress tolerant, oil and seed quality and male sterility.

MATERIAL AND METHODS

In present study literature on Brassica species geographical distribution, collection, conservation and evaluation was reviewed and compiled.

RESULTS AND DISCUSSIONS

India possesses rich genetic diversity of oilseed Brassicas. Brassica rapa and *B. juncea* considered to be native of Indian gene centre, are distributed in eight agro-ecological zones of the country. Much of the diversity is concentrated in the Indo-gangetic plains and sub-mountain Himalayas. The oleiferous Brassicas are widely distributed in Indian sub-continent. Plains of Uttar Pradesh, Bihar and West Bengal are rich in the diversity of early and dwarf types of *B. rapa* (var. toria and yellow sarson). Leafy types of Indian mustard with small seed and late maturity mainly occur in North-eastern parts of India. Wild forms of B. tournefortii are available in drier tracts of Rajasthan, Punjab and Haryana.

Several explorations were undertaken, leading to the collection of oilseed brassica germplasm from across the India. In our country, Rapeseed-mustard germplasm are maintained at ICAR-NBPGR, New Delhi and ICAR-DRMR, Bharatpur, Rajasthan. ICAR-DRMR, Bharatpur is national active germplasm site for rapeseed-mustard germplasm where 2548 accessions of rapeseed-mustard are maintained in medium term genebank. The Rapeseed-mustard germplasm are being used in hybridization programme at ICAR-DRMR and under All India Coordinated Research Project on Rapeseed-Mustard across different centres. To meet the expanding need for rapeseed-mustard varietal improvement the evaluation of the diverse genetic resources and dissemination of the information generated is a pre-requisite. Many accessions, thus, identified are registered and being used in the Brassica improvement.

A total of 96 trait specific germplasm of Brassica species was registered by PGRC, New Delhi till October, 2022. From these species maximum germplasm were registered in Brassica juncea (63 Acc.) followed by B. oleracea (12 Acc.), B. napus (10 Acc.) and B. rapa (6 Acc.). Out of 96 germplasm, 31 trait specific rapeseed-mustard germplasm developed and registered by ICAR-DRMR. Out of these 31 germplasm, 14 genetic stocks (BPR-541-4, BPR-543-2, BPR-349-9, BPR-549-9, BPR-540-6, DRMR-541-44, DRMR10-40, DRMR 2059, DRMR 4001, DRMR 4005, DRMR 2300, DRMRHT-13-22-10, DRMR 2017-26, DRMR 2018-27) have been protected for abiotic stress tolerance including high water use efficiency, thermo-tolerance, salinity tolerance and drought tolerance in Indian mustard. For disease tolerance mainly for white rust disease, 07 genetic stocks (NRCDR 515, DRMR-2019, DRMR-2035, DRMRIJ 12 -48, DRMR 1-5, DRMRIJ 12-40, DRMR 18-37) were registered. For oil quality traits (low erucic acid, low glucosinolate, high oleic acid and high antioxidants) 02 germplasm (DRMR 1-5, DRMRQ1-16-27) has been protected. These accessions are conserved in National Genebank, NBPGR, New Delhi and Mustard genebank, at ICAR-DRMR, Bharatpur.

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INDIAN SOCIETY OF OILSEEDS RESEARCH

Instructions to Authors for Preparation of Manuscript for Journal of Oilseeds Research

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Full-length articles, short communications, book reviews and review articles are published in the Journal. Review articles and book reviews are published usually by invitation. Full length articles and short communications should report results of original investigations in oilseeds, oil bearing plants and relevant fields of science. Choice of submitting the paper(s) either as full length paper or short communication rests with the authors. The Editor(s) or Reviewer(s) will examine their suitability or otherwise only in that specific category. Each article should be written in English correctly, clearly, objectively and concisely. All the statements made in the manuscript should be clear, unambiguous, and to the point. Plagiarism is a crime and therefore, no part of the previously published material can be reproduced exactly without prior permission from the original publisher or author(s) as deemed essential and the responsibility of this solely rests on the authors. Also, authors shall be solely responsible for the authenticity of the results published as well as the inferences drawn thereof. Telegraphic languages should be avoided. The data should be reported in a coherent sequence. Use active voice. Active voice is clear, unambiguous and takes less space. Use past tense while reporting results. Do not repeat ideas in different forms of sentences. Avoid superfluous sentences such as `it is interesting to note that', `it is evident from the table that' or `it may be concluded that' etc. Use % for percent, %age for percentage, / for per, @ for at the rate of hr for hours, sec for seconds. Indicate date as 21 January 2010 (no commas anywhere). Spell out the standard abbreviations when first mentioned eg. Net assimilation rate (NAR), general combining ability (GCA), genetic advance (GA), total bright leaf equivalents (TBLE), mean sum of squares (MSS).

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Title of the article and name(s) of the author(s) should be written sufficiently below the caption. The photographs (black and white) should have a glossy finish with sharp contrast between the light and the dark areas. Colour photographs/ figures are not normally accepted. One set of the original figures must be submitted along with the manuscript, while the second set can be photocopy. The illustrations should be numbered consecutively in the order in which they are mentioned in the text. The position of each figure should be indicated in the margin of the text. The photographs should be securely enclosed with the manuscript after placing them in hard board pouches so that there may not be any crack or fold. Photographs should preferably be 8.5 cm or 17 cm wide or double the size. The captions for all the illustrations (including photographs) should be typed on a separate sheet of paper and placed after the tables.

Expression of Plant Nutrients on Elemental Basis

The amounts and proportions of nutrient elements must be expressed in elemental forms e.g. for ion uptake or in other ways as needed for theoretical purposes. In expressing doses of nitrogen, phosphatic, and potassic fertilizers also these should be in the form of N, P and K, respectively. While these should be expressed in terms of kg/ha for field experiments, for pot culture studies the unit should be in mg/kg soil.

SI Units and Symbols

SI Units (System International d 'Unities or International System of Units) should be used. The SI contains three classes of units: (i) base units, (ii) derived units, and (iii) supplementary units. To denote multiples and sub-multiples of units, standard abbreviations are to be used. Clark's Tables: Science Data Book by Orient Longman, New Delhi (1982) may be consulted.

Some of these units along with the corresponding symbols are reproduced for the sake of convenience.

Names and Symbols of SI Units

Physical Symbol for SI Unit Symbol Remarks quantity physical quantity for SI Unit

Primary Units					
length	l		time	t	
metre	m		second	s	
mass	m		electric current	I	
kilogram	kg		ampere	A	
Secondary Units					
plane angle	radian	rad	Solid angle	steradian	sr
Unit Symbols					
centimetre	cm		microgram	μg	
cubic centimetre	cm^3		micron	μm	
cubic metre	m^3		micronmol	μmol	
day	d		milligram	mg	
decisiemens	dS		millilitre	mL	
degree-Celsium	°C [=(F-32)x0.556]		minute	min	

gram	g	nanometre	nm
hectare	ha	newton	N
hour	h	pascal	Pa
joule J	(= 10^7 erg or 4.19 cal.)	second	s
kelvin	K (= °C + 273)	square centimetre	cm^2
kilogram	kg	square kilometre	km^2
kilometre	km	tonne	t
litre	L	watt	W
megagram	Mg		

Some applications along with symbols

adsorption energy	J/mol (= cal/molx4.19)	leaf area	m^2/kg
cation exchange capacity	cmol (p+)/kg (= m.e./100 g)	nutrient content in plants (drymatter basis)	µg/g, mg/g or g/kg
Electrolytic conductivity	dS/m (= mmhos/cm)	root density or root length density	m/m^3
evapotranspiration rate	m^3/m^2/s or m/s	soil bulk density	Mg/m^3 (= g/cm^3)
heat flux	W/m^2	specific heat	J/kg/K
gas diffusion	g/m^2/s or m^3/m^2/s or m/s	specific surface area of soil	m^2/kg
water flow	kg/m^2/s (or) $m^3$$m^2$s (or) m/s	thermal conductivity	W/m/K
gas diffusivity	m^2/s	transpiration rate	mg/m^2/s
hydraulic conductivity ion uptake	m/s	water content of soil	kg/kg or m^3/m^3
(Per kg of dry plant material)	mol/kg	water tension	kPa (or) MPa

While giving the SI units the first letter should not be in capital i.e cm, not Cm; kg not Kg. There should not be a full stop at the end of the abbreviation: cm, not cm. kg, not kg.; ha, not ha.

In reporting the data, dimensional units, viz., M (mass), L (length), and T (time) should be used as shown under some applications above. Some examples are: 120 kg N/ha; 5 t/ha; 4 dS/m etc.

Special Instructions

I. In a series or range of measurements, mention the unit only at the end, e.g. 2 to 6 cm2, 3, 6, and 9 cm, etc. Similarly use cm2, cm3 instead of sq cm and cu m.

II. Any unfamiliar abbreviation must be identified fully (in parenthesis).

III. A sentence should not begin with an abbreviation.

IV. Numeral should be used whenever it is followed by a unit measure or its abbreviations, e.g., 1 g, 3 m, 5 h, 6 months, etc. Otherwise, words should be used for numbers one to nine and numerals for larger ones except in a series of numbers when numerals should be used for all in the series.

V. Do not abbreviate litre to` l' or tonne to `t'. Instead, spell out.

VI. Before the paper is sent, check carefully all data and text for factual, grammatical and typographical errors.

VII. Do not forget to attach the original signed copy of `Article Certificate' (without any alteration, overwriting or pasting) signed by all authors.

VIII. On revision, please answer all the referees' comments point-wise, indicating the modifications made by you on a separate sheet in duplicate.

IX. If you do not agree with some comments of the referee, modify the article to the extent possible. Give reasons (2 copies on a separate sheet) for your disagreement, with full justification (the article would be examined again).

X. Rupees should be given as per the new symbol approved by Govt. of India.

Details of the peer review process

Manuscripts are received mainly through e-mails and in rare cases, where the authors do not have internet access, hard copies of the manuscripts may be received and processed. Only after the peer review the manuscripts are accepted for publication. So there is no assured publication on submission. The major steps followed during the peer review process are provided below.

Step 1. ***Receipt of manuscript and acknowledgement***: Once the manuscript is received, the contents will be reviewed by the editor/associate editors to assess the scope of the article for publishing in JOR. If found within the scope of the journal, a Manuscript (MS) number is assigned and the same will be intimated to the authors. If the MS is not within the scope and mandate of JOR, then the article will be rejected and the same is communicated to the authors.

Step 2. ***Assigning and sending MS to referees***: Suitable referees will be selected from the panel of experts and the MS (soft copy) will be sent to them for their comments - a standard format of evaluation is provided to the referees for evaluation along with the standard format of the journal articles and the referees will be given 4-5 week time to give their comments. If the comments are not received, reminders will be sent to the referees for expediting the reviewing process and in case there is still no response, the MS will be sent to alternate referees.

Step 3. ***Communication of referee comments to authors for revision***: Once the referee comments and MS (with suggestions/ corrections) are received from the referees, depending on the suggestions, the same will be communicated to the authors with a request to attend to the comments. Authors will be given stipulated time to respond and based on their request, additional time will be given for attending to all the changes as suggested by referees. If the referees suggest no changes and recommend the MS for publication, then the same will be communicated to the authors and the MS will be taken up for editing purpose for publishing. In case the referees suggest that the article cannot be accepted for JOR, then the same will be communicated to the authors with proper rationale and logic as opined by the referees as well as by the editors.

Step 4. ***Sending the revised MS to referees***: Once the authors send the revised version of the articles, depending on the case (like if major revisions were suggested by referees) the corrected MS will be sent to the referees (who had reviewed the article in the first instance) for their comments and further suggestions regarding the acceptability of publication. If only minor revisions had been suggested by referees, then the editors would look into the issues and decide take a call.

Step 5. ***Sending the MS to authors for further revision***: In case referees suggest further modifications, then the same will be communicated to the authors with a request to incorporate the suggested changes. If the referees suggest acceptance of the MS for publication, then the MS will be accepted for publication in the journal and the same will be communicated to the authors. Rarely, at this stage also MS would be rejected if the referees are not satisfied with the modifications and the reasoning provided by the authors.

Step 6. ***Second time revised articles received from authors and decision taken***: In case the second time revised article satisfies all the queries raised by referees, then the MS will be accepted and if not satisfied the article will be rejected. The accepted MS will be taken for editing process where emphasis will be given to the language, content flow and format of the article.

Then the journal issue will be slated for printing and also the pdf version of the journal issue will be hosted on journal webpage.

Important Instructions

- Data on field experiments have to be at least for a period of 2-3 years
- Papers on pot experiments will be considered for publication only as short communications
- Giving coefficient of variation in the case of field experiments Standard error in the case of laboratory determination is mandatory. For rigorous statistical treatment, journals like Journal of Agricultural Science Cambridge, Experimental Agriculture and Soil Use and Management should serve as eye openers.

SPECIAL ANNOUNCEMENT

In a recently conducted Executive Committee meeting of the Indian Society of Oilseeds Research, it was decided to increase the scope of the Journal of Oilseeds Research by accommodating vibrant aspects of scientific communication. It has been felt that, the horizon of scientific reporting could be expanded by including the following types of articles in addition to the Research Articles, Shor Communications and Review Articles that are being published in the journal as of now.

Research accounts (not exceeding 4000 words, with cited references preferably limited to about 40-50 in number): These are the articles that provide an overview of the research work carried out in the author(s)' laboratory, and be based on a body of their published work. The articles must provide appropriate background to the area in a brief introduction so that it could place the author(s)' work in a proper perspective. This could be published from persons who have pursued a research area for a substantial period dotted with publications and thus research account will provide an overall idea of the progress that has been witnessed in the chosen area of research. In this account, author(s) could also narrate the work of others if that had influenced the course of work in authors' lab.

Correspondence (not exceeding 600 words): This includes letters and technical comments that are of general interest to scientists, on the articles or communications published in Journal of Oilseeds Research within the previous four issues. These letters may be reviewed and edited by the editorial committee before publishing.

Technical notes (less than 1500 words and one or two display items): This type of communication may include technical advances such as new methods, protocols or modifications of the existing methods that help in better output or advances in instrumentation.

News (not exceeding 750 words): This type of communication can cover important scientific events or any other news of interest to scientists in general and vegetable oil research in particular.

Meeting reports (less than 1500 words): It can deal with highlights/technical contents of a conference/ symposium/discussion-meeting, etc. conveying to readers the significance of important advances. Reports must

Meeting reports should avoid merely listing brief accounts of topics discussed, and must convey to readers the significance of an important advance. It could also include the major recommendations or strategic plans worked out.

Research News (not exceeding 2000 words and 3 display items): These should provide a semi-technical account of recently published advances or important findings that could be adopted in vegetable oil research.

Opinion (less than 1200 words): These articles may present views on issues related to science and scientific activity.

Commentary (less than 2000 words): This type of articles are expected to be expository essays on issues related directly or indirectly to research and other stake holders involved in vegetable oil sector.

Book reviews (not exceeding 1500 words): Books that provide a clear in depth knowledge on oilseeds or oil yielding plants, production, processing, marketing, etc. may be reviewed critically and the utility of such books could be highlighted.

Historical commentary/notes (limited to about 3000 words): These articles may inform readers about interesting aspects of personalities or institutions of science or about watershed events in the history/development of science. Illustrations and photographs are welcome. Brief items will also be considered.

Education point (limited to about 2000 words): Such articles could highlight the material(s) available in oilseeds to explain different concepts of genetics, plant breeding and modern agriculture practices.

Note that the references and all other formats of reporting shall remain same as it is for the regular articles and as given in Instructions to Authors

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