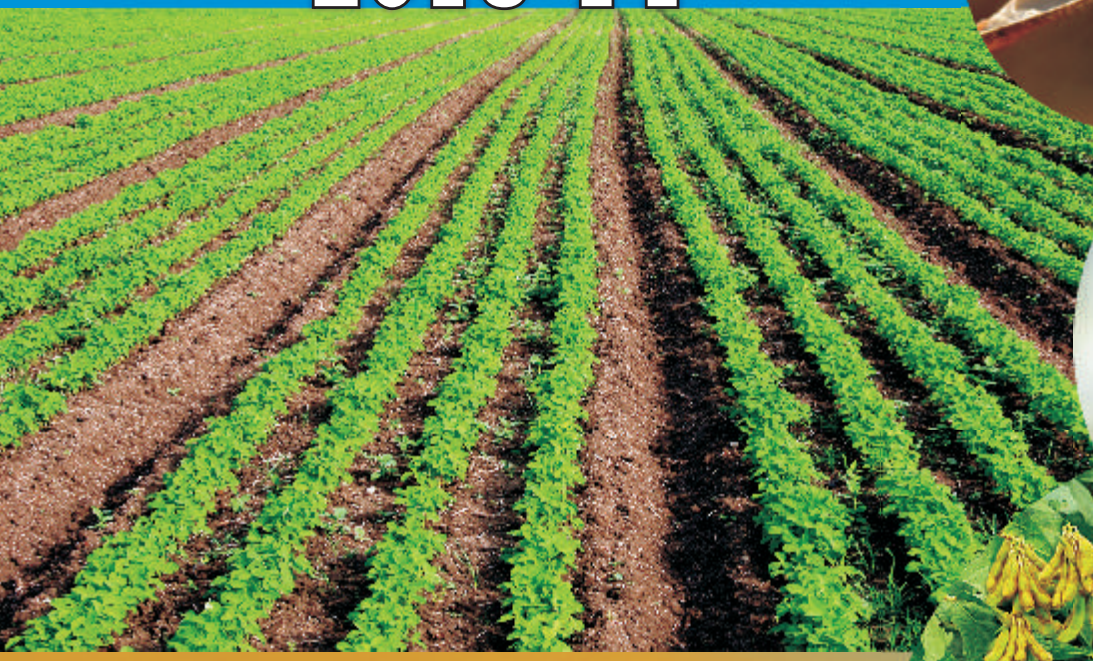
ANNUAL REPORT 2013-14



भाकृ अनुप
ICAR

Directorate of Soybean Research

Khandwa Road, Indore - 452 001 (M.P.)

वार्षिक प्रतिवेदन
Annual Report

2013-14

सोयाबीन अनुसंधान निदेशालय

Directorate of Soybean Research

(भारतीय कृषि अनुसंधान परिषद्)

(Indian Council of Agricultural Research)

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PREFACE

Soybean is an important agricultural crop of the world. There is a strong global demand for soybean for its oil and meal. Its demand is also increasing as it is an important commodity for food manufacturers, animal feed companies and biodiesel producers. The estimates of world soybean area, production and productivity for 2013-14 are 113.01 million ha, 283.79 million tonnes and 2.51 t/ha, thus exhibiting an increase in area (3.5%), production (5.6%) and productivity (2.0%) over the corresponding figures of 2011-12. The increase in world soybean production is on account of increased area in Brazil, Argentina and India and substantial increase in productivity in the USA and Argentina. Among the major soybean growing countries, India ranks fourth in terms of area and fifth in terms of production as per USDA estimates while as per DAC estimates it ranks fourth both in terms of area and production. Acording to the latest USDA's World Agricultural Demand and Supply Estimates (WASDE) report, global soybean prices may move marginally lower as the world soybean production for 2014-15 is projected to further increase.

Soybean in India has become a leading oilseed crop with 47% and 25% contribution towards the total oilseeds and edible oil production in the country during 2012-13. Besides contribution to edible oil pool, the crop has earned Rs. 9283 crores of foreign exchange during 2013-14 season through export of DOC. Being a protein rich crop with many nutraceutical chemicals providing health benefits, the food uses of soybean in the country are also showing an increasing trend. On price front also, against the MSP of Rs. 2200 soybean prices have remained much higher ranging from Rs.3200-4500 per quintal during 2013-14.

In 2012, soybean in India was planted in 10.69 million ha with a production of 14.66 million tonnes and average productivity of 1370 kg/ha (Table 2). Compared to 2012, there has has been substantial increase in area (12.03 million ha) under soybean during 2013. However, the total production (11.95 million tonnes) and the average productivity (993 kg/ha) is estimated to reduce significantly. The reduction in production and productivity is mainly on account of unusual weather in most of the soybean growing regions of India that included Madhya Pradesh, Maharashtra, Rajasthan, and Andhra Pradesh. The whole soybean region received heavy to very heavy rainfall that resulted in severe water logged and high moisture conditions resulting in poor productivity of the crop. The heavy rainfall that continued till the harvesting not only reduced the productivity but also severely damaged the quality of seeds resulting in possible strain on availability of good quality seeds for planting during *kharif* 2014 season. The contingency plans have been initiated such as production of soybean seed during off season so that seed problem of

soybean is avoided. No major pest and disease attack on soybean crop was observed/reported from any part the country during 2013-14 season. Madhya Pradesh, Maharashtra and Rajasthan continue to be the leading states with 6.26, 3.87 and 1.06 million ha under soybean and a contribution of about 95% towards total production of the crop in the country. There has been increase in area, in all the major soybean growing states in 2013 as compared to 2012.

There is challenge to meet manifold increase in the demand of soybean for edible oil, animal feed and direct consumption as a food and also to overcome new challenges threatening soybean productivity such as climate change leading to increased threat of abiotic stresses and changing scenario of biotic stresses. The DSR would continue to strive for increasing productivity, enhancing input use efficiency, reducing cost and post-harvest losses, minimizing risks and improving quality of end use commodity through conventional techniques as well as new science and tools.

I am glad and enthusiastic in presenting the Annual Report of Directorate of Soybean Research, Indore for the year 2013-14. A glance to this report will give the scenario of research and development activities undertaken during the period under report.

I take this opportunity to express my deep sense of gratitude to Dr. S. Ayyappan, Secretary, DARE, Govt. of India and Director General, ICAR for providing ceaseless directives and consistent support. I gratefully acknowledge the valuable guidance provided by Prof. S. K. Datta, Deputy Director General (Crop Science) for the physical, technical, academic and intellectual progress of the Directorate. I am extremely thankful to Dr. B. B. Singh, Assistant Director General, (O&P) for giving functional and reasonable suggestions and inspiring guidance for growth and development of the Directorate.

All the scientific, technical, administrative, accounts and supporting staff of DSR and of AICRPS who have contributed incredible inputs in bringing out this report are worthy of appreciations. I extend my hearty thanks and congratulations to each of them.

(S. K. Srivastava)
Director

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EXECUTIVE SUMMARY

1. A total of 900 accessions of soybean germplasm were evaluated for yield and yield attributing traits.
2. A total of 33 farmers's varieties of soybean were collected from Manipur and Nagaland in an exploration to NEH regions of India.
3. Molecular characterization and genetic diversity of 83 accessions of soybean was studied using 44 SSR markers.
4. A total of 115 accessions of soybean germplasm were evaluated in multilocation trails at six locations namely, Pantnagar, Jabalpur, Dharwad, Parbhani, Imphal and Indore.
5. NRC 86 a high yielding and multiple disease resistant new cultivar is released for cultivation in central zone. It has an yield potential of 2128 kg/ha and matures in 95-97 days.
6. The entry NRC 93 performed well in AVT I in northern and southern zones of India.
7. Three highest yielding lines namely NRC 99, NRC 100 and NRC 101 were selected from 30 advanced progenies of different crosses for testing in IVT of AICRP on soybean.
8. A large number of new crosses were effected using diverse germplasm accessions having specific traits, general adaptability, high yield potential and selected breeding lines/advanced lines.
9. Uniform row bulks of 22 crosses belonging to F_3 to F_8 generation were evaluated in field for yield, maturity, lodging resistance and reaction to pest and diseases.
10. A total of 15 advanced breeding lines and donor parents were supplied to 10 co-operating centres of AICRP on soybean.
11. Marker assisted introgression of null allele of lipoxygenase-2 to popular variety JS 97-52 showed 94 per cent genome recovery of recurrent parent JS 97-52 in BC_2F_1 generation.
12. Marker assisted backcross breeding in BC_3F_1 of cross JS 97-52/PI 542044 showed 97.3 to 98.2 per cent genome recovery of recurrent parent JS 97-52.
13. *Glycine soja* derived backcross population of 300 BC_2 individuals was developed to identify putative yield QTLs in soybean.
14. Six photoinsensitive genotypes MACS 330, EC 325097, EC 333897, EC 34101, EC 325118 and EC 390977 were characterised with three allele specific CAPS markers of E_4 locus.

15. In marker assisted backcross breeding for photoinsensitivity, 28 BC_1 plants derived from cross JS97-52/ (JS97-52/ERC390977) were genotyped with molecular markers linked to E_3 and E_4 genes.

16. Inheritance of long juvenility studied in the F_2 population derived from cross JS 93-05/AG S25 and JS 95-60/AGS 25 under net house condition and open growth condition showed monogenic inheritance.

17. Strong genotypic differences for increased temperatures in terms of growth and yield were observed. Genotypes EC 538828, NRC 7, Hardee, EC 456548, JS 97-52 and JS 71-05 were relatively tolerant to high temperature.

18. Maximum plant height, branches/plant, pods/plant, seed yield/plant, seed index, agronomic and recovery efficiency, PFP, N uptake, additional yield and returns and IBCR was observed with BBF system as compared to flat bed system.

19. The fifth year trial conducted to study the system efficiency enhancement through conservation technologies revealed that the highest soybean yield was recorded under conventional tillage carried out after every two years and remained at par with conventional tillage alternate year and every year.

20. Preliminary prototype of the online data entry system for AICRPS Agronomy trial data system was developed.

21. Application of P significantly increased P content in seed and straw irrespective of the cropping system.

22. Prepared trap cultures of native AMF from long-term organic, inorganic integrated (50:50 organic and inorganic) field trial for attempting mass production of most dominant AM species (*G.intraradices*) in different soybean processing mill wastes.

23. Optimized method for assessing live-biomass of AMF through signature fatty acids. Use of high throughput method for extraction of lipids in soil and roots using internal standard 19:0 for AM fungi biomarker 16:1w5 neutral and phospholipids lipids in soil and root samples were optimized.

24. The elution of lipid extracts of either soil or root samples with two times chloroform have been found to be optimum to recover whole NLFA fractions. About 20 to 35 mg root samples (ground in liquid nitrogen and freeze dried) were found to be appropriate to recover phospho and neutral lipids.

25. The study conducted to know the stability and growth trend in the

productivity of soybean in India revealed that instability in soybean yields was high at both the state (21 to 43 per cent) as well as the national level (about 20 per cent).

26. Geoinformatic analysis revealed that in the last two decades expansion of area under soybean is more rapid in the states of Maharashtra, Andhra Pradesh and Karnataka as compared to Madhya Pradesh, Chhatisgarh and Rajasthan.

27. A tractor operated subsoiler was developed and tested. This machine is very useful to manage and eliminate the deep rooted weeds and insect control besides preventing inundation due to excessive rainfall.

28. Ferti-seed planter, Single ridge-seed planter, Seed drill cum planter (Two in one), Farm yard manure spreading trailer and Inter crop seed drill cum planter with BBF system are ready for commercialization.

29. *Anethum graveolens* (suwa) was found to be a preferred host for soybean semilooper (*Chrysodeixis acuta*).

30. Native Pseudomonas RI-1 strain was found most effective for the management of Sclerotium blight with 13.2% lower total mortality and 21.7% higher yield than recommended chemical check.

31. The protocol for isolating DNA from *Colletotrichum truncatum* was standardized for finger printing and variability studies.

32. Anthracnose and pod blight (*Colletotrichum truncatum)* is observed to cause up to 48% yield loss under field conditions. Spraying of mixture of kasugamycin+coc coupled with seed treatment either with carboxin or with *Trichoderma viride* showed consistently good results.

33. Based on the survey, the map on the distribution of plant parasitic nematodes in the soybean growing areas of India was prepared.

1. INTRODUCTION

The Directorate of Soybean Research (DSR) was established by the Indian Council of Agricultural Research (ICAR) in year 1987 at Indore, Madhya Pradesh as an apex organization to support the soybean production systems with basic and strategic research and advanced breeding materials. It also coordinates the All India Coordinated Research Project on Soybean (AICRPS) and Soybean Breeder Seed Production. National Active Germplasm Site (NAGS) for soybean is also located at DSR.

1.1. Physiography

DSR campus is situated in the village Piplyarao of district Indore, which lies in Vidhyanchal range of Malwa Plateau (22° 4'37" N and 75° 52'7" E), at an altitude of 550 m above the mean sea level. The Directorate with an area of 56.7 hectares is 4 km away from the Indore city and 6 km from Railway station.

1.2. Soil

The soil of DSR research farm is deep black cotton soil with pH 7.6 to 8.1 (basic/ alkaline), low to medium in organic carbon and available phosphorus and high in potassium. Taxonomically, it is classified as fine, montomorillonitic, hyperthermic family of Typic Chromusterts and fine clay loam, montmorillonitic family of Lithic Vertic Ustochrepts.

1.3. Climate

The climate of the Malwa Plateau of Madhya Pradesh is semi-arid with a growing period of 150-180 days. The climate of this region is characterized by three distinct agricultural seasons. Rainy season, also known as monsoon or *kharif*, usually begins from mid June and extends up to early October. Generally, duration of the monsoon is approximately 98 days with about 800 mm mean annual rainfall. Pre-monsoon showers are experienced in the last week of May or early June. Soybean occupies most of the cropped area and it is largely cultivated as a rainfed crop. Post-rainy season which runs from mid October to March, also known as *rabi*, is dry and cool. Warm and dry season, which begins in February and lasts until April-May/June is called *zaid* or summer/spring. Any crop grown during this season requires irrigation.

1.4. Past Achievements

Directorate of Soybean Research has been a catalyzing force in the growth story of soybean in the country during the last 27 years. Introduction of soybean in its present command area has resulted in utilisation of existing monsoon fallows, crop diversification and increased cropping intensity. It has also been instrumental in delivering technologies for its sustainable production in different regions of the country. As a result of sustained research efforts of DSR, the national productivity of soybean

reached to 1.35 tonnes/ha in the year 2012-13 During the year 2013-14 the total area under the soybean crop in the country is 12.03 million ha with expected production of 11.95 million tonnes The annual soy meal exports from the country in the financial year 2013-14 were 2.60 million tonnes In an endeavour to further increase the productivity and production of soybean, the Directorate has been actively engaged in procurement and evaluation of genetic material to identify the desirable traits, development of advance breeding material and its distribution to different cooperating centres. Through the AICRP system, the Directorate has developed and released more than 108 varieties. The Directorate has been instrumental in the development of integrated insect pest, disease, weed and nutrient management practices and low input technologies for improved soybean production system. Improved soybean production technology has been disseminated through frontline demonstrations since 1989; as a result yield gap II could be narrowed down from 1050 kg ha^{-1} to 313 kg ha^{-1} during 2013-14.

1.5. Mandate

Following are the mandate to support production systems research along with basic information and breeding material:

- To serve as National Repository of soybean germplasm and its utilization in basic, strategic and applied research.
- To conduct basic, strategic and applied research on environmentally eco-friendly technologies and value addition.
- To coordinate multilocation interdisciplinary soybean research through AICRP for soybean.
- To facilitate transfer of research emanated technologies and to conduct impact analysis through socio-economic research.
- To produce breeder seed of improved varieties of soybean.

1.6. Organizational Set-up

In order to achieve the mandate and objectives of the Directorate, an effective organizational set-up has been evolved (Fig.1).

1.7. Library

The Directorate has developed a reasonably good library with relevant books and journals to the research system. At present the library is equipped with 2312 books and subscribing 39 national and international journals. DSR library is also a beneficiary of CERA that gives online access to more than 2000 scientific journals.

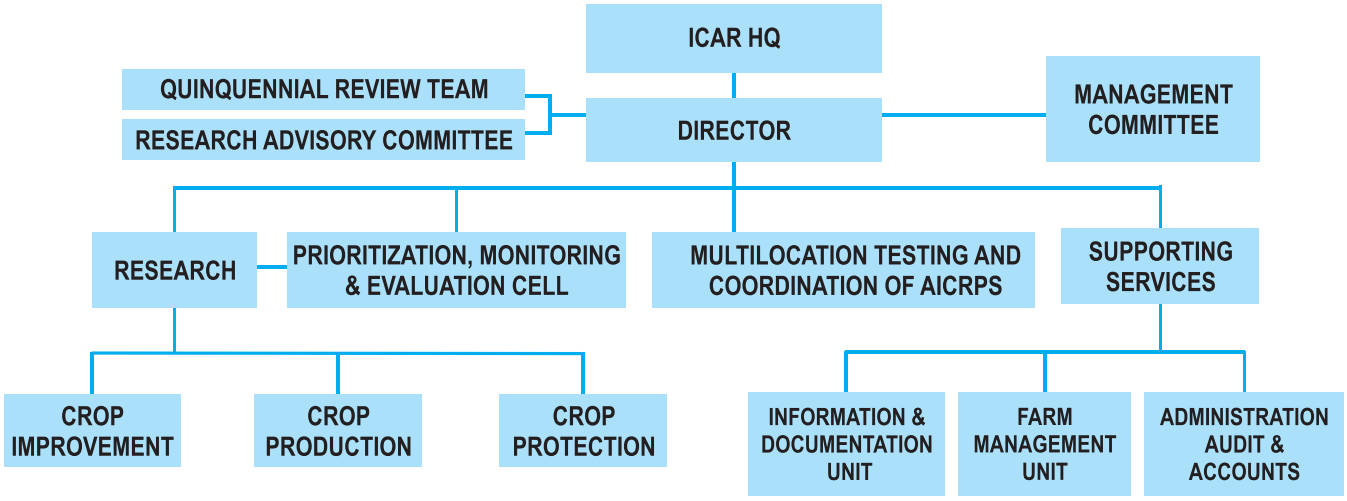
1.8. Staff and Budget

The total sanctioned staff position of DSR as on 31 March 2014 is 95 comprising 37 scientific, 29 technical, 13 administrative and 16 supporting positions. Out of which a total of 75 persons were in position as on 31 March 2014 (Chapter 13). The budget allocation and expenditure of the DSR for the year 2013-14 is given in Table 1.

Table 1. Budget and expenditure of DSR for the year 2013-14

(Rs. in lakhs)

Head	Plan		Non Plan	
	R. E.	Actual Exp.	R. E.	Actual Exp.
Pay & Allowances	-	-	590.00	587.82
Wages	-	-	16.50	16.00
T.A.	7.00	6.99	4.00	3.97
O.T.A.	-	-	0.20	0.04
Other Charges Recurring	133.14	133.12	75.19	73.30
(a) Information Technology	7.53	7.52	-	-
(b) Equipments	54.49	54.43	3.02	2.98
(c) Works	-	-	14.26	14.18
(d) Library	10.50	10.49	-	-
(e) Livestock	-	-	-	-
(f) others Items	-	-	-	-
(g) HRD	2.16	2.16	-	-
(h) TSP	7.70	7.49	-	-
(i) Furniture & Fixtures	2.48	2.42	1.98	1.91
Total	**225.00**	**224.62**	**705.15**	**700.20**



DISCIPLINE	DISCIPLINE	DISCIPLINE
PLANT BREEDING	AGRONOMY	ENTOMOLOGY
GENETICS	MICROBIOLOGY	PLANT PATHOLOGY
CYTOGENETICS	SOIL SCIENCE	NEMATOLOGY
BIOTECHNOLOGY	PHYSIOLOGY	
BIOCHEMISTRY	AGRICULTURAL EXTENSION	
SEED TECHNOLOGY	FARM MACHINERY & POWER	
	COMPUTER APPLICATION	
	AGRICULTURAL STATISTICS	
	AGRICULTURAL ECONOMICS	

Fig. 1. Organogram of DSR

2. RESEARCH ACHIEVEMENTS

2.1. Crop Improvement

2.1.1. Augmentation, Management and Documentation of Soybean Genetic Resources

2.1.1.1. Maintenance of soybean germplasm

Germplasm accessions (4248) comprising of wild species (*Glycine soja*, *G. tomentella*, *G. tabacina, G. canescens, G. clandestina),* land races, cultivars and breeding lines are being maintained in the medium term storage module at DSR. In an exploration to North Eastern Hill region of India, 33 farmer's varieties were collected from Manipur and Nagaland. During *kharif* 2013, a total of 1200 accessions were multiplied for rejuvenation and 900 accessions were characterized for various morphological and yield attributing traits. The soybean genetic resources were also supplied to various soybean researchers for utilization in soybean crop improvement programs.

2.1.1.2. Molecular diversity analysis of soybean germplasm

A total of 82 soybean genotypes were characterised using 44 SSR markers and analysed for molecular diversity. Out of total 44 SSRs analyzed, 40 (90.9 per cent) were found to be polymorphic (Fig. 2). The allele sizes ranged from 70bp (Satt126), to 330bp (Satt393). The allele numbers for each SSR locus varied between two to four with an average of 2.97 alleles per marker. A total of 119 alleles, were observed across 82 genotypes for 40 polymorphic SSR loci. Of these 119 alleles four were rare, with a frequency less than 0.05 in the whole sample studied. Unique alleles were amplified by five SSR markers. The allelic diversity measured by PIC values, ranged from 0.101 in Satt 285 to 0.742 in Satt 129 with an average of 0.434.

Jaccard's similarity coefficients were calculated for all 119 SSR alleles to assess the genetic resemblances among the genotypes. The pair wise genetic similarity among 82 soybean genotypes varied from 0.20 to 0.90. The similarity coefficient matrix was used for UPGMA cluster analysis. The dendrogram based on genetic similarities between genotypes classified the 82 genotypes into three major clusters. The Cluster I contains four genotypes namely Kohime from Taiwan, EC 37183 from Russia, PI 175192 and EC 458385 from USA. The Cluster II also contains four genotypes namely JS 20-78 and AMS 39-2-1 from India, AGS 751 from Taiwan and DT 21 from Australia. The Cluster III is largest, which consists of 74 genotypes and was further subdivided into two subclusters namely IIIa and IIIb. The subcluster IIIa contains six genotypes, of which three are from India one each from Brazil, USA and China. The rest of the genotypes were grouped in subcluster IIIb.

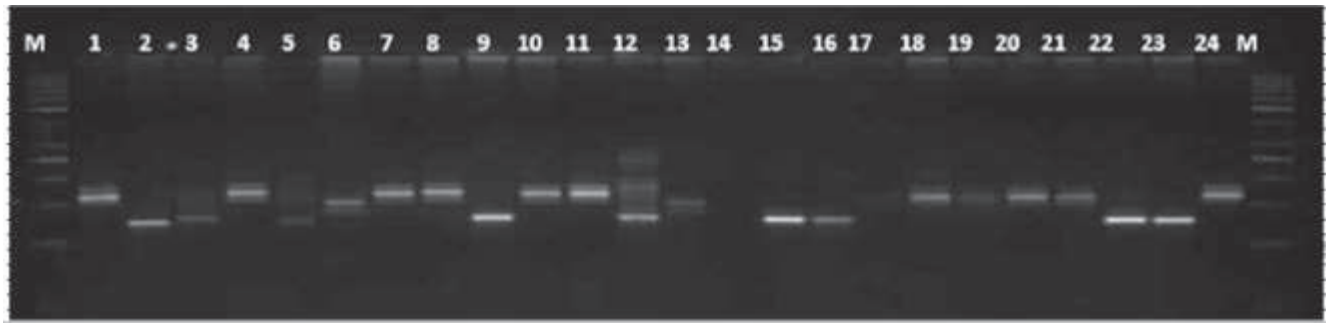


Fig. 2. Genotyping of soybean germplasm with SSR marker Satt184. M-50bp DNA marker

2.1.1.3. Multilocational evaluation of soybean germplasm

A multilocation evaluation trial of 115 promising lines was conducted at six centres namely, Pantnagar, Jabalpur, Dharwad, Parbhani, Imphal and Indore. The promising genotypes identified at Indore are given in Table 2.

Table 2. Promising genotypes identified for different attributes at DSR, Indore

Days to maturity		Number of pods per clusters		Number of pods per plant		Yield per three plants (g)	
JS 20-38	80	CAT 2755	15.6	EC 251858	61.6	JS 20-75	11
EC 325099	79	EC 251858	16	JS 20-79	69	JS 20-38	11.3
EC250607	79	JS 20-20	16	CAT 537	76	JS 20-31	11.3
JS 20-34	79	JS 20-34	16.5	JS 20-52	80.3	JS 20-60	12
EC 250619	79	JS 20-31	18.3	EC 457161	80.3	RVS 2002-7	12.3
JS 20-23	79	JS 20-79	20	JS 20-31	86.3	JS 20-52	12.6
JS 20-20	79	JS 20-38	23.5			CAT 2755	15
JS 20-27	79					JS 20-79	16.3

2.1.1.4. Evaluation of germplasm for biotic stresses

Three thousand germplasm lines were screened under natural field conditions against major diseases. Out of which, 60 lines were found tolerant to major diseases namely, bacterial pustules, *Myrothecium* leaf spot, anthracnose, yellow mosaic virus, sterility mosaic virus and root rot diseases (Table 3).

Table 3. List of soybean germplasm with multiple disease tolerance identified at Indore

P 955	SL 794	JSM 170	EC 242007
EC 481306	JS 20-09	JSM -287	AGS 74
DS 2	Himso 1521	JSM 185	EC 456609
AMS 99-33	CAT 3345	NRC 79	BR 4
EC 308314	CAT 3119	NRC 57	BS 2
SL 740	EC 528628	NRC 64	EC 274717
PK 1308	CAT 2814	JSM 188	EC 457326
EC 2587	EC 528622	JSM 259	PI 283327
IC 39220	AMS 22-5-1	JSM 360	JS 81-302
IC 313230	JSM 226	JSM 272	EC 333876
G 4 P15	EC 481571	NRC 77	EC 457198
JSM 230	G5P22	EC 172576	EC 15966
JSM 246	G 76	F 2-2911	EC 457214
JSM 283	JS 95-60	EC 39751	G 11
JSM 285	EC 457326	PI 283327	BB 24-94

2.1.2. Genetic Improvement for Yield Potential and Associated Characters in Soybean

2.1.2.1. Development and release of new varieties

NRC 86 was identified for cultivation in central zone. The variety possesses good yield potential and resistance to biotic stresses. It showed 11 per cent yield advantage over the best check. NRC 86 is a medium duration variety with resistance to charcoal rot. It has moderate to high degree of resistance for bacterial pustules, pod blight and collar rot. It also showed moderate resistance to girdle beetle and stem fly (Fig. 3 and Table 4).

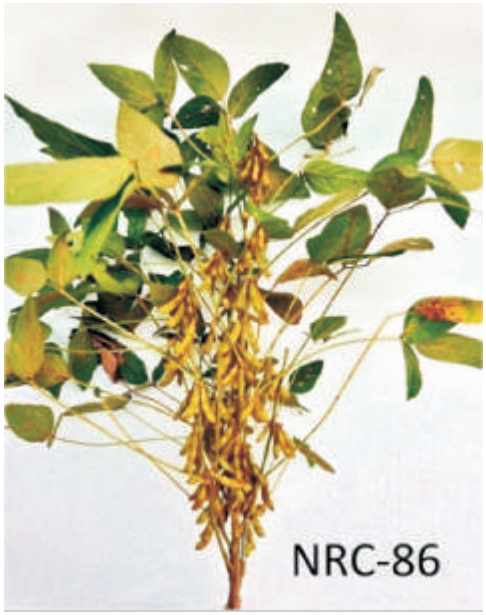


Fig. 3. Soybean plant of newly released cultivar, NRC 86 at pod development stage

Table 4. Salient features of newly released soybean cultivar NRC 86

Yield (Kg/ha)	2128
Days to flowering	41 days
Days to maturity	95-97 days
Plant height(cm)	60
Pods per plant	40-46
100 seed weight(g)	10-11

2.1.2.2. Promising entries in AICRPS breeding trials

In AVT I trials, the entry NRC 93 performed well in diverse zones of North-East and South showing its wider adaptability. In Southern zone NRC 93 ranked first while in North-Eastern zone it ranked fifth (Table 5).

Table 5. Performance of NRC 93 in AVT I trial

Zone	Yield (Kg/ha)	Per cent increase over best check	Maturity days
North Eastern	2004	9.5	104
South	2362	5.7	95

2.1.2.3. Evaluation of advanced breeding lines

Thirty advanced progenies of different crosses were evaluated in three separate trials. Due to the unfavorable weather conditions, general yield levels were low but still many lines recorded yields of 2.0-2.5 t/ha. The highest yielding three lines NRC 99, 100 and 101 have been selected for testing in IVT of AICRPS (Table 6).

In addition to these three lines, several breeding lines showed superior performance as compared to check. NRC 2011F-1-1(2349), NRC 2012B-1-8-1-25(2236) and NRC 2012-A-3-10-1(2125kg/ha) showed highest yield increases over the best check NRC 37. The maturity duration of these lines ranged from 95-107 days (Table 7).

2.1.2.4. Evaluation of mid-generation breeding stocks

Eighty five progenies from F_4/F_5 generation of different crosses were planted in an augmented trial with five checks. Data on yield and associated characters was recorded. Lines from crosses G841/NRC7, JS 97-52/PBM1, MAUS 61-2/NRC 7, EC 546882/PS 1044

Table 6. Performance of promising lines selected for initial varietal trial of AICRPS

Number	Name of the entry	Yield kg/ha	Maturity days	% Yield increase over best check (NRC 37)	Per day productivity (kg/ha/day)
NRC 99	NRC 2012-F-1-26-5	2475	111	187.12	22.29
NRC 100	NRC 2012-A-3-2-1	2110	98	144.77	21.53
NRC 101	NRC 2012-B-1-8-1-2-2-5	2236	100	159.39	22.36
Check	NRC 37	862	110	-	7.83

Table 7. Performance of selected advanced breeding lines

Sl. No.	Name of the entry	Yield kg/ha	Maturity days	% Yield increase over best check (NRC 37)	Per day productivity (kg/ha)
1	NRC 2012-E-2-10-1-1	1375	105	59.51	13.09
2	NRC 20012-E-2-6-4-1	1466	96	70.06	15.27
3	NRC 2012-B-1-8-1-2-2-1	2092	106	142.69	19.73
4	NRC 2012-E-2-16-1-1	1323	98	53.48	13.5
5	NRC 2011-F-1-1	2394	107	177.72	22.37
6	NRC 20011-E-2-5-1-2	1643	97	90.60	16.94
7	NRC 2012-B-1-8-1-4-1-1	1870	106	116.93	17.64
8	NRC 2012-F-1-1-2	1942	106	125.29	18.32
9	NRC 2012-A-3-21-1	1987	96	130..51	20.70
10	NRC 2012-E-2-5-13-3-1	1219	88	41.41	13.85
11	NRC 2012-F-1-18-1	1955	108	126.79	18.10
12	NRC 2012-F-1-25-4	1948	110	125.98	17.70
13	NRC 2012-A-3-10-1	2127	95	146.75	22.38
14	NRC 2012-B-1-8-1-2-2-5	2236	100	159.39	22.36
Check	NRC 37	862	110	-	7.83

outperformed checks by huge margins. The general yield levels were low due to excessive rains during this crop season. The highest yielding line G841/NRC7-3-30-1-1 yielded 2851 kg/ha and matured in 96 days. The yields of selected progenies ranged from 1418 to 2851 kg/ha. The maturity duration ranged from 84 days (G516/NRC 7) to 116 days (JS 97-52/PBM 1) (Table 8).

Table 8. Performance of selected mid-generation progenies

Sl. No.	Entries	Yield Kg/ha	Days to maturity	100 seed weight (g)
1	JS 93-05x NRC 37-1-1-3-1	1558	88	9.99
2	JS 97-52xPBM 1-1-2-1	2151	111	11.42
3	MAUS 61-2x NRC 7-1-8-1-4-1-2-2	1988	105	16.31
4	G841 x NRC7-3-15-1-1	2053	96	10.23
5	EC 546882 x PS 1044-1-1-1-1	2264	110	12.78
6	G841 x NRC7-3-13-2-2	2687	105	10.14
7	MAUS 61-2 x NRC 7 1-8-1-5-1-1-1	1751	105	14.45
8	G841 x NRC 7-3-13-2-1	2314	95	9.80
9	DOKO x JS 95-60-1-5-1	1418	105	9.33
10	NRC 37x PBM -1-1-6-3	1484	111	9.18
11	G516xNRC 7-3-2-1-1	1544	84	10.80
12	MAUS 61-2xNRC 7-1-8-1-4-1-2-3	1938	108	15.71
13	JS 97-52 x PBM 1-2-10-2	2154	113	11.55
14	G841 x NRC7-3-30-1-1	2815	96	10.84
15	JS 97-52 xPBM-1-2-10-1	2570	112	12.19
16	MAUS 61-2x NRC 7 -1-8-1-2-2-2-1	2310	104	14.82
17	JS 97-52 x PBM 1-1-8-1	2624	116	12.81
18	DOKO x JS 95-60 -1-8-1	1604	90	10.19
19	NRC 2 x PS 1044-3-9-1-1	1739	98	12.13
20	NRC 37 (C)	441	108	9.27
21	JS 93-05 (C)	553	99	9.24
22	JS 335 (C)	701	106	9.16
23	NRC 7 (C)	495	97	9.18
24	JS 95-60 (C)	623	88	12.33

2.1.2.5. Hybridization and generation advancement

Twenty four new crosses were affected in *kharif* 2013 using germplasm accessions having specific traits, general adaptability, high yield potential and selected breeding lines or improved varieties. The traits targeted were yield, earliness, sturdy plant type, early vigour, lodging resistance and diseases resistance. F_1 and F_2 populations were raised. True hybrids in F_1 were confirmed using morphological markers. Plants in F_2 population of different crosses were selected based on targeted traits. Six hundred twenty one progenies row from plants selected in *kharif* 2013 belonging to 37 crosses were planted and 974 single plant selections were made in F_3-F_6 generation (Table 9).

Table 9. Performance of selected plant in F_3-F_6 generation

Sl. No.	Crosses	Single plant yield (g)	100 seed weight (g)
1.	EC 546882 x EC 538823-1-8-1	13.05	12.80
2.	NRC 37xEC 602272-2-8-1	11.48	10.24
3.	NRC 37xEC 6022722-2-1-1	10.72	8.04
4.	NRC 37 x JS 335-1-4-1	11.09	9.40
5.	NRC 37 x JS 335-1-7-1	11.15	11.60
6.	JS 97-52 x PBM 1-1-9-1-5-1	16.15	12.06
7.	JS 97-52 x PBM 1-1-9-1-5-2	17.04	14.60
8.	JS 97-52 x PBM 1-1-9-2-9-2	23.77	8.24
9.	JS 97-52 x PBM 1-1-9-2-9-3	17.90	10.40
10.	JS 97-52 x PBM 1-1-9-2-10-2	17.27	12.60
11.	JS 97-52 x PBM 1-1-9-2-10-3	16.83	13.20
12.	JS 97-52 x PBM 1-1-9-2-8-1	26.21	9.40
13.	JS 97-52 x PBM 1-1-9-2-5-1	18.70	8.40
14.	JS 97-52 x PBM 1-1-9-2-6-2	18.86	10.80
15.	JS 97-52 x PBM 1-2-1-13-1-1	18.22	14.30
16.	JS 97-52 x PBM 1-2-6-5-1-1	17.43	10.60
17.	NRC 51 x EC 5388051-9-1-1-1	14.07	11.20
18.	NRC 51 x EC 5388051-9-1-5-1	10.55	9.60

2.1.2.6. Selection among uniform progeny rows bulk

Uniform row bulks of 22 crosses belonging to F_3 to F_8 generations were evaluated in field for yield, maturity, lodging resistance, reaction to pest and diseases. A total of 137 bulks were planted. Excessive rainfall and unfavorable conditions in the season limited the growth and yield. Several crosses showed tolerance to excessive soil moisture, cloudy conditions and diseases by recording favorable yields and seed index (Table 10).

Table 10. Performance of uniform progeny rows

Sl. No.	Crosses	Yield kg/ha	100 seed weight (g)
1	JS 97-52x PBM 1-1-9-2-6	2244	12.62
2	JS 97-52x PBM 1-1-9-2-8	2351	11.56
3	JS 97-52x PBM 1-1-9-2-6	2053	9.24
4	JS 97-52x PBM 1-1-9-1-5	1915	10.15
5	EC 546882 x PS 1044-1-22-1-1-6	2306	12.61
6	EC 546882 x PS 1044-1-4-1-1-4	2333	12.35
7	EC 546882 x PS 1044-1-4-1-1-5	2044	11.47
8	EC 546882 x PS 1044-1-24-2-2-3	2324	13.55
9	EC 546882x PS 1044-1-24-2-2-1	2329	11.65
10	NRC 7x EC 538828-5-3	1053	8.25
11	NRC 37 x PBM 1-1-2-2-2	1422	7.69
12	MAUS 61-2 x NRC 7-1-8-1-5-1-4-1	1715	12.31

2.1.2.7. Supply of breeding materials to different co-operating centers

Advanced breeding lines and donor parents (15 lines) were supplied to 10 co-operating centres including Bengaluru, Adilabad, Imphal, Ranchi, Raipur, Parbhani, B. Chariali, Sehore, Kota and Amravati. These lines were of different traits namely, early maturing and high yielding (two lines), extra early with bold seeds(two lines), high yield, profuse branching (three lines), high yield medium duration with good seed longevity (four lines), tall medium duration large number of pods per plant (three lines) and insect tolerant (one line).

2.1.3. Breeding for Food Grade Characters and High Oil Content

2.1.3.1. Hybridization programme

For genetic removal of kunitz trypsin inhibitor (KTI), the anti nutritional factor and the off-flavor producing lipoxygenase isozymes, 13 new crosses were attempted with an aim to incorporate the null alleles of lipoxygenase gene (*Lx*) and KTI into high yielding background and vegetable type soybean and also to pyramid both the alleles in same genetic background. Newly developed KTI free soybean genotype NRC 101 was crossed with Sawarn Vasundhara, SL 525, Dadachamame and JS 95-60. Recently developed *Lx* 2 free soybean genotype NRC 109 was crossed with KTI free line developed from Lsb1, Samrat and PI 205085 (source of null allele of *Lx*3). Crossing between *Lx* 3 and 2 free lines developed from JS 335 were also affected.

With an aim to develop high oil genotypes seven crosses were attempted. Recently developed high oil line NRC 108 was crossed with AGS 191 (high oil line) and IC 210 (high oleic line). High oil lines derived from NRC 7 x G 76 were crossed with high oil line derived from Hardee x NRC 7.

2.1.3.2. Marker assisted introgression of null allele of lipoxygenase-2

Marker assisted introgression of null allele of lipoxygenase-2 into a popular Indian soybean variety JS 97-52 was accomplished by achieving more than 94 per cent genome recovery with the help of background and foreground selection using SSR markers. SSR markers Satt522 and Satt656 linked with *Lx2* locus on linkage group F were employed for the confirmation of the true F_1, BC_1F_1 (Fig. 4) and BC_2F_1 individuals of the cross JS 97-52 x PI 596540 developed for the removal of off-flavour generating *Lx2* gene, from a high yielding cultivar JS 97-52. One hundred fifty polymorphic SSR markers from the different linkage groups were used for the background selection of the BC_1F_1 generation. Five best BC_1F_1 plants exhibiting 80 to 83 per cent recipient alleles were backcrossed with the recurrent parent to develop BC_2F_1 generations. These BC_2F_1 individuals were confirmed for the true hybridity with the linked markers and analysed for the recurrent parent genome content (RPGC) using the polymorphic SSR markers which were heterozygous in the BC_1F_1 generation. These plants exhibited RPGC from 86.29 to 94.35 per cent. Fig. 5 shows the recovery of recurrent parent genome at locus Satt516 from BC_1F_1 to BC_2F_1..

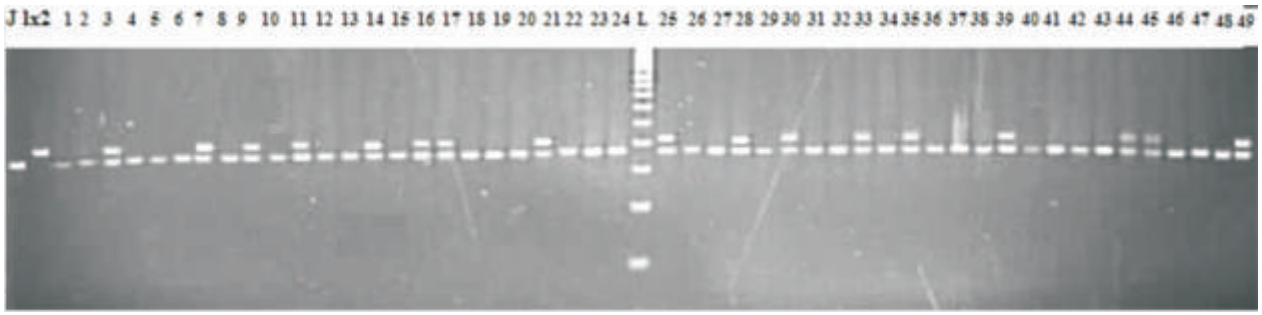


Fig. 4. True BC_1F_1 plants of JS 97-52 x PI 596540, confirmed using Satt 522 on 3 % metaphore gel

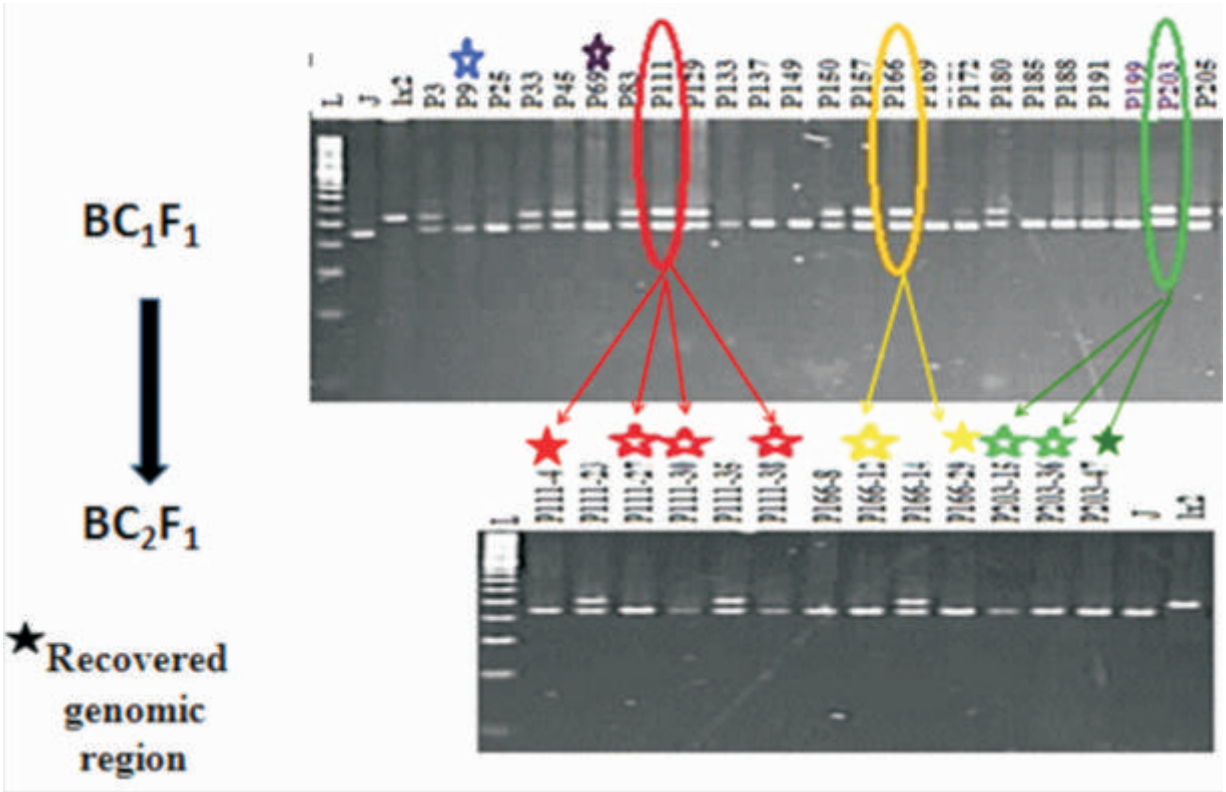


Fig. 5. Recovery of recurrent parent genome at locus Satt516 (LG F) from BC_1F_1 to BC_2F_1

2.1.3.3. Marker assisted selection for development of kunitz trypsin inhibitor free soybean varieties

Background selection was performed in BC_3F_1 generation of the cross JS 97-52 x PI 542044 using SSR markers which were heterozygous in BC_2F_2 generation. A recovery of 97.3 to 98.2 per cent of the recurrent parent (JS 97-52) genome was observed (Fig. 6). Fig. 7 & 8 shows the genome recovery of the plant P3-3-41-15 and P33-17-56-24, respectively. Fig. 9 depicts the representative slides from background selection of BC_3F_1 generation of the cross JS 97-52 x PI 542044. DNA from the BC_3F_2 generation derived from cross JS 97-52 x (JS 97-52x PI 542044) were extracted and amplified using SSR marker Satt228 linked to Ti locus and gene specific marker. PCR products were separated on 3% metaphore agarose gel and results were analysed. Homozygous recessive (titi) plants for the trait were identified. Trypsin inhibitor content of the homozygous recessive lines (titi) was determined and so far no line showed trypsin inhibitor content more than 21 mg per gram of the defatted flour.

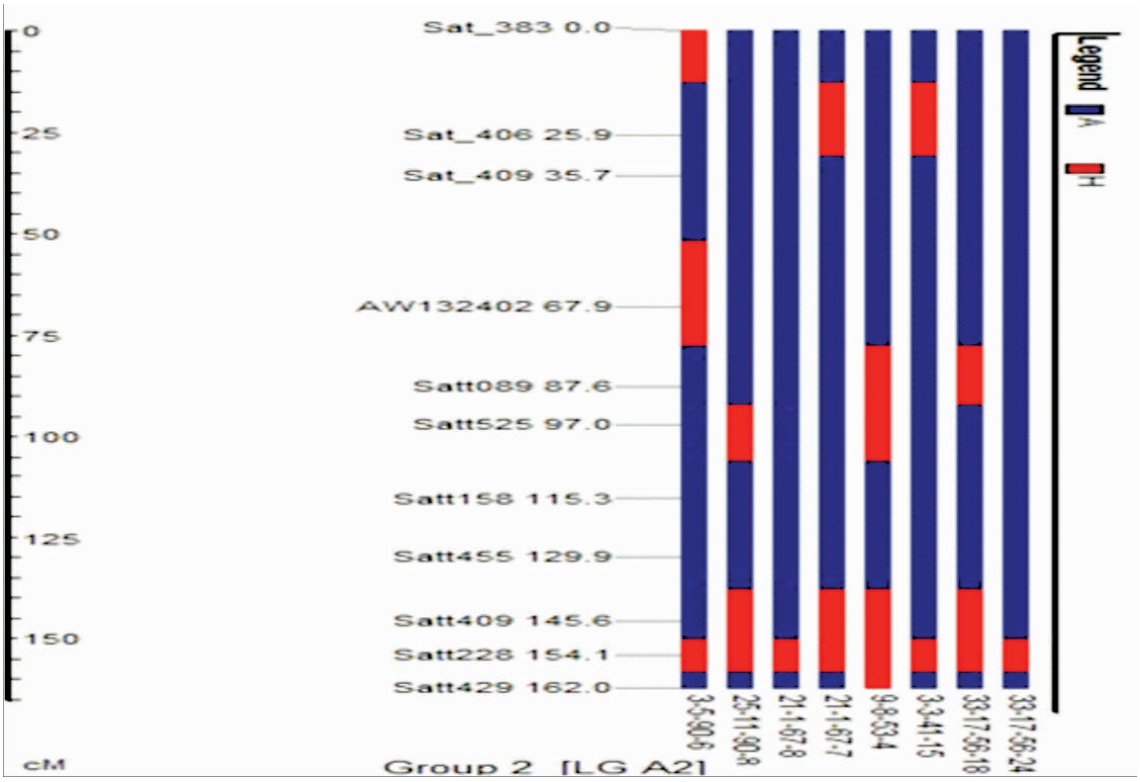


Fig. 6. Graphic representation of recovery of recurrent parent genome (JS 97-52) at LGp A-2 (carrier chromosome) using software GGT 3.2 . The blue zone in each bar depicts the recuurent parent genome while the red zone signifies the donor parent genome

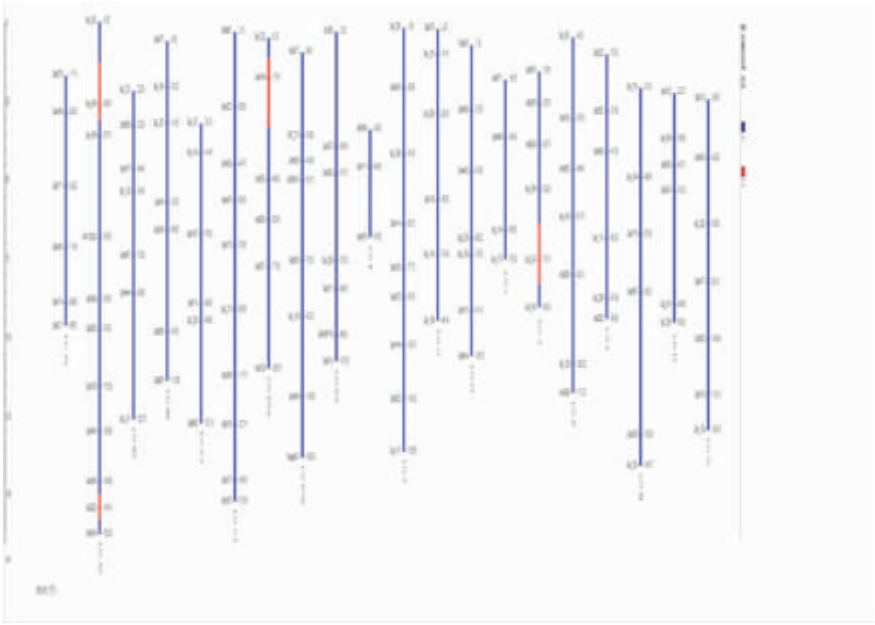


Fig. 7. Genomic representation of recovery of the recurrent parent JS 97-52 across the genome of the BC_3F_1 plant P3-3-41-15 using GGT3.2. The blue zone in each bar depicts the recuurent parent genome while the red zone signifies the donor parent genome

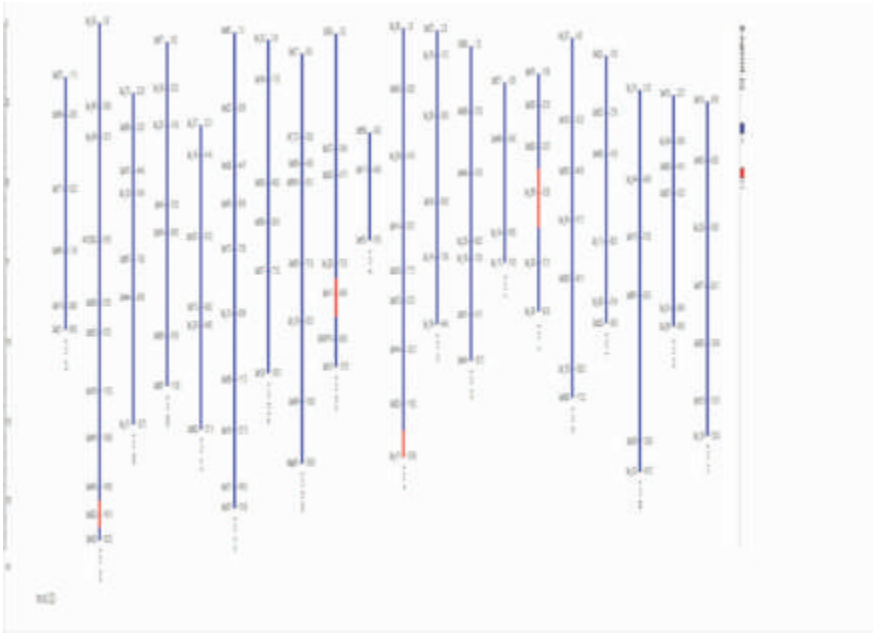


Fig. 8. Genomic representation of recovery of the recurrent parent JS 97-52 across the genome of the BC_3F_1 plant P33-17-56-24 using GGT3.2. The blue zone in each bar depicts the recuurent parent genome while the red zone signifies the donor parent genome

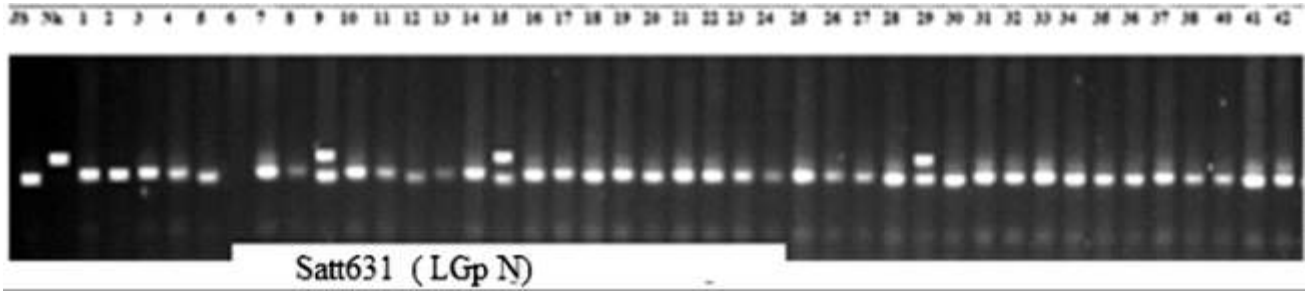


Fig. 9. Background selection in BC_3F_1 generation of the cross JS 97-52 x (JS 97-52 x PI 542044)

2.1.4. Breeding for Resistance to Rust and Yellow Mosaic Virus Diseases in Soybean

The genotypes collected from various sources such as PS 1024, PS 1029, JS 80-21 and Indira Soy 9, EC 389148, EC 389149, EC 389160, EC 389165, EC 391160, EC 457148, EC 457181, EC 457186, EC 457464, EC 458385, EC 458390, EC 389392, EC 241778, EC 241780, PI 200492, PI 230970, PI 462312, Ankur, PI 459025, PI 459024, PI 200477, PI 230971, Wayne, TK 5 were screened for their reaction towards soybean rust at rust hot spot area. All the genotypes were found susceptible, except EC 241780 and EC 241778 which have been used further in breeding programmes for the development of rust resistant cultivars.

Screening for YMV under field condition showed PK 416, PK 564, PK 1042, SL 295, SL 525, PK 1162, SL 459, SL 517, SL 528, NRC 20, DSB 4 and UPSM 534 as consistently resistant for YMV. Two advanced breeding lines namely B-23J and B-15 were promoted to AVT-1 and IVT respectively. Efforts are also being undertaken to pyramid both rust resistance and YMV resistance into single genetic background. Crosses between SL 295 x EC 241780 and B23J x EC 241780 were affected to generate segregating material and to select desired plant material conferring resistance to both rust and YMV.

2.1.5. Molecular Mapping and Genomics Assisted Breeding for Rust Resistance in Soybean

New crosses were initiated between the susceptible parent (JS 335) and resistant parent (EC 241780) for the development of recombinant inbred lines (RILs). New crosses were also attempted using other resistance sources developed at Mahatma Phule krishi Vishwavidyalaya, Rahuri, Maharashtra. Isolates of P. *pachyrhizi* collected from different states such as Maharashtra, Karnataka and North-Eastern states were subjected to molecular characterization.

2.1.6. Development of Backcross Mapping Population and Genotyping for QTL Identification

To identify yield related QTLs from wild relative of soybean *G. soja,* a backcross population of 300 BC_2 individuals have been developed. The BC_2 population is presently grown in glass house to generate BC_2F_2 population (Fig. 10) which will be used for genotyping and phenotyping in *Kharif* 2014. A population of 190 F_3 individual lines derived from the cross Type49 X JS 335 has been genotyped with two SSR markers Satt474 and Satt066.

Fig. 10. Plants of BC_2 mapping population from cross JS 335 x *Glycine soja*

2.1.7. Breeding Soybean for Wider Adaptability Using Photoperiod Response and Growth Habit

2.1.7.1. Allelic characterization for *E4* locus in photo-insensitive lines of soybean using CAPS marker

Six photo-insensitive genotypes MACS 330, EC 325097, EC 333897, EC 34101, EC 325118 and EC 390977 were used for characterization of three allele specific CAPS markers of *E4* locus. One allele for CAPS marker e4-Kes, produced by restriction enzyme Bsph1 was detected in the genotype EC 325097 and one allele e4-Kam, produced by restriction enzyme AlfII was detected in genotype EC 325118. These new alleles will be validated and used in breeding programme.

2.1.7.2. Marker assisted confirmation of backcrosses

A total of 24 backcross progeny derived from backcross AGS 25 x (JS 93-05x AGS 25) were confirmed using molecular markers. Four polymorphic markers Satt105, Satt049, Satt055 and Satt474 were used for allele characterization.

Out of total 24 BC_1 plants analyzed, 21 produced heterozygous alleles containing one of the allele derived from donor parent JS 93-05. One BC_1 plant produced unknown allele indicating off-type plant. While two BC_1s have not shown any heterozygotes, indicating doubtful status and need to use more markers for further confirmation.

2.1.7.3. Marker assisted backcross breeding for photoinsensitivity

Twenty eight BC_1 plants from JS 97-52 (photosensitive) x [JS 97-52 x EC 390977 (photoinsensitive)] were screened using validated molecular markers for E3 and E4 genes and true backcross plants with donor alleles (e3, e4, e3e4) were identified. Seven plants for E4 locus, eleven plants for E3 locus and three plants for both E3 and E4 loci carried recessive donor allele e3, e4, e3e4, respectively. These plants have been used for generating BC_2 generation to transfer the photo-insensitive alleles e3 and e4 to JS 97-52.

2.1.7.4. Inheritance of long juvenility

Segregation of two F_2 populations *viz.,* JS 93-05 x AGS 25 and JS 95-60 x AGS 25 for conventional and long juvenility was studied in pots under net house and open grown conditions. F_2s reaching R1 stage at or before mid parent value were categorized as conventional juvenile (Table 11). F_2s from JS 93-05 x AGS 25 in both of the screening conditions segregated into 3:1 ratio (conventional juvenile: long juvenile). The F_2 population derived from cross JS 95-60 x AGS 25 segregated into 3:1 under net house condition.

2.1.7.5. Hybridizations and generation advancements

Sixteen hybridizations were made for photo-insensitivity, long juvenility and for combining these traits together. Six crosses were advanced to F_2, eight each to F_3 and F_4, one to F_5, four to BC_1F_2 and one to BC_2.

2.1.7.6. Single plant selections in segregating generations

Based on the phenotype, earliness and grain yield per plant, individual plant selections were made in different segregating generations involving eight parents. Continuous rains and heavy disease pressure resulted in very low grain yield per plant (Table 12) which ranged from 3.7 g (NRC 7) to 11.9 g (EC 538828) in parents. Individual plants with (1) more than 10 g of grain yield and more than 90 days of maturity and (2) less than 90 days of maturity duration and more than 6 g of grain yield were selected.

2.1.8. Breeding Soybean for High Phosphorus Uptake Efficiency

In breeding for high phosphorous uptake efficiency, 89 soybean varieties were evaluated for dry matter production with and without phosphorus application in phosphorus exhausted field. Dry matter production ranged from 0.37 to 5.7 g/plant and 1.17 to 7.27 g/plant in with and without phosphorus application treatment, respectively. For identification of phosphorus responsive and efficient genotypes, dry matter content from without phosphorus application

treatment was plotted against that from with phosphorus application treatment. This enabled 89 genotypes to be classified relative to each other for P-efficiency and responsiveness (Table 13).

Table 11. F_2 segregation for conventional (CJ) and long (LJ) juvenility in short day conditions of *rabi*, 2013

Parent / Population	Days to R1	CJ: LJ (Ratio Tested)	χ^2 (Probability)
Net House Grown JS 93-05 x AGS 25			
AGS 25 (LJ Parent)	88	144:51 (3:1)	0.14 (0.90-0.10)
JS 93-05 (CJ Parent)	47		
F1	51		
F2 LJ Mean (Range)	75.0 (69.0 – 87.0)		
F2 CJ Mean (Range)	60.5 (44.0 - 68.0)		
F2 Mean (Range)	64.3 (44.0 - 87.0)		
Mid parent	67.5		
Net House Grown JS 95-60 x AGS 25			
AGS 25 (LJ Parent)	88	113:42 (3:1)	0.37 (0.90-0.10)
JS 95-60 (CJ Parent)	46		
F2 LJ Mean (Range)	73.9 (68.0 - 88.0)		
F2 CJ Mean (Range)	58.3 (42.0 - 68)		
F2 Mean (Range)	62.5 (42.0 – 88.0)		
Mid parent	67		
Open Grown JS 93-05 x AGS 25			
AGS 25 (LJ Parent)	129	130:44	0.008 (0.95-90)
JS 93-05 (CJ Parent)	71		

Table 12. Parental and selected individual plant yield in segregating generations

Generation/cross (number of plants selected)	Average grain yield (g) / plant
JS 95-60	5.6
JS 93-05	6.0
JS 335	7.7
NRC 37	7.3
NRC 7	3.7
JS 97-52	9.3
EC 390977	4.4
EC 538828	11.9
Selections for grain Yield (>90 days maturity & > 10 g yield)	
F_2 JS 97-52 x EC 390977 (41)	21.9 (12.5 – 38.3)
F_4 EC 390977 x EC 538828 (131)	15.5 (10.0 – 28.7)
F_2 JS 97-52 x EC 333897 (9)	12.5 (10.2 – 19.2)
F_3 NRC 37 x EC 390977 (16)	13.9 (10.2 – 20.2)
F_3 JS 97-52 x EC 325097 (2)	11.6 & 11.9
F_3 NRC 37 x EC 325097 (1)	20.4
F_3 NRC 37 x EC 390977 (20)	14.0 (10.3 – 23.1)
F_3 JS 97-52 x EC 333897 (4)	10.2, 10.4 & 10.7, 10.9
F_3 JS 93-05 x EC 390977 (1)	11.6
F_3 EC 390977 x JS 95-60 (3)	10.3, 10.8, 12.1
F_3 EC 390977 x EC 538828 (5)	19.6 (12.2 – 24.8)
F_3 JS 97-52 x MACS 330 (4)	17.6 (13.5-20.6)
Selections for Early Maturity (<90 days maturity & 6 g yield)	
F_3 JS 97-52 x EC 333897 (5)	9.7 (6.3 – 26.3)
F_3 NRC 37 x EC 390977 (7)	10.84 (8.1– 14.5)
F_3 JS 93-05 x EC 390977 (5)	7.16 (6.4 – 14)

Table 13. Classification of soybean genotypes for P responsiveness and P efficiency

Class	Genotype
Non Responsive-Efficient (NR & E)	PS 1225, VLS 65, JS 76-205, IS 9, Gujarat Soya 1, Durga, AGS 25, Pusa 22, MACS 13, MAUS 61, KB 79, MAUS 2, JS 79-81, Birsa Soya 1
Non Responsive-Inefficient (NR & I)	PS 1241, PS 1024, PRS 1, PS 564, VLS 2, Pusa 97-12, PS 1092, Co Soya 2, Shivalik, Pusa 24, RKS 18, SL 688, VLS 1, Co Soya 1, Pusa 20, LSb 1, JS 90-41, PK 327, Pusa 98-14, MAUS 81, JS 93-05, JS 95-60, Type 49, RKS 24, Bragg, MACS 57, MAUS 158, Ankur, ADT 1, JS 80-21, Lee, DS 228, Alankar, PK 416, Improved Pelican, NRC 7, SL 295, PK 1347
Responsive-Efficient (R & E)	PS 1042, Shilazeet, JS 335, JS 71-05, Pusa 16, Pk 471, JS 2, Hardee, NRC 37, MACS 450, MACS 58, Hara Soya, Pb1, Kalitur, Guj Soya 2, MAUS 71, Palam Soya 1, Pusa 40, TAMS 38, Gaurav, MAUS 1, EC 538828, Pusa 32, MAUS 47, TAMS 98-21, JS 97-52, MAUS 32
Responsive-Inefficient (R & I)	VLS 21, RAUS 5, KhSb 1, MAUS 61-2, PK 472, Monetta, Co Soya 3, NRC 12, MACS 124, NRC 2

2.1.9. Breeding for Drought Tolerant Varieties in Soybean

2.1.9.1. Hybridization and early generation selection

Thirteen exotic and twelve indigenous drought responsive genotypes/ cultivars were maintained under field conditions in *Kharif* 2013 and are in use as parents for hybridization programme. Four new crosses *viz.* PI 416937xJS 97-52, PI 416937xJS 335, PI 416937xJS 95-60, and JS 71-05xJS 97-52 were initiated to introduce slow wilting trait in commercial cultivars. Three hundred ninety three selections were made among 9820 F_2 generation plants from 19 crosses, 63 selections in F_3 from six crosses and 112 selections in F_4 from 12 crosses for increased vigour and high number of pods per plant (30 – 160 pods per plant). These generations were also advanced through single seed descent and bulk methods.

2.1.9.2. Development of RILs population

Four populations from F_3 generation *viz.* JS 97-52 x NRC 37, JS 335 x CAT 2797, JS 71-05 x Cat 2797, Doko RC x JS 335 and five from F_4 generation *viz.* JS 335 x Young, EC 538828 x Young, NRC 7 x Jackson, JS 95-60 x Young, Young x Kaeri 651-6 have been advanced to F_4 and F_5 generation, respectively.

2.1.9.3. Screening for terminal water-stress tolerance

Thirty three F_4 bulks along with 15 genotypes/ cultivars were laid out in three replications in off-season field nursery under fully irrigated and water stressed treatments to assess terminal drought responsiveness. A hand-held infrared thermometer LT300 was used to measure leaf canopy temperature (Tc). Canopy temperature differential (Tcd) and relative water content (RWC %) were determined as per the standard formulae. To minimize the potential influence of stage of development on Tc, most of the Tc measurements were taken at R6 stage. Correlation coefficient of 'RWC in water stressed treatment' was negative with Tc water stressed (-0.198) and Tc irrigated treatment (-0.324) (Table 14).

The least significant difference (CD 5%) for Tc was 3.6^{0}C in water stressed and 2.8^{0}C in irrigated treatments. The populations/genotypes differed for Tc by 7 ^{0}C in water stressed treatment and 4.8^{0}C in irrigated treatment. Tcd were consistently larger under water stressed treatment (Fig.11).

Table 14. Correlation coefficients between canopy temperature and relative water content under water stressed and irrigated treatments in soybean

	Tc Water stressed	RWC Water stressed	Tc Irrigated
RWC Water stressed	-0.198		
Tc Irrigated	0.627**	-0.324*	
RWC Irrigated	-0.009	0.358*	-0.004

*significant at the 0.05 probability level, **significant at the 0.01 probability level

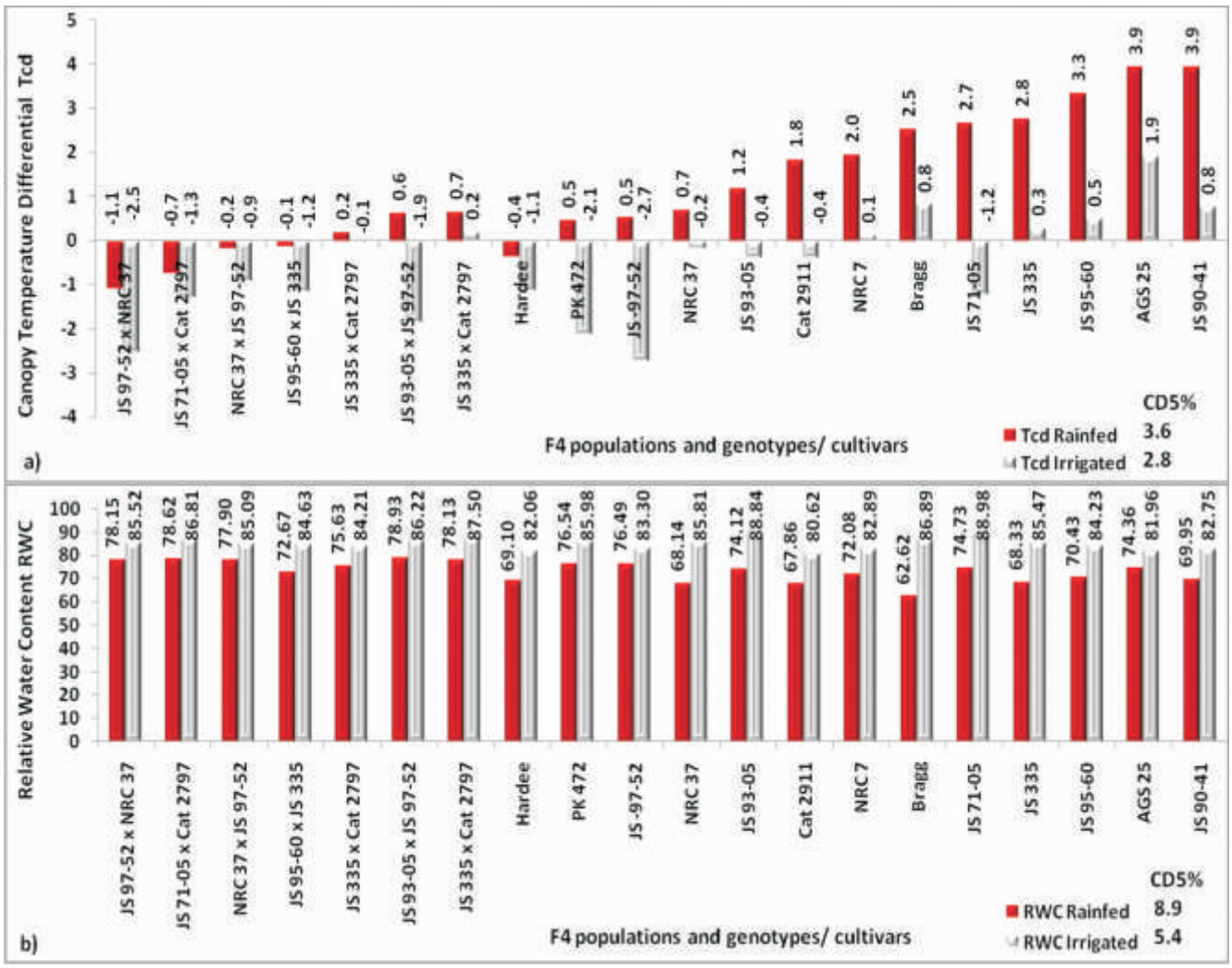


Fig. 11. Off-season field screening of F_4 bulk populations for potential terminal water-stress tolerance through minimum canopy tempeature differenitial (Tcd) and maximum relative water content (RWC) in soybean

The F_4 bulk populations derived from cross JS 97-52 x NRC 37 (-1.1), JS 71-05 x CAT 2797 (-0.7), JS 95-60 x JS 335 (-0.1) and a drought tolerance genotype Hardee (-0.4) showed negative Tcd value under both under irrigated and water stressed conditions. On the other hand, under irrigated condition, the RWC in F4 bulk populations JS 71-05 x Cat 2797 (86.81%) and JS 97-52 x NRC 37 (85.52%) was on par with drought tolerant genotype Hardee (82.06%). However, RWC of these two bulk populations was significantly different (78.62% and 78.15% respectively) from Hardee (69.10%) under water-stressed condition. Therefore, the bulk population derived from crosses JS71-05 x CAT2797 and JS 97-52 x NRC37 expressed potential for terminal drought tolerance (Fig 1).

Out of 33 F_4 bulks population derived from 16 crosses screened for late wilting at R7-R8 stage in off-season during 2013, six bulk populations showed delayed leaf senescence and found to be promising for late wilting. Further individual plant selection for plant vigour in 16 crosses resulted in identification of 105 vigorous plants. Seeds of these 105 plants were grown in plant-to-progenies during *kharif* 2013 season along with promising six delayed wilting bulk populations. Out of 105 families in F_5 generation only 42 families were survived could be due to poor germination. Selections in the bulk populations led to the identification of 323 individual plants, having high pod bearing ability (40-100 pods per plant) and potential late wilting traits, from four populations *viz.* JS 97-52 x NRC 37 (170), JS 71-05 x Cat 2797 (4), JS 93-05 x JS 97-52 (75), and JS 90-41 x JS 97-52 (74).

In conclusion, the bulk populations derived from crosses JS 71-05 x CAT 2797 and JS 97-52 x NRC 37 showed potential for late wilting, high RWC, low canopy temperature under off-season terminal drought and high pod bearing ability in normal *kharif* season.

2.1.10. Breeding for Water Logging Tolerance in Soybean

2.1.10.1. Screening for water logging tolerance

Twenty soybean genotypes *viz.,* JS 90-41, JS 97-52, JS 335, JS 95-60, JS 20-29, JS 20-38, JS 20-69, MAUS 26-1, MAUS 47, MAUS 61, CAT 3299, RKS 18, Pusa 40, NRC 7, NRC 37, JS 93-05, PK 262, PK 472, JS 88-66 and Bhatt were screened for water logging tolerance under three conditions in RBD with two replications. Water logging tolerant variety JS 97-52 was used as check for tolerance as reported earlier. Experiment was laid out in three conditions. The first set was left for natural water logging screening with abrupt and alternate water logging/ dry conditions. Second set was filled with water up to 10 cm at R1 stage for 15 days. Third set was considered as control with good drainage practices. The observations were recorded on plant height, number of pods, seed weight, dry matter weight and chlorophyll content at different stages. The result showed that based on seed yield, JS 20-38 was found to be superior over check and ranked I followed by PK 472 (Fig. 12 & 13).

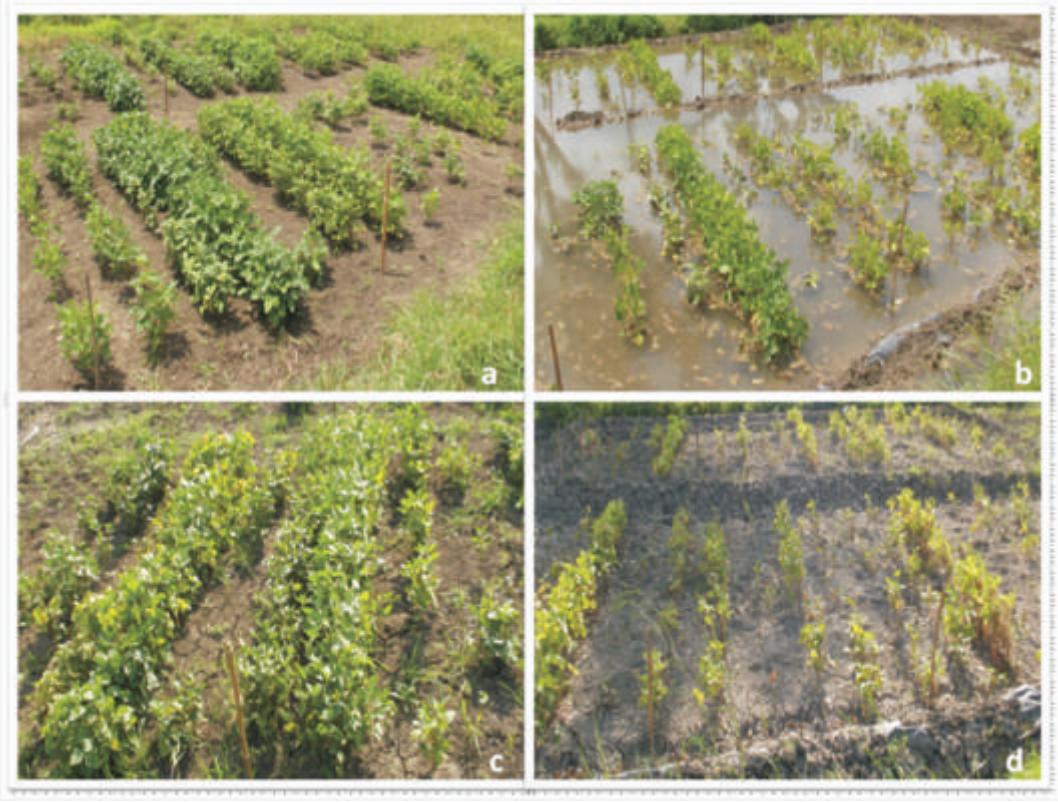


Fig. 12. Plant growth at different stages: (a) control (b) treatment- At 15 days of waterlogging, (c) control (d) treatment- After 10 days of survival period

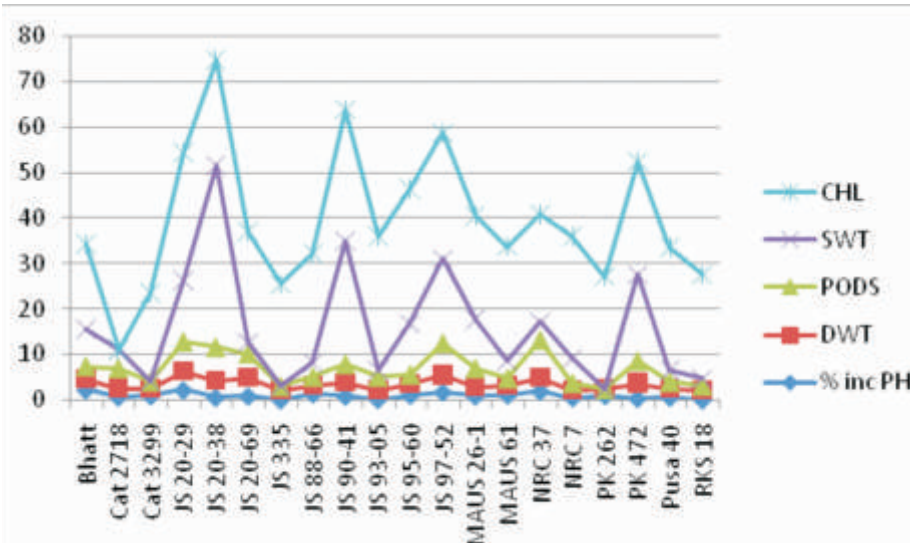


Fig. 13. Performance of different genotypes under treatment for different traits (CHL-chlorophyll, SWT-Seed Weight, PODS-no of pods, DWT- Dry Weight, % inc PH- percent increase in plant height)

2.1.10.2. Hybridization programme and Development of RILs

To develop varieties tolerant to water logging condition, 13 were crosses were affected using six genotypes *namely* JS97-52, JS*95-60,* JS90-41, JS335, JS88-66 and PK 472 during the year 2013-14. With an aim to develop RIL population, 131 plants of F_4 generation derived cross JS 7-52 x JS 90-41 was advanced to F_5 generation by single pod descent method.

2.1.11. Development of Multiparent Advanced Generation Intercross (MAGIC) Population in Soybean

Four popular and high yielding Indian soybean varieties namely, JS 335, JS 95-60, NRC 37, NRC 86 and four promising exotic lines EC 546882, EC 333901, EC 572109 and EC 572136 representing different countries were used as founder parents to develop multiparent advanced generation intercross (MAGIC) population in soybean. The F_1 cross combination of 2-way crosses were generated by attempting the hybridization among eight founder parents. The hybridization in the present study was carried out by non-emasculation method which resulted in high success of 66 per cent pod setting and 52 per cent of the crossed pods were harvested (Table 15). A portion of 2-way F_1 seeds from EC 572109 x JS 95-60, EC 572136 x JS 335, EC 546882 x NRC 37 and EC 333901 x NRC 86 were sown during the *rabi* 2014 to attempt hybridization to generate 4-way intercross hybrids. Crosses were also attempted towards developing nested association mapping (NAM) population, interspecific populations and to incorporate rust resistance to popular varieties.

2.1.12. Management and Enhancement of Soybean Seed Quality through Application of Chemical and Invigoration Techniques

An experiment was conducted to study the efficiency of polymer coating of fungicides, bio-control agents and growth activators for the management of soybean diseases and yield improvement, using the cultivars JS 335 and NRC 7 (Fig. 14 & 15) (Table 16). The results revealed that the field emergence was significantly improved by the polymer coating of gibberelic acid (GA) + salicylic acid (SA). Maximum field emergence of 82 per cent was observed with GA+SA treatment in NRC 7 and 98 per cent with GA+ indole 3- acetic acid (IAA) + ASA in JS 335 as compared to the control (66 and 74 per cent in NRC 7 and JS 335, respectively). Seedling mortality due to collar rot was least in polymer coating with *Trichoderma viride* (0.61 per cent) followed by SA (0.70 per cent) as compared to control (9.8 per cent). At later stage, per cent plant infestation and the intensity of foliar diseases (*Myrothecium* leaf spot, Anthracnose and Rhizoctonia aerial blight) was lower in polymer coated *T. viride,* followed by salicylic acid treatment. The effect of growth activators was significant on yield. Polymer coating of GA+SA resulted in maximum yield of 1.97 kg/plot followed by GA+IAA+SA (1.89 kg/plot). Present findings show that polymer coating of soybean seeds served as an effective system for dust free delivery of bio-control agents *(T. viride*) and growth activators (GA, SA, and IAA) for the management of soybean seed-borne and foliar diseases.

Table 15. Summary of success of pod setting in various genotypic combinations during F_1 generation

Genotypic combination	No. of pollinations	No. of pods harvested	Success (%)	Objectives/targeted traits
EC 572109 x JS 95-60	130	71	54.61	To develop 2-way intercross hybrids for generating multiparent advanced generation intercross population.
EC 572136 x JS 335	118	64	54.23	
EC 546882 x NRC 37	80	53	66.25	
EC 333901 x NRC 86	112	66	58.92	
EC 333901x JS 95-60	51	20	39.21	To develop Nested Association Mapping (NAM) population.
NRC 86 x JS 95-60	25	14	56.00	
EC 572136 x JS 95-60	22	6	27.27	
EC 546882 x JS 95-60	30	14	46.66	
NRC 37 x JS 95-60	24	10	41.66	
JS 335 x JS95-60	12	5	41.60	
JS 95-60 x *G. soja*	37	24	64.86	To broaden the narrow genetic base of cultivated soybean.
NRC 86 x *G. soja*	16	5	31.25	
NRC 37 x *G. soja*	19	7	36.84	
JS 335 x EC 241780	7	4	57.14	To incorporate rust resistance.
JS 95-60 x EC 241780	3	1	33.33	
NR C37 x EC 241780	2	1	50.00	
NRC 86 x EC 241780	3	2	66.66	
EC 572109 x JS 335	33	8	24.24	To attain higher yield.
EC 333901x EC 572109	9	7	77.00	
EC 572109 x NRC 86	9	6	66.66	
Total	**742**	**388**	**52.29**	-

Fig. 14. Polymer coating of soybean seeds with different chemicals and bio-control agent

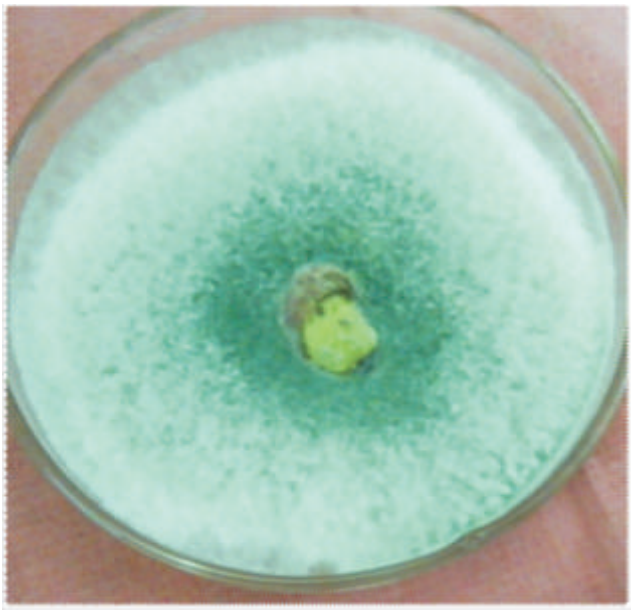


Fig. 15. Growth of *Trichoderma viride* from the seeds coated with *T. viride* using polymer

Table 16. Disease incidence in the field of polymer coated seeds of NRC 7 and JS 335

Treatments	Myrothecium Leaf Spot				Anthracnose				Rhizoctonia Arial Blight					
	% of Plants infected		Disease rating (1-10)		% of Plants infected		Disease rating (1-10)		% of Plants infected		Disease rating (1-10)		Total diseased plants (%)	
	NRC 7	JS 335	NRC 7	JS 335	NRC 7	JS 335	NRC 7	JS 335	NRC 7	JS 335	NRC7	JS 335	NRC 7	JS 335
GA+IAA	1.5	1.6	3	5	1.22	1.6	5	3	-	-	-	-	2.72	3.2
GA+SA	0.91	-	3	-	0.3	0.45	3	3	-	0.67	-	3	1.21	1.12
GA+IAA+SA	1.24	-	3	-	0.31	1.06	3	3	-	0.42	-	3	1.55	1.48
GA+IAA+ASA	0.92	-	3	-	0.91	1.85	3	3	-	0.55	-	5	1.83	2.4
T. viride	0.34	-	3	-	-	0.46	-	1	-	-	-	-	0.34	0.46
SA	0.67	-	3	-	0.33	0.22	3	3	-	-	-	-	1	0.22
Control	1.5	1.96	5	5	2.64	1.71	3	5	1.13	1.22	5	3	5.27	4.89

2.1.13. Identification of physio-chemical attributes of seed coat and seed influencing mechanical damage of soybean seeds

Mechanical damage to soybean seed coat and seed is one of the major causes for soybean seed quality loss in the tropical and sub-tropical regions. The variation in strength of seed coat among the soybean varieties was studied in the present investigation. The soybean varieties were screened by the texture analyzer for seed coat strength and significant variation was found amongst the cultivars (minimum 90 Newton in case of SL525 to 149 Newton in case of Type 49). Therefore, there is a great opportunity to improve seed coat strength with breeding and proper selection criteria. The lignin is most important constituent of seed coat to contribute towards mechanical strength for resistance against physical forces during harvesting and post harvest operations. The lignin content of seed coat of different varieties was estimated and it was found that there was a continuous variation for seed coat lignin content in the tested varieties (Fig. 16).

Mineral composition namely calcium, silicon, iron and zinc content of seed coat of soybean varieties was also estimated. Significant variation was found amongst the soybean cultivars. Calcium content varied from 320 to 521 mg/100g seed coat, silicon content 25 to 58 mg/100g seed coat. Significantly high correlation was found between strength of seed coat and seed coat lignin (0.81), calcium (0.71) and silicon content (0.73). Positive correlation was observed between strength and iron and zinc content of seed coat. There was a significantly high correlation between calcium content and silicon content of seed coat. The other minerals were not significantly correlated among themselves.

The peroxidase enzyme plays a key role in lignin bio-synthesis. Peroxidase enzyme profiling was undertaken to find out the key isozymes linked to lignifications of seed coat. Only one form of isozyme was found in seed coat whereas, four different forms (70, 60, 50 and 40 KDa) were observed in plant (Fig. 17). Very close relationship was observed between high lignin content in seed coat and 70 KDa plant peroxidase isoform (Fig. 18).

2.1.14. Central Sector Scheme for Plant Variety and Farmers' Right Authority (DUS Testing)

All the released and notified soybean varieties (102 varieties) and 71 collections from farmers' field of Madhya Pradesh were maintained and characterized under this project as per the guidelines of "Distinctiveness, Uniformity and Stability Testing in Soybean" during the *Kharif* 2013-14. One soybean variety was tested for DUS Testing under the category of "New Variety" for second year at DSR, Indore and UAS, Dharwad. Monitoring of DUS testing of the candidate variety was done on 29 August 2013 at DSR, Indore and on 3 October 2013 at UAS, Dharwad.

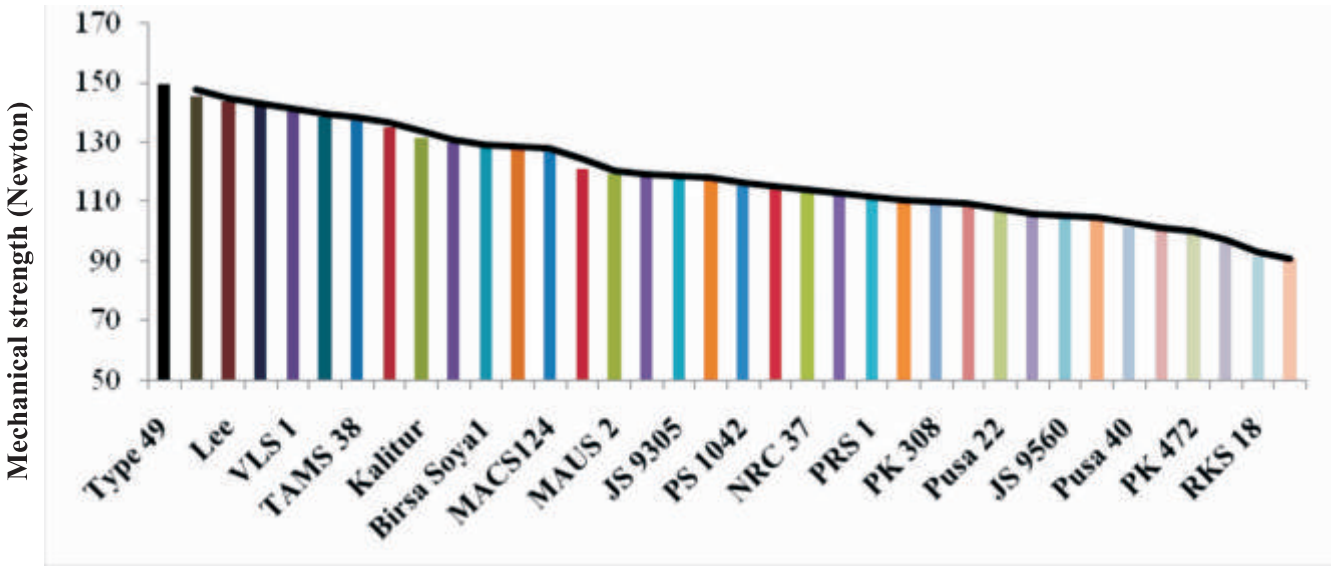


Fig. 16. Variations in mechanical strength of seed coat amongst the soybean cultivars

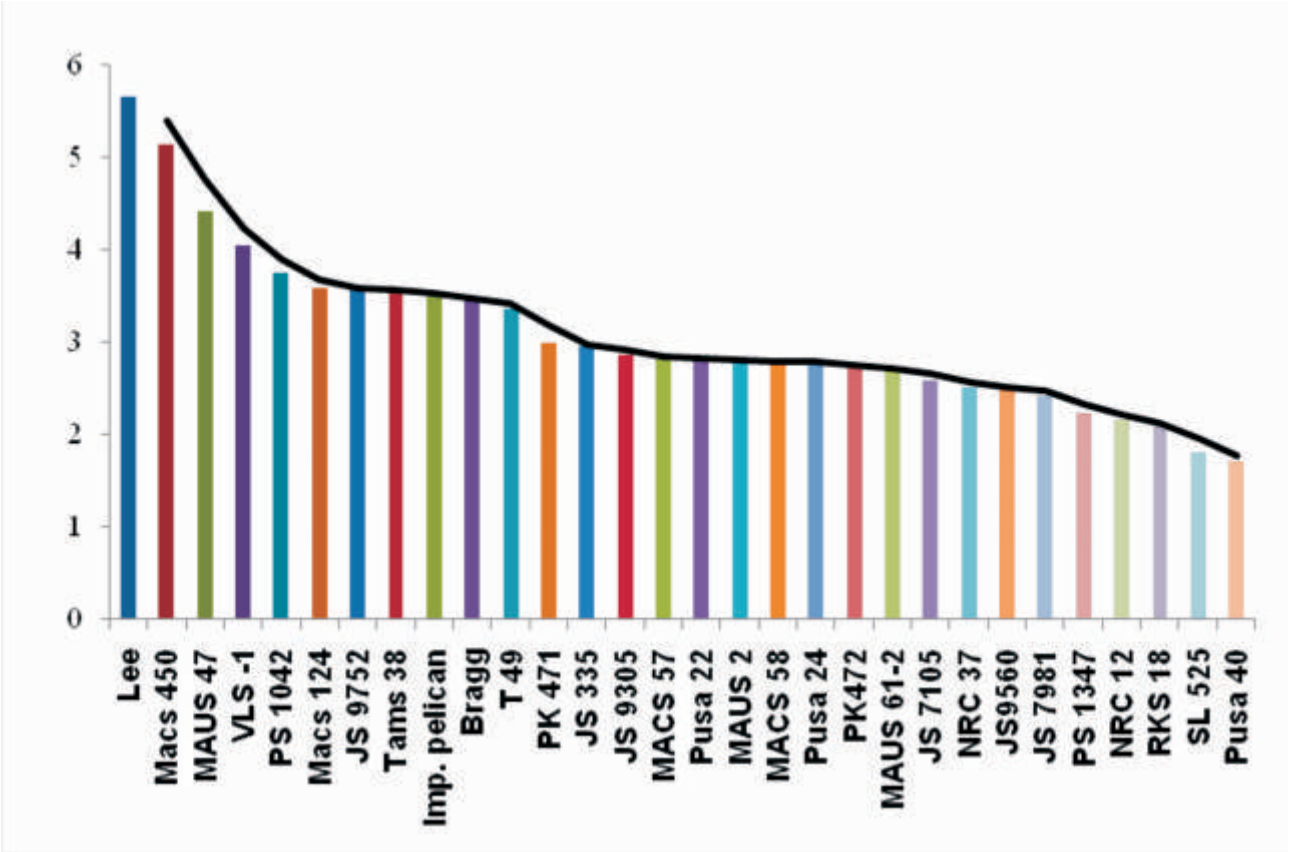


Fig. 17. Variations in seed coat lignin content amongst the soybean cultivars

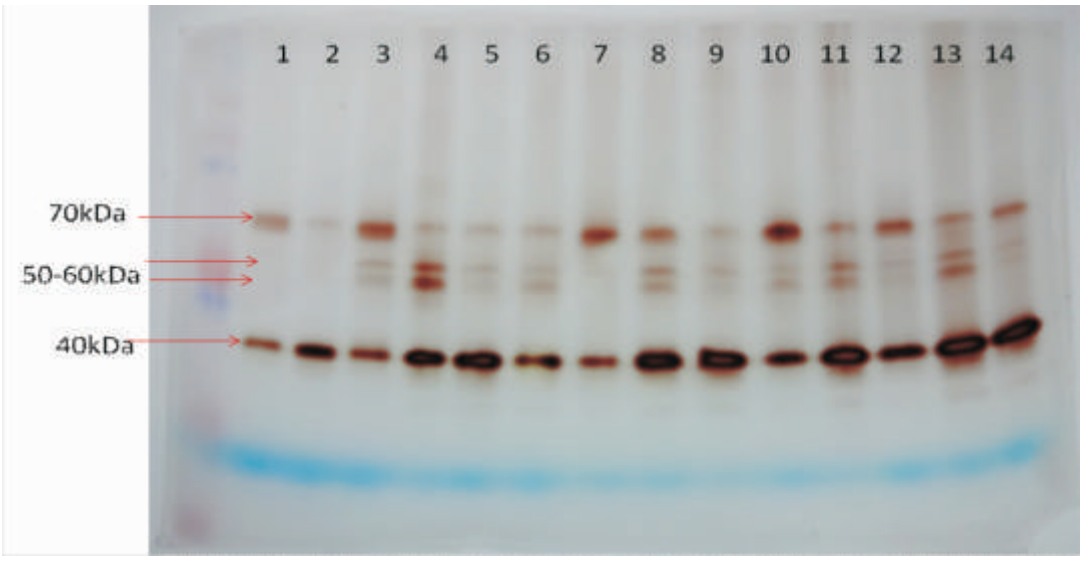


Fig. 18. Soybean plant peroxidase isoenzyme profile 1. Birsa Soya 1, 2. PUSA 40, 3. Bragg, 4. VLS 1, 5. JS 79-81, 6. PS 1347, 7. Type 49, 8. PS 1042, 9. NRC 12, 10. Lee, 11. PK 471, 12. MACS 124, 13. PUSA 22 and 14. Pusa 24

Five soybean varieties namely NRC 37 (Certificate No. 000490 and registration No.156/2012), JS 95-60 (Certificate No. 000792 and registration No.246/2013), JS 93-05 (Certificate No. 000790 and registration No. 244/2013), JS 97-52 (Certificate No. 000787 and registration No. 241/2013) and MAUS 71 (Certificate No. 000788 and registration No. 242/2013) were registered for plant variety protection under the provision of PPV&FR Act-2001. Application for protection of Soybean varieties namely Pant Soybean-1225, Pant Soya-1092 and Pant Soybean-1347 was submitted to PPV&FR Authority, New Delhi for registration under Extant Notified Variety category.

2.2. CROP PRODUCTION

2.2.1. Evaluation of Soybean Genotypes for Tolerance to High Temperature Conditions

Global warming due to climate change and resultant high temperature conditions are affecting the soybean performance. Therefore, experiments were conducted with an objective to evaluate soybean genotypes for their performance in terms of growth and yield under elevated temperatures. Eleven soybean genotypes (Table 1) were planted in four green houses each maintained at day/night temperatures of 30/22, 34/24, 38/26 and 42/28 ^{0}C, with an average temperature of 26, 29, 32 and 35 ^{0}C, respectively. Beside physiological attributes, data on yield and its attributes was recorded at harvest. The maximum average seed yield of soybean genotypes (11.7 g/pl) was observed in plants grown at 30/22 ^{0}C and increase in temperature up to 34/24 ^{0}C did not affect the yield significantly (11.4 g/pl) (Table 17). However, further increase in temperature had a significant negative influence on seed yield of soybean. The seed yield declined by 45 and 60% in plants grown at 38/26 and 42/28 ^{0}C, as compared to the plants grown at 30/22 ^{0}C respectively. The decline in yield at these temperatures was associated with reduction in pods/plant (30 and 42%), 100 seed weight (22 and 35%) harvest index (32.6 and 21.2%). The average biomass of soybean genotypes was significantly higher in plants grown at 34/24 ^{0}C (28.0 g/pl) as compared to plants grown at higher and lower temperatures. The average biomass in plants grown at 34/24 ^{0}C was 12% higher as compared to plants grown 30/22 ^{0}C indicating that increase in temperature up to 34/22 ^{0}C may help in improving the biomass. Nevertheless, the improved biomass was not reflected in improved productivity as the harvest index at this temperature was significantly low (41.1 %) as compared to the plants grown at 30/22 ^{0}C (47.6 %) indicating that partitioning of dry matter could be limiting factor.

Genotypes also differed significantly for seed yield and yield attributes. Among genotypes the average seed yield was highest for JS 97-52 (11.6 g/pl) which was at par with the yield observed in genotypes NRC 7 (10.9 g/pl), EC 602288 (10.7 g/pl), EC 456548 (10.5 g/pl) (Table 1). The genotypes which showed very low yield were JS 95-60 (3.4 g/pl), JS 93-05 (6.2 g/pl) and NRC 37 (6.8 g/pl). The interaction of temperature with genotypes was significant for seed yield and yield attributes studied except for seeds/pod, indicating that soybean genotypes responded differently to increasing temperatures. The reduction in seed yield in response to increasing temperature was low for genotypes EC 538828, NRC 7, Hardee, EC 456548, JS 97-52 and JS 71-05 as compared to rest of the varieties indicating that these genotypes are relatively tolerant to high temperature (Table 18 and Fig. 19). The results clearly indicate that there are strong genotypic differences for increased temperatures in terms of growth and yield and there is a need to screen large genetic material to identify genotypes which would perform well under high temperature conditions. Identification of genetic sources and there use in breeding programmes would help in developing varieties with tolerance to high temperature and sustainable soybean production under current and future climatic variability.

Table 17. Effect of temperature on seed yield and its attributes of 11 soybean genotypes

Treatments	Seed weight (g/pl)	Total biomass (g/pl)	Harvest index (%)	Pods/pl	Seeds/pod	100 seed weight (g)
Day/night Temperatures (°C) (T)						
30/22	11.7	24.9	47.6	57.7	1.89	12.2
34/24	11.4	28.0	41.1	57.1	1.89	11.5
38/26	6.4	19.9	32.6	40.2	1.75	9.5
42/28	4.7	17.3	21.2	33.6	1.66	7.9
LSD (P>0.05)	0.39	1.03	1.23	2.09	0.127	0.41
Genotypes (G)						
JS 97-52	11.6	29.3	38.5	70.5	1.99	7.9
EC 602288	10.7	26.8	38.4	72.8	1.80	7.6
JS 95-60	3.4	10.1	30.3	16.5	2.23	8.2
JS 93-05	6.2	17.3	32.8	35.3	2.05	7.6
EC 456548	10.5	23.1	44.6	42.8	1.64	14.6
Hardee	9.5	25.0	37.0	56.4	1.70	9.6
NRC 37	6.8	24.1	27.6	55.5	1.54	7.6
JS 335	7.4	26.1	27.8	44.7	1.79	8.9
JS 71-05	9.0	24.8	35.4	45.5	1.83	9.4
EC 538828	7.8	13.8	56.2	20.9	1.68	20.2
NRC 7	10.9	27.4	39.8	57.6	1.55	11.4
LSD (P>0.05)	**0.82**	**1.70**	**2.49**	**3.65**	**0.132**	**0.52**
T x G	**1.65**	**3.40**	**4.97**	**7.31**	**NS**	**1.04**

Table 18. Interaction of temperature with genotypes for seed yield, total biomass and harvest index in soybean

Genotypes	Seed yield (g/pl)			
	Day/night temperatures (^{0}C)			
	30/22	34/24	38/26	42/28
JS 97-52	15.5	15.1	9.0	6.7
EC 602288	15.1	14.5	8.2	5.0
JS 95-60	5.8	5.2	1.5	1.1
JS 93-05	10.3	8.9	3.5	2.0
EC 456548	13.7	14.3	7.8	6.2
Hardee	11.8	12.6	7.5	5.9
NRC 37	10.8	9.7	4.0	2.8
JS 335	10.7	10.2	5.4	3.5
JS 71-05	12.1	11.5	7.2	5.2
EC 538828	9.6	9.6	6.7	5.4
NRC 7	13.4	13.4	9.5	7.4
LSD (P<0.05)		**1.65**		

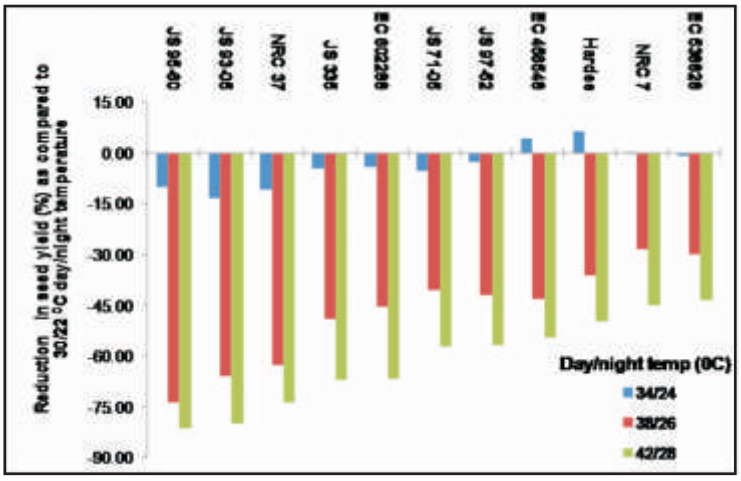


Fig. 19. Reduction in seed yield (%) in different soybean genotypes grown at higher day/night temperatures (34/24, 38/26 and 42/28 ^{0}C) as compared to lower day/night temperature (30/22 ^{0}C)

2.2.2. Identification of Resilient Soybean Production Systems

In an experiment conducted to optimize the nitrogen levels for soybean genotypes under different land configuration systems, two land configuration systems (broad bed furrow; BBF and flat bed systems; FB), two genotypes (JS 95-60 and JS 97-52) and six nitrogen levels (0, 20, 40, 10+10, 20+20 and 20+40 kg N/ha) were tested. Single and split levels of nitrogen were applied as basal and top dressing at R5 stage. The experiment was laid out in strip plot design with three replications. The results revealed that the maximum plant height, branches/plant, pods/plant, seed yield/plant, seed index, agronomic and recovery efficiency, PFP, N uptake, additional yield and returns and IBCR was with BBF system. Soybean yield was higher under BBF (11.86%) as compared to FB system. The higher values of plant height, branches/plant pods/plant, straw yield, N use efficiencies, additional yield and returns and IBCR were recorded in JS 97-52. Variety JS 97-52 gave higher yield (200.8%) than JS 95-60. Soybean yield increased along with the N levels. Further enhancement was recorded when nitrogen applied in splits. The application of nitrogen as basal increased seed yield to the tune of 9.1 and 18.5% due to 20 and 40 kg N/ha respectively. The split application of nitrogen increased the yield to the tune of 4.6, 15.8 and 27.2% due to 10+10, 20+20 and 20+40 kg N/ha respectively as compared to the recommended dose of nitrogen. However, N use efficiency decreased as the levels increased. The highest net returns and incremental cost benefit ratio (IBCR) was recorded with 20+40 kg N/ha.

2.2.3. System Efficiency Enhancement through Conservation Technologies

A long term field trial was conducted involving seven rotational tillage systems namely, conventional-reduced (CR-CR-CR-CR), CR-RR-CR-RR, CR-RR-RR-CR, CR-RR-RR-RR, RR-RR-RR-RR, SRR(single reduced tillage) and sub soiling and three soybean based cropping systems [soybean-wheat (S-W), soybean-chickpea (S-C) and soybean-mustard (S-M)]. The project was initiated during the 2009 *kharif* and the tillage treatments have been stabilized in due course of time for actual assessment of tillage impact on system productivity. The fifth year trial (2012-13) results revealed that the highest soybean yield was recorded under conventional tillage carried out after every two years and remained at par with conventional tillage alternate year and every year. Reduced tillage like every year cultivator (double), cultivator every year (only in *kharif*) and sub soiling once in four year behaved identical. A similar trend was also observed in straw yield and harvest index of soybean. Plant height, branches/plant, pods/plant seed yield/plant and seed index behaved in same fashion as was observed in seed yield of soybean. Soybean yield remained unaffected due to cropping system, however, marginally higher yield was recorded when chickpea was grown in *rabi* season. Significantly highest straw yield was recorded when preceding crop was wheat. However, the maximum harvest index was observed when preceding crop was chickpea. The remaining all the parameters followed the same trend as was observed in seed yield.

2.2.4. Online Data Management System for AICRPS Agronomy Trial Data

Preliminary prototype of the online data entry system for AICRPS Agronomy trial data system was developed. ASP.NET development tool provided in Visual Studio.NET was used for the development of the system. The prototype system contains modules for main data entry and footer data entry of the factorial design trials. Main data includes data of different agronomy trials. Footer data includes standard error of means (SEM) and critical difference (CD) for main factors and their interactions. It has separate modules for management of users having different authorizations-administrator and data entry operator. It also provides online registration form for new users.

The web forms for master database tables; zone, trial, character, treatments, locations, *etc*. were completed to facilitate the AICRPS agronomy Principal Investigator to add, edit and delete the above mentioned data in the respective database tables. The data entry form for factorial design was completed. Using this web form the user can add, edit and delete the AICRPS agronomy trial data from different locations for all the trials having factorial design.

The database tables were developed to store data pertaining to the zones, trials, trial designs, treatments, characters, main data and footer data of different replications. Different primary and foreign keys were identified and defined during the development of the database. Different stored procedures were written using SQL language to get the desired data by applying different SQL queries. These stored procedures were tested on SQL server using the historical databases

2.2.5. Growth, Rhizosphere Properties, P Acquisition and Mobilization of Intercropped Soybean and Maize in Soil Amended with Phosphate

2.2.5.1. Influence of different doses of inorganic phosphorus

A study was conducted to assess the changes in rhizosphere properties, soil P transformation and P-use efficiency under soybean-maize intercropping system as influenced by different doses of inorganic phosphorus. In both sole soybean and sole maize dry matter accumulation at 50 DAS was found to be significantly increased with increasing the dose of applied P. However, in intercropped soybean the dry matter accumulation decreased as compared to sole soybean. In intercropped maize the dry matter accumulation increased as compared to the sole soybean. It has been observed that in both sole and intercropping, dry matter accumulation increased with increasing level of P application. Nodule number and dry weight were found to be significantly higher in sole soybean as compared to intercropped soybean. Application of 39 kg P/ha decreased nodule number and dry weight. P concentration in shoot and root were found to be significantly higher in intercrop soybean/maize as compared to sole cropping.

Rhizosphere pH decreased in both sole cropping as well as in intercrop and with increase

in P levels. The rhizosphere pH decreased to 7.76, 7.72, 7.70 and 7.67 with application of inorganic P at 39 kg/ha as compared to 7.90, 7.82, 7.82 and 7.78 in sole soybean, intercrop soybean, sole maize and intercrop maize, respectively in control. Rhizosphere enzyme activities, auxin production, microbial respiration and microbial biomass-P were found to be higher in intercropping system as compared to sole cropping. Acid phosphatase activity was found to be higher with application of 39 kg P/ha. The increase with application of 39 kg P/ha was 18.4, 24.5, 22.7 and 27.6% over control in sole soybean, intercrop soybean, sole maize and intercrop maize, respectively. Similarly, the increase in alkaline phosphatase was to an extent of 18.7, 20.3, 15.7, and 17.9 % over control. The increase in glucosidase activity was 21.4, 22.89, 29.5 and 28.0% while dehydrogenase activity was 21.0, 24.5, 15.6 and 19.6% in sole soybean, intercrop soybean, sole maize and intercrop maize, respectively with application of 39 kg P/ha over control.

Application of P significantly increased seed yield as compared to control. Highest seed yield was recorded with 39 kg P/ha and the increase was 12.5, 15.6, 18.5 and 21.6% in sole soybean, intercrop soybean, sole maize and intercrop maize, respectively over control and 8.6, 10.3, 12.2 and 14.9% over application of 26 kg P/ha.

Application of P significantly increased P content in seed and straw irrespective of the cropping system. Maximum P content was observed with the application of 39 kg P/ha. Application of P at 39 kg P/ha significantly increased available P content in intercropped maize and soybean. Agronomic use efficiency was found to be higher in intercrop soybean and sole maize with the application of 26 kg P/ha and higher as compared to application of 39 kg P/ha.

2.2.6. Soil Microorganisms for Higher Productivity of Soybean

At DSR mass multiplication of predominant niche AM fungi (AMF) is being carried out through pot cultures (in various substrates), aeroponic and root organ culture techniques. The interaction of AMF with other PGPR strains for soybean growth promotion and mineral nutrition is also being studied.

2.2.6.1. Co-inoculation of phytate mineralizing and phosphate solubilizing *Bacillus aryabhattai* strain MDSR14 with AM fungi

P mobilizing traits of *Bacillus aryabhattai* (strain MDSR14) and AM fungi (AMF) co-inoculation were evaluated in soybean-maize cropping system. Co-inoculation with *B. aryabhattai* and AMF significantly increased dry matter accumulation (root and shoot), nodule number and dry weight; improved rhizosphere properties (rhizosphere pH, acid and alkaline phosphatases, dehydrogenase , glucosidase, auxin content, microbial respiration and biomass) in soybean+maize as compared to sole cropping. Higher spore density, root mycorrhizal colonization and glomalin content were observed with co-inoculation of *B. aryabhattai* and AMF under soybean+maize system. There was concomitant depletion in native organic P ($NaHCO_3$-Po and NaOH-Po) and acid

extractable–P (HCl-P) and increase in inorganic P ($NaHCO_3$-Pi and NaOH-Pi) in rhizosphere soil with co-inoculation of B. *aryabhattai* and AMF under soybean+maize indicating their role in mobilization of native unavailable organic P and inorganic insoluble-P pool of soil to available P.

Highest soybean and maize yield was also registered with co-inoculation of *B. aryabhattai* and AMF. Co-inoculation of *B. aryabhattai* and AMF improved P use efficiencies. Co-inoculation of *B. aryabhattai* and AMF also increased zinc and iron content in seeds of soybean and maize under soybean+maize system and decreased phytic acid/Zn and Phytic acid/Fe molar ratios indicating that AMF and PGPR can be utilized as suitable candidates for biofertilization and biofortification purposes.

16s rRNA gene sequences of *B. thuringiensis* JUKD-2 (NCBI Accession KC469973), *Bacillus cereus* KMR-5 (NCBI Accession KC469972), *B. cereus* BHKD-6 (KC478355), *B. cereus* MUKD-2 (KC478357), *B. cereus* DBU-5 (KC478359), *B. cereus* BBU-5 (KC491180), *B. cereus* KKS-2 (KC491182), *B. cereus* KKH-1 (KC491183), *B. subtilis* subsp. *inaquosorum* strain KKI-4 (KC771226) rhizobacterial strains were submitted to NCBI.

Microbial cultures of isolates, *B. aryabhattai* MDSR14 (MCC2207), *B. tequilensis* JUKD-5 (MCC2208), *B. sp.MDSR11* (MCC2209), *B. thuringeinsis* KKI-6 (MCC2095), *B. cereus* KMR-5 (MCC 2236), *B. thuringiensis* JUKD-2 (MCC2237), *B. cereus* MUKD-2 (MCC2240) were deposited with Microbial Culture Collection (MCC), National Centre for Cell Science (NCCS), Pune.

B. aryabhattai MDSR7 (NAIMCC-B-01440), *B. aryabhattai* MDSR11 (NAIMCC-B-01441), *B. aryabhattai* MDSR14 (NAIMCC-B-01442), *B. endophyticus* MDSR34 (NAIMCC-B-01442), *Burkholderia arboris* NKD-11 (NAIMCC-B-01383), *Acinetobacter calcoaceticus* BK-5 (NAIMCC-B-01384), *Pseudomonas aeuginosa* FU-2 (NAIMCC-B-01386), *P. aeuginosa* PPI-5 (NAIMCC-B-01387), *P. aeuginosa* RI-1 (NAIMCC-B-01389), *P. aeuginosa* DKH-3 (NAIMCC-B-01390), *P. mosselii* KDH-3 (NAIMCC-B-01385), *B. thuringiensis* KKI-6 (NAIMCC-B-01391), *B. tequilensis* JUKD-5 (NAIMCC-B-01392), *B. cereus* MUKD-4 (NAIMCC-B-01393) cultures were deposited with National Agriculturally important Microbial culture collection (NAIMCC), NBAIM, Mau, India.

2.2.6.2. Isolation of niche AMF from soybean rhizosphere maintained under long term organic agricultural system

The investigation was aimed to study the impact of organic farming practices on soybean production. Higher population of AMF (3.2 spores/g soil) was observed in plots maintained under organic farming practices irrespective of cropping system. In order to identify the most frequently occurring AMF species in soybean rhizosphere of organic system were multiplied on *Trigonella* sp. (*methi*). Spore density of 16-20 g^{-1} soil was obtained in *Trigonella* sp. trap which is being used further for mass production using different soybean substrates.

2.2.6.3. Optimization of method for assessing live biomass of AMF through signature fatty acids

Phospholipid fatty acid (PLFA) analysis has been used to study soil microbial community responses to agricultural management systems. High throughput method was used for extraction of lipids in soil and roots using internal standard 19:0 and carried out extraction of AMF biomarker 16:1w5 neutral and phospholipids lipids in soil and root samples. The elution of lipid extracts of either soil or root samples with two times chloroform have been found to be optimum to recover whole NLFA fractions. Further elution/third fraction of chloroform did not have NLFA fractions. About 20 to 35 mg root samples (ground in liquid nitrogen and freeze dried) were found to be appropriate to recover neutral lipids. As an alternate method for phospholipids and neutral lipids, a simple easy direct trans-esterification method called ester-linked fatty acid methyl ester (EL-FAME) was also used and quantified 16:1w5 fatty acid. An Agilent (Agilent Technologies, Wilmington, DE, USA) 6890 gas chromatograph (GC) equipped with auto sampler, split–split less inlet, and flame ionization detector was used. The system was controlled with MIS Sherlock® (MIDI, Inc., Newark, DE, USA) and Agilent ChemStation software. FAMEs were separated on an Agilent Ultra 2 column, 25 m long × 0.2 mm internal diameter × 0.33 µm film thickness. A split ratio of 40:1 was used with hydrogen carrier gas at 1.2 ml/min constant flow rate. Initial oven temperature was 190 C, ramping to 285 C at 10 C /min and then to 310 C at 60 C /min, followed by a hold at 310 C for 2 min. Injector temperature was 250 C and detector temperature was 300 C. FAMEs were identified using the MIDI PLFAD1 calibration mix and naming table.

2.2.7. Growth and Variability in Soybean Yield in India

The stability and growth trend in the productivity of soybean in India since its commercial introduction was analyzed to understand the underlying factors. National soybean productivity is on the increasing trend though at a slower pace. The productivity of soybean in India during its initial phase of introduction (1970-71) was 425 kg ha^{-1}, which has gradually increased to 1186 kg ha^{-1} by the TE 2012 almost treble. State-wise analysis reveals that, the highest productivity of 1400 kg ha^{-1} was found in Rajasthan during the TE 2012, which has increased from 533 kg ha^{-1} during the TE 1982 (Table 19). However, the soybean yield levels had shown a declining trend in the states like Andhra Pradesh, Uttar Pradesh and Gujarat during the TE 2002 as compared to the TE 1992, but recovered in recent decade. Growth in soybean yield was highest during the decadal years of 1981-1991 in all the soybean growing states. It is important to note that, with the constant research and extension efforts in the country, the growth in the soybean yield has increased in the recent decade.

Instability in soybean yields was found to be high at both the state (21 to 43 per cent) as well as the national level (about 20 per cent). In addition, the trend in soybean yield instability over the decades in all the soybean growing states is on an increase, which is a point of concern for

the policy makers and researchers. One of the important factors responsible is the erratic and changing rainfall pattern, as the crop is mainly grown under rain-fed conditions in the semi-arid tracts of the country.

2.2.8. Geoinformatic Analysis of Expansion in Area Under Soybean Cultivation in India Since its Commercial Introduction

To understand the patterns of soybean expansion in the country, GIS (Geographic Information System) was used to analyze the district-wise data on area, production, productivity of major *kharif* crops of six major soybean growing states. These states together account for more than 95 per cent of the national soybean acreage. GIS was used to prepare decadal thematic maps (Fig. 20 & 21). Spatial analysis shows that soybean area in seventies was concentrated mainly in western Madhya Pradesh (MP), Chhattisgarh (CG) (61 districts) and adjoining 7 districts of Rajasthan (RJ). During 1982-84 the area under soybean was 0.47 mha and rapidly occupied the fallow land that were existing in these regions. In 80's the area under soybean cultivation increased to 2.18 mha (1988-90) and spread mainly to MP, Maharashtra (MH) and RJ and to Karnataka (KA) to a small extent. In this decade soybean replaced sorghum and cotton. In 90's, area under soybean increased rapidly in the states of MP, MH and RJ. However, in the states of KA and Andhra Pradesh (AP) the increase was meager. In 1998-00 national soybean acreage was 6.38 mha. During this decade soybean replaced mainly sorghum, groundnut, and bajra. In the first decade of 21st century, soybean area further increased in all the six major soybean growing states (MP, CG, MH, RJ, AP, and KA) with higher percentage increase in CG, MH, and AP. In 2008-10 national soybean acreage was 10.87 mha. During this decade also soybean mainly replaced sorghum, bajra, and groundnut. In the last two decades expansion of area under soybean is more rapid in the states of MH, AP and KA as compared to MP, CG and RJ.

2.2.9. Development of Implements for Mechanization of Soybean Cultivation

2.2.9.1. Design, development and validation of tractor operated disc harrow for vertisols.

Initial study of tractor operated disc harrow for tillage in soybean in vertisols showed great promise. The discs of 8 mm specification and total weight of the machine along with gang angle have been found to be incorporated for the prototype of the machine to be manufactured. Front discs need to be notched/cutaway for better elimination of weeds.

2.2.9.2. Design, development and validation of tractor operated rotary weeder for soybean

Initial study of tractor operated rotary weeder for soybean has indicated that horizontal blades or vertical blades can be considered for the prototype of the machine to be manufactured.

2.2.9.3. Subsoiler developed and tested

A tractor operated subsoiler was developed and tested. The machine is 70 PTO hp tractor drawn. In this machine the depth of 2.5 feet is achieved. This machine is very useful to manage and eliminate the deep rooted weeds and insect control besides preventing inundation due to excessive rainfall (Fig. 22).

2.2.9.4. Prototypes of the machines already commercialized

- Seed planter (Fig. 23)

2.2.9.5. Prototypes of the machines ready for commercialization

- Ridge Ferti-seed drill
- Single ridge-seed drill
- Seed drill cum planter (Two in one) (Fig. 24)
- Tractor PTO operated Farm yard manure spreading trailer
- Inter crop seed drill cum planter with BBF system (Fig. 25)

Table 19. Growth and instability in yield of soybean in major states

States	Andhra Pradesh	Madhya Pradesh & Chhattisgarh	Karnataka	Maharashtra	Rajasthan	Uttar Pradesh & Uttarakand	Gujarat	All India
Yield (kg/ha)								
TE 1982		702			533	629	364	681
TE 1992	1286	865	514	800	877	1280	839	862
TE 2002	989	891	884	1253	981	740	810	965
TE 2012	1345	1171	726	1197	1400	1374	803	1186
Compound Annual Growth Rate (%)								
1981-1991		2.4			6.8	7.9	11.4	2.6
1991-2001	-0.9	1.0	5.0	4.4	0.3	-8.7	2.4	1.6
2001-2011	1.8	5.3	-0.5	-1.4	4.1	6.5	-0.3	3.3
1980-2012	2.3	1.6	1.9	3.1	2.5	1.3	1.9	1.8
Coefficient of Variation (%)								
1981-1991		22.7			28.5	16.2	62.6	19.9
1991-2001	20.5	18.1	41.1	28.3	30.5	39.4	20.4	17.5
2001-2011	35.3	25.3	34.3	35.8	49.4	24.4	32.0	24.2
1980-2012	29.5	21.3	43.4	32.4	36.0	27.8	41.7	19.7

Fig. 20. Thematic map prepared using GIS for the area under soybean cultivation during 1982-84, 1 dot = 100 ha

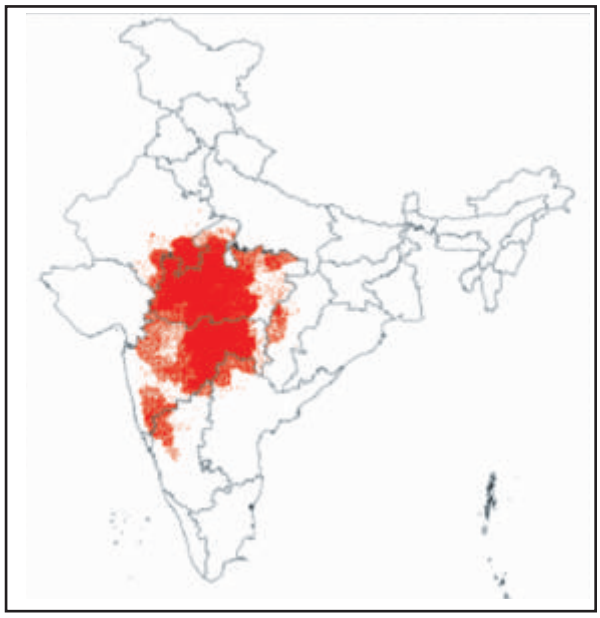


Fig. 21. Thematic map prepared using GIS for the area under soybean cultivation during 1982-84, 1 dot = 100 ha

Fig. 22. Sub soiler developed at DSR, Indore

Fig. 23. Crop sown with soybean seed planter

Fig. 24. Two in one (Soybean seed drill cum planter)

Fig. 25. BBF planter sown crop (new variant of BBF seed drill)

2.3 CROP PROTECTION

2.3.1. Conservation and Enhancement of Natural Enemies of Soybean through Habitat Diversification

2.3.1.1. Influence of vegetational diversity on soybean pest incidence

Anethum graveolens (suwa) was found to be a preferred host for soybean semilooper (*Chrysodeixis acuta*) (8.25 and 11.35 larvae per meter crop row) as compared to soybean (1.08 and 2.11 larvae per meter crop row) before and after the peak population period respectively. However, during the peak population period such discrimination was not observed. With respect to stemfly, stem tunneling was significantly lower in the treatment soybean + marigold (50.08%) as compared to soybean alone (75.1%).

2.3.1.2. Identification of spider fauna in soybean canopy

Ground dwelling spider fauna in soybean crop canopy was sampled using 'pit fall traps' and identified. Eleven ground dwelling spider species belonging to seven families namely, Lycosidae, Salticidae, Filistatidae, Corinnidae, Zodariidae, Pisauridae, and Gnaphosidae were identified. *Pardosa* sp. (Lycosidae) was found to be the most predominant spider species in soybean crop canopy

2.3.2. Field Evaluation of Entomopathogenic Fungi against Soybean Defoliators

A field trial was conducted at the Research Farm of Directorate of Soybean Research (ICAR), Indore during *kharif* 2013 to evaluate the efficacy of native strains of *Beauveria bassiana* against major soybean lepidopteron defoliators namely, *Chrysodeixis acuta* (Walker), *Diachrysia orichalcea* (Fabricius), *Gesonia gemma* Swinhoe, and *Spodoptera litura* (Fabricius). There were seven treatments consisting of six *B. bassiana* strains (four of DSR, Indore, one of NBAII, Bengaluru, one commercial strain) and untreated control. One aqueous spray of 10^8 spores/ml was applied at pod initiation stage. Observations were recorded seven days after spraying for number of larvae for meter crop row length (mrl) and yield at harvest.

Treatment effects were not significant and *B. bassiana* infection was not observed in the field. However, in treatment DSRBB5 lower semiloopers population (0.33per mrl) was recorded as compared to the control (0.67 per mrl). The population of *G. gemma* larvae was lower in all the treatments as compared to control (2.22 per mrl) and in the treatment DSRBB1 lowest population (0.22 per mrl) was recorded. The same treatment was also found to be free from *S. litura* infestation. Though treatment effects on grain yield were not significant, all the treatments yielded higher as compared to the control (291 Kg ha^{-1}), highest being recorded in DSRBB3 (423 Kg ha^{-1}) followed by the commercial strain (402 Kg ha^{-1}).

2.3.3. Interactive Effects of Strains of *Trichoderma* and *Pseudomonas* for the Management of Sclerotium Blight of Soybean Under Field Condition.

A field experiment comprising of 16 treatments of potential native antagonistic strains of *Pseudomonas*, *Trichoderma*, their

combinations and three controls (Table 20) was undertaken for third consecutive year for the management of Sclerotium blight in soybean. After 15 days after the inoculation of sowing furrows with *S. rolfsii* (10^5 CFU g^{-1} of selective medium), talc based antagonists and/or consortium treated seeds were sown @1250 seeds per plot at a depth of 1.5 cm. Daily count on emergence of seedlings was done up to 10 days after sowing (DAS). Seedling mortality up to 65 (DAS) was also recorded.

Study conducted in the year 2013 revealed that the germination though was highest in thiram + carboxin control (treated check), it was similar to the germination in strain RI-1 of *Pseudomonas, Trs 1 of T. viride,* combination of RI-1+Trs-1, Trs-1+Trs-6 of T. *harzianum*, Trs-6+RI-1, Trs-6+Trs-1+RI-1, Trs-1+PPI-5 of *Pseudomonas and RI-1*+KDH-3 of *Pseudomonas (Table 20). Pre-emergence mortality was significantly lower with RI-1 strain. Post-emergence mortality with RI-1 strain though was minimum and significantly lower than with the treated check but comparable with KDH-3, Trs-1+Trs-6, Trs-6+Trs-1+RI-1.* Collar rot induced total mortality (pre- and post-emergence) was significantly low in RI-1. Total mortality with treated check was at par with those of all other treatments involving bio-control agents (BCAs). Seed index with RI-1 was higher but at par with treated check and many other BCAs. With RI-1 yield was also the maximum and significantly higher than treated check, but at par with BCAs like Trs-1+Trs-6+RI-1, Trs-1+PPI-5, RI-1+KDH-3, However, yield levels in treated check was at par with all other rest treatments except KDH-3.

Pooled analysis of three years data also established the supremacy of RI-1 strain (13.2% lower total mortality and 21.7% higher yield than recommended treated check). This strain and combination of strains Trs-1+Trs-6 performed better than treated (seed treatment with thiram+carboxin). Combinations of PPI-5+RI-1 and Trs-1+PPI-5 also performed better, almost equal to treated check.

2.3.4. Biology, Epidemiology and Management of Stem Blight Disease of Soybean

2.3.4.1. Isolation of the pathogen

Samples of soybean stems/pods showing blight symptoms were collected from Amrawati, Dharwad, Palampur and Umiam for isolating the causal organism. From all the samples *Colletotrichum truncatum was isolated except from* Dharwad sample which yielded *C. gloeospoeum*.

2.3.4.2. Disease appearance

The disease appeared first in the petioles and leaf veins at flowering (R2 stage). Under high humidity (>90 %) and temperature (25 -30 ^{0}C) conditions necrosis appeared first in leaf veins followed by stems and pods. In susceptible varieties/lines the plants get dried and die within 20-30 days after infection.

2.3.4.3. Role of seed and soil borne inoculum in the disease development

A pot experiment was conducted with infected seeds sown in healthy soil, healthy seeds sown in infected soil, and healthy seeds sown in

Table 20. Influence of bio-control agents and their consortium on germination, Sclerotium blight induced mortality

S. No.	Treatment/ Bio-agent	Seedling emergence (%)		Pre-emergence mortality (%)		Post-emergence mortality (%)		Total mortality (%)		Seed index(g)		Yield q/ha	
		2013	Pooled#	2013	Pooled	2013	Pooled	2013	Pooled	2013	Pooled	2013	Pooled
1	RI-1	59.65 (50.57)*	38.19 (38.17)*	2.70 (9.41)*	6.21 (14.43)*	9.00 (17.44)*	20.94 (27.23)*	5.87 (14.00)*	21.47 (27.60)*	9.15	9.64	4.370	5.017
2	PPI-5	50.98 (45.56)	32.21 (34.58)	11.36 (19.69)	18.56 (25.52)	14.00 (21.96)	26.74 (31.14)	12.68 (20.86)	32.63 (34.84)	7.76	8.34	2.963	3.144
3	KDH-3	52.00 (46.15)	33.85 (35.58)	10.35 (18.65)	15.79 (23.41)	10.33 (18.72)	26.25 (30.82)	9.69 (18.10)	31.44 (34.11)	8.22	8.78	2.580	3.062
4	Trs-1	51.76 (46.97)	37.28 (37.63)	10.58 (18.93)	12.36 (20.58)	14.85 (22.63)	24.79 (29.86)	12.71 (20.87)	26.63 (31.10)	8.43	9.01	3.017	4.018
5	Trs-6	51.23 (45.71)	34.17 (35.77)	11.12 (19.42)	16.29 (23.80)	11.66 (19.97)	22.92 (28.60)	11.89 (20.14)	28.00 (31.95)	8.46	8.98	3.093	3.762
6	Trs-1+Trs-6	55.13 (47.95)	37.78 (37.93)	7.22 (15.46)	10.12 (18.55)	10.33 (18.75)	21.03 (27.30)	8.77 (17.89)	22.89 (28.58)	8.60	9.57	3.287	4.642
7	Trs-1+RI-1	56.33 (48.64)	35.21 (36.40)	6.10 (14.10)	14.36 (22.27)	13.66 (21.69)	26.00 930.66)	9.84 (18.26)	29.72 (33.10)	8.75	8.72	3.443	3.693
8	Trs-6+RI-1	54.00 (48.45)	33.10 (35.12)	6.35 (14.38)	17.12 (24.44)	12.33 (20.54)	22.18 (28.10)	9.34 (17.73)	28.27 (32.12)	8.75	8.88	3.413	3.352
9	TRS-1+Trs-6+ RI-1	55.83 (48.36)	34.59 (36.0)	6.52 (14.13)	15.05 (22.83)	10.11 (18.54)	22.04 (28.00)	9.17 (17.55)	27.03 (31.33)	8.93	8.98	4.263	3.938
10	Trs-1+PPI-5	56.63 (48.81)	36.79 (37.34)	5.72 (37.34)	12.23 (20.47)	14.33 (22.24)	24.26 (29.51)	10.10 (18.44)	26.62 (31.10)	8.15	8.92	3.637	4.314
11	Trs-6+PPI-5	50.08 (45.10)	33.39 (35.30)	12.26 (20.49)	16.89 (24.27)	13.36 (21.43)	26.92 (31.25)	12.82 (20.97)	31.74 (34.29)	7.80	8.47	2.950	3.171
12	Trs-1+KDH-3	50.30 (45.17)	33.24 (35.21)	12.05 (20.26)	18.72 (25.64)	14.33 (22.24)	27.64 (31.72)	20.00 (21.27)	32.07 (34.49)	7.86	8.47	3.057	3.876
13	Trs-6+KDH-3	52.58 (46.48)	33.03 (35.10)	9.76 (18.12)	17.58 (24.79)	12.20 (20.43)	25.83 (30.55)	10.98 (19.32)	31.38 (34.10)	8.39	8.59	3.210	3.390
14	PPI-5+RI-1	50.86 (45.50)	37.20 (37.58)	11.48 (19.81)	11.15 (19.51)	15.66 (23.31)	24.86 (29.91)	13.57 (21.62)	26.28 (30.84)	7.96	8.86	3.097	3.860
15	RI-1+KDH-3	55.92 (48.40)	34.81 (36.16)	8.76 (17.21)	15.74 (23.37)	12.38 (20.60)	25.48 (30.32)	10.30 (19.64)	30.00 (33.21)	8.60	9.44	3.567	4.640
16	PPI-5+KDH-3	50.30 (45.17)	33.02 (35.10)	11.72 (20.00)	17.88 (25.10)	14.00 (21.97)	23.17 (28.77)	12.86 (21.10)	29.01 (32.60)	7.60	9.10	2.857	3.443
17	Thiram+Carboxin	62.35 (52.15)	40.89 (39.75)	- -	- -	12.60 (20.75)	24.75 (29.83)	12.60 (20.75)	24.75 (29.83)	8.72	9.67	3.407	4.123
18	Abs. Control No *Sclerotiom*	53.73 (47.14)	37.23 (37.60)	12.23 (20.42)	13.27 (21.36)	11.56 (19.88)	22.31 (28.19)	23.80 (29.18)	28.40 (32.20)	8.15	8.96	3.163	3.882
19	Abs. Control + *Sclerotiom*	45.86 (42.63)	31.71 (34.27)	20.23 (26.69)	21.04 (27.30)	28.30 (32.11)	32.99 (35.10)	48.53 (44.16)	42.77 (40.84)	7.38	7.81	2.240	2.422
	CD at 5% Treatment	3.82	3.65	3.38	5.68	2.29	4.32	3.41	6.27	0.55	0.66	0.823	0.80
	Year		2.11		3.28		2.49		3.62		0.38		0.46
	Treatment x Year		0.84		1.31		0.99		1.44		0.15		0.18

*arc-sine transformed values; # Pooled analysis of 2011, 2012 and 2013

sterilized soil. Data revealed that infected seeds either did not germinate or died within 15 days after germination. In infected soil the seeds germinated and only six per cent plants developed anthracnose symptoms and died prematurely, whereas in case of control the seed germination was unaffected and disease development did not appear till maturity. This showed that the disease is mostly seed borne (Table 21). Inoculated and un-inoculated seeds were used to determine the effect on seed germination. With un-inoculated seeds germination was 55 per cent, whereas in inoculated seeds it was 18 per cent.

2.3.4.4. DNA finger printing and variability studies of *Colletotrichum truncatum*

The protocol for isolating DNA from C. *truncatum* was standardized for finger printing and variability studies. PCR primers were designed using the genes which are specific to the *C. truncatum* and also from the internal transcribed spacer (ITS) region of 18S ribosomal gene. PCR conditions are being standardized. In addition to gene specific and ITS primers, inter-simple sequence repeat (ISSR) is also being used for fingerprinting of C. truncatum (Fig. 26). Amplifications of *Colletotrichum truncatum* were observed based on AG, TC and CA repeat based ISSR markers. PCR primers were designed to amplify *C. truncatum* based the conserved expressed sequences (EST). The amplification of expected size was observed using three different EST based primers and was specific to *C. truncatum.*

2.3.4.5. Yield loss assessment

A field experiment was conducted with soybean cultivar NRC 7 to assess the yield losses due to anthracnose/pod blight disease. Benomyl 50WP which was found effective against *C. truncatum in vitro* has been sprayed @ 0.2%. First treatment received spray after 20 days of sowing (DAS), second treatment received two sprays at 20 and 35-40 DAS and in third treatment three sprayings were done at 20 DAS, flowering and pod formation. Un-sprayed treatment served as a control. Disease incidence was recorded 10 days after last spraying. Yield per plot and disease incidence were recorded. The data revealed that the disease can cause up to 48% yield loss under field conditions (Fig. 27).

2.3.4.6. Field evaluation of chemical and bio-control agents against anthracnose and pod blight

A field experiments was conducted in randomized block design with three replicates using soybean variety NRC 7 under field conditions. There were 20 treatments, which includes seed treatment alone with fungicides/bio-agents and with spraying of fungicides at R2 stage and 21 days after first spray. Observations on germination, total number of plants and anthracnose/pod blight affected plants were recorded.

As compared to control all the treatments were effective, and reduced the disease except seed treatment (ST) with *Pseudomonas fluorescence*. ST alone was less effective than ST+fungicide sprays. ST with carboxin + fungicide sprays showed better results than seed treatment alone and ST with bioagents plus spraying of fungicides. Among seed treatment

with carboxin coupled with fungicides spray, the best control was observed with spraying of captan/mixture of kasugamycin + coc / carbendazim/benomyl/thiophanate methyl. Spraying of mixture of kasugamycin+coc showed consistently good result both either seed treatment with carboxin or St with Tv (Table 23). As compared to untreated control and St with Tv and St with Pf, chemical St plus fungicide spray had increased pods/plant, yield/plant and 100 seed weigh (Table 22).

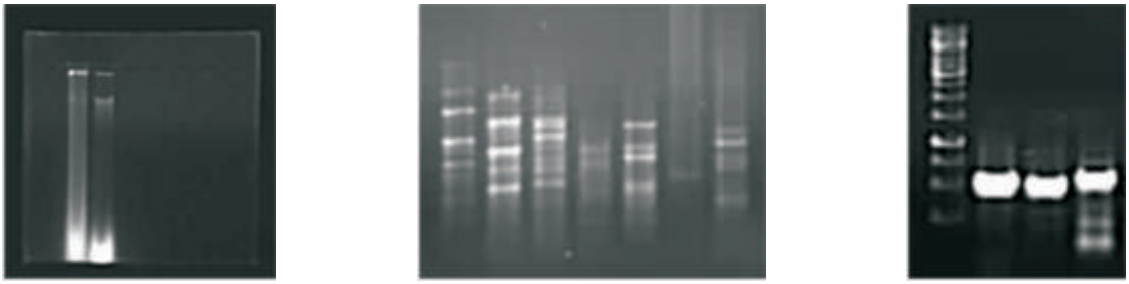


Fig. 26. DNA isolated from *C. truncatum*

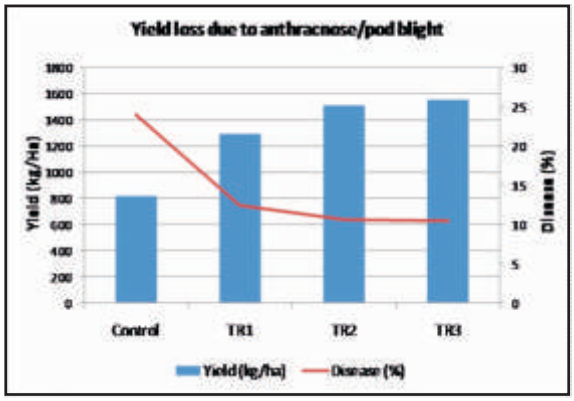


Fig. 27. Yield losses due to soybean anthracnose

Table 21. Effect of source of inoculum on the development of soybean anthracnose/pod blight disease

Treatment	Germination (%)	Seedling mortality		Disease (%)
		Pre-emergence	Post-emergence	
Inoculated seeds sown in uninfected soil	15.0	34	6	100
Healthy seeds sown in infected soil	82.5	7	2	6
Healthy seeds sown in sterilized soil	95.0	0	0	0

Table 22. Effect of fungicides on disease incidence and yield contributing characters

Treatment	Plant stand ($16.2m^2$)	Plant height (cm)	Br/pl	Number of Pods/pl	Unfilled pods/pl	Yield (kg/ha)	Seed index	Disease (%)
Control	384	32.8	1.6	25.0	11.7	814.8	7.5	14.4
Seed Treatment carboxim + thiram (VV) @ 3g/kg seed	445	37.6	2.1	30.0	11.3	937.8	7.6	10.5
Seed Treatment Tv@5g/kg seed	394	32.7	1.9	28.3	11.3	878.7	7.8	11.6
Seed Treatment Ps.flu. 5g/kg seed	305	38.0	2.5	26.3	11.0	869.3	8.0	14.1
T1+carbendazim @ 0.1%	500	35.8	2.7	35.7	4.3	1512.4	8.8	6.4
T1+Propiconazole @0.1%	516	33.6	2.3	32.0	4.7	875.2	8.5	6.6
T1+Benomyl @0.1%	524	35.1	2.5	34.3	5.7	1550.7	8.9	6.3
T1+Pyroclostrobin @0.1%	519	36.2	1.9	26.7	6.3	1000.6	8.2	7.5
T1+Thiophanate-Methyl @0.2%	518	37.6	2.3	31.7	6.3	1291.5	8.5	6.0
T1+Hexaconazole @0.1%	550	34.6	2.3	31.3	6.0	1041.8	8.8	6.5
T1+Captan @ 0.2%	596	37.5	2.0	32.3	6.0	1213.7	8.7	5.1
T1+Kasugamycin+COC @0.3%	535	37.8	2.8	35.0	4.3	1622.7	9.0	6.0
T2+Carbendazim @0.1%	524	35.9	2.9	36.7	6.0	1530.7	9.9	6.1
T2+ Propiconazole @0.1%	437	35.2	1.9	26.3	8.7	1032.4	7.9	7.9
T2+Benomyl @0.1%	477	38.3	2.5	37.3	6.3	1634.6	9.9	7.8
T2+ Pyroclostrobin @0.1%	431	34.9	1.9	25.3	5.0	1051.7	8.4	9.3
T2+Thiophanate Methyl @0.2%	477	38.9	2.8	36.0	6.3	1340.8	8.6	7.3
T2+Hexaconazole @0.1%	486	35.8	1.9	33.3	5.7	958.7	8.7	7.5
T2+Captan @ 0.2%	519	36.7	2.3	36.3	5.0	1040.3	8.4	6.1
T2+Kasugamycin+COC @0.3%	493	36.9	2.5	36.3	6.0	1553.7	9.7	6.5
LSD (5%)	**98.0**	**2.9**	**0.8**	**3.8**	**2.2**	**215.7**	**0.8**	**2.4**

2.3.4.7. Evaluation of soybean varieties against *C. truncatum*

Ninety seven soybean cultivars were evaluated for their reaction towards *C. truncatum.* Three leaves from each variety were collected randomly from field grown plants at flowering and after removing the leaflets, petioles were kept in a sterilized wet plate (150 mm). Each petiole was inoculated with 10–days old 5 mm culture disc of *C. truncatum* and was incubated at room temperature for 6 days. In control treatment 5 mm PDA disc without inoculum was used. The browning/growth of the fungus on the petioles indicated a susceptible reaction and no browning/growth of the fungus on the petiole indicated a resistant reaction. Out of 97 varieties tested only 12 showed moderate resistance reaction (Table 23 and 24).

Table 23. Soybean varieties showing susceptible reaction to against *C. truncatum* (artificial inoculation)

ADT 1	JS 71-05	MAUS 1	PK 416	Pusa 40
Alankar	JS 75-40	MAUS 2	PK 471	Pusa 97-12
Ankur	JS 76-205	MAUS 32	PK262	Pusa 98-14
Bragg	JS 80-21	MAUS 47	PK327	RAUS 5
BS-1	JS 90 41	MAUS 61	PK472	RKS 18
CO Soya 2	JS 93-05	MAUS 61-2	PRS 1	RKS 24
CO Soya 3	JS 97-52	MAUS 71	PS 1024	Shivalik
CO-1	Kalitur	MAUS 79	PS 1029	SL 295
DS 228	Karuna	MAUS 81	PS 1092	SL 525
Durga	KB 79	MAUS 158	PS1042	SL 688
Gaurav	Lee	Monetta	PS1225	SL 96
GS 2	LSB 1	NRC 2	PS1241	T 49
Harasoya	MACS 57	NRC 37	PS564	TAMS 98-21
Improved Pellican	MACS 58	NRC 7	Pusa 16	VLS 2
Indira Soya 9	MACS 124	NRC 7	Pusa 20	VLS 21
JS 2	MACS 13	NRC 12	Pusa 22	VLS 47
JS 335	MACS 450	Pb 1	Pusa 24	VLS 65

Table 24. Soybean varieties showing moderately resistant reaction to *C.truncatum* (artificial inoculation)

GS 1	JS 79-811	PS 1347	Shilajeet
Hardee	LSB 1	Pusa 37	TAMS 38
JS 95-60	Palam soya	RVS 2001-4	VLS 1

2.3.5. Studies on the Distribution of Plant Parasitic and Entomopathogenic Nematodes associated with Soybean.

2.3.5.1. Survey on the distribution of plant parasitic nematodes in the soybean growing areas of India

A survey was carried out to study the distribution of plant parasitic nematodes in the soybean growing areas of India. Soil samples were collected from the soybean rhizospheres across the country. Community analysis of 58 soil samples representing 23 districts of 14 states revealed the presence of *Helicotylenchus* sp. (Spiral nematode), *Rotylenchulus* sp. (Reniform nematode), *Pratylenchus* sp. (Lesion nematode), *Hoplolaimus* sp. (Lance nematode), *Tylenchorhynchus* sp. (Stunt nematode), *Heterodera* sp. (Cyst nematode), *Rotylenchus* sp. (Spiral nematode), *Hirschmanniella* sp. (Root nematode), *Meloidogyne* sp. (Root Knot nematode) and *Trichodorus* sp. (Stubby Root nematode) with varying population densities. Among the different plant parasitic nematodes recorded, spiral nematodes were found to be most widely distributed as it recorded from 39 (67%) samples, whereas Lance, Lesion, Reniform, Stunt and Cyst nematodes were recorded from 28 (48%), 27 (47%), 26 (45%), 11 (19%) and 7 (12%) samples respectively. Based on the prominence value (PV), Reniform nematode (PV: 410) was found to be more important followed by Spiral (PV: 362), Lesion (PV: 202), Lance (PV: 173), Stunt (PV: 88) and Cyst (PV: 8.5) nematodes. The map on the distribution of plant parasitic nematodes in the soybean growing areas of India was prepared based on the survey (Fig. 28).

2.3.5.2. Community analysis of plant parasitic nematodes associated with soybean.

A total of 26 representative soil samples were collected from 26 blocks of DSR research farm for studying the association of plant parasitic nematodes with soybean cultivation. Plant parasitic nematodes namely, Spiral (*Helicotylenchus* sp.), Reniform (*Rotylenchulus* sp.), Lesion (*Pratylenchus* sp.), Lance (*Hoplolaimus* sp.), Cyst (*Heterodera* sp.) and Stunt (*Tylenchorhynchus* sp.) nematodes were encountered with different population densities. Based on the Prominence Value (PV), Reniform nematode (PV: 330) was found to be more important followed by Lance (PV: 93), Lesion (PV: 31), Spiral (PV: 26), Cyst (PV: 23) and Stunt (PV: 2) nematodes. The prevalence of plant parasitic nematodes in the research farm was documented as nematode distribution map (Fig. 29).

2.3.5.3. Field evaluation ofentomopathogenic nematode, *Steinernema glaseri,* spinasad and their combinations against soybean semiloors.

Two different doses (recommended and half of the recommended doses) of *Steirnema glaseri* (@ 2000 infective juveniles (IJ) / ml and 1000 IJ / ml) and spinosad (@ 200 ppm and 100 ppm) along with their different combinations were sprayed against soybean semiloopers. All the treatments resulted in significant reduction in the larval population on 3 and 7 days after treatment (DAT). Complete mortality was achieved with spinosad used alone or in combination with *S. glaseri*. The recommended and half of the recommended doses of *S. glaseri* reduced the larval population on 3 DAT up to 70 and 74 per cent respectively, as compared to the control. However, the efficacy was 87 and 53 per cent by 7DAT.

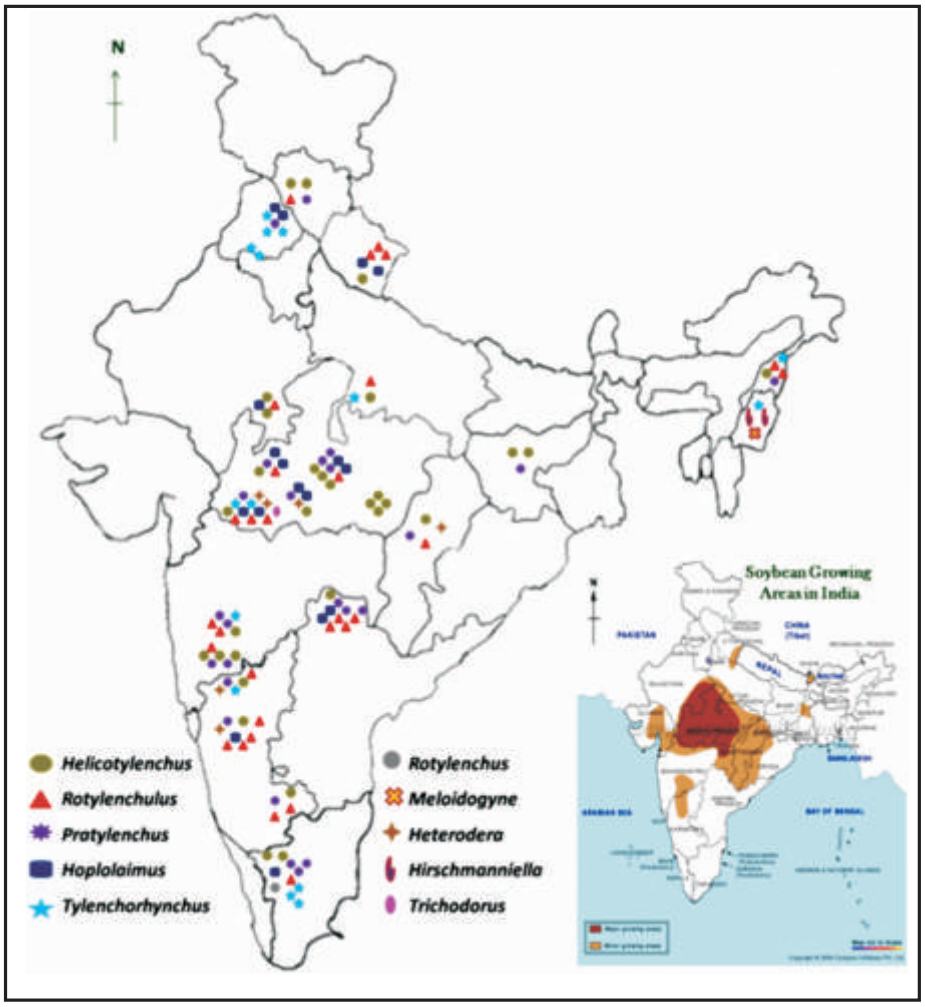


Fig. 28. Distribution of plant parasitic nematodes in the soybean growing regions of India

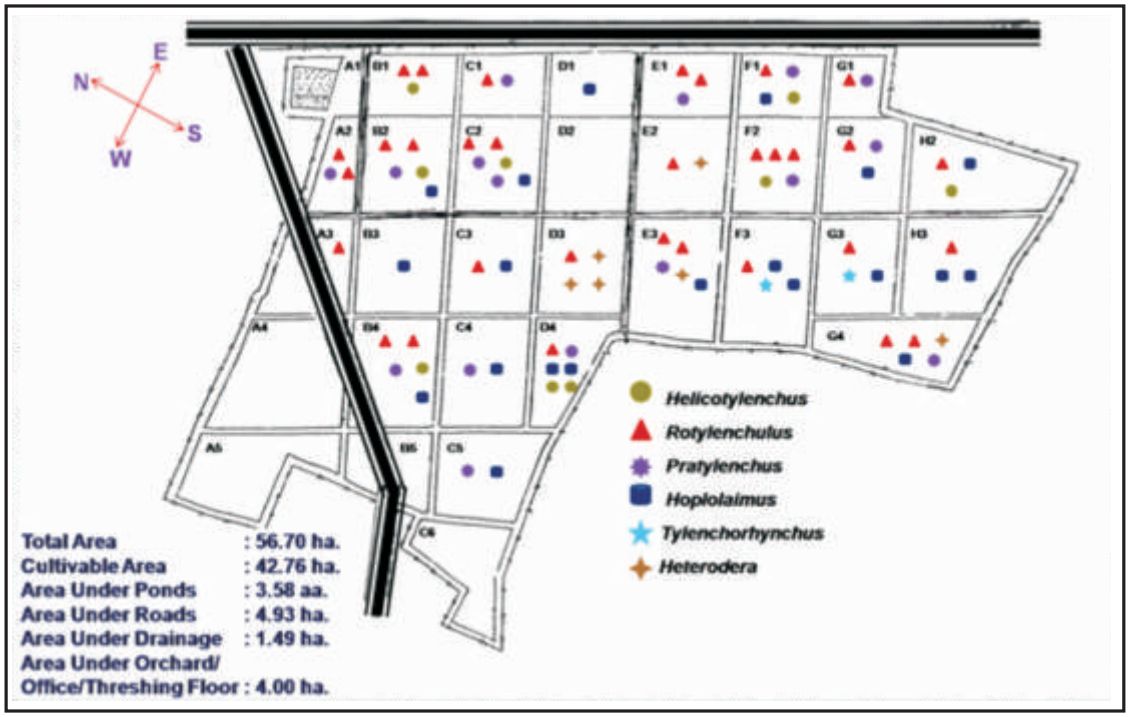


Fig. 29. Distribution of plant parasitic nematodes in the research farm of DSR, Indore

3. TECHNOLOGY TRANSFER

3.1. Impact of Changing Climate on the Technology Adoption and Soybean Yield

Data on climatic variation vis-à-vis different parameters including soybean yield have been collected from 250 farmers following interview method during the last two years. The interview schedule consisted of various questions related to the adoption of improved package of practices along with farmers' perception about the aberrations in climatic parameters. Preliminary assessment of the feedback received from the farmers gave an indication that, over the last four decades, farmers witnessed significant changes with respect to onset of the monsoon, spatial and temporal distribution of the monsoon (which perceived to be so erratic), cessation of monsoon, number of cloudy days, atmospheric temperature, etc. These changes in climatic parameters had an adverse impact on the soybean yields.

3.2. Impact Analysis of Awareness and Utilization of Soybean for Food Preparations in Madhya Pradesh

Data on the impact of training programmes conducted on processing and utilization of soybean for food uses have been collected using pre-structured interview schedule. The respondents included 100 each from participant and non-participant group. The preliminary assessment of the feedback received gave an indication that there was a significant improvement in the knowledge gained by the participants regarding the nutraceutical aspects of soybean. Further, the respondents started using soybean for food uses mainly for *roti* making besides soy nuts and soy *bari*. The trained women participants shared the acquired knowledge to their neighbors and relatives. An extension folder entitled "*Soybean ke prasanskrit khadya padarth*" was also published under tribal sub-plan (TSP) programme.

3.3. Participation in Agricultural Exhibitions

The DSR has actively participated in the recently held National Agricultural Exhibition, 'Krishi Vasant 2014' organized by the Department of Agriculture and Cooperation, New Delhi at Central Institute of Cotton Research, Nagpur during 9-13 February 2014 (Fig. 30). DSR was identified as Nodal Agency for coordinating the activities for identification of resource persons, printing and editing of crop/location specific publications for the farmers of Madhya Pradesh.

3.4. Soybean *Diwas*

The DSR organized '*Soybean Diwas*' at Village Ambachandan, Mhow Tehsil, Indore District on 4 September 2014. About 100 farmers of Ambachandan, Katkatkhedi, Borkhedi and other neighbouring villages actively participated in the event. They were also taken to the frontline demonstrations laid out in the village showcasing improved package of practices as well as newly released soybean cultivars namely, JS 20-34, JS 20-29 and NRC 86 which were introduced for the first time in the state after their notification (Fig. 31 & 32).

3.5. Frontline Demonstrations

A total of 20 frontline demonstrations were conducted at Ambachandan and Katkatkhedi villages (Mhow Tehsil, Indore). Four soybean varieties namely JS 95-60 (12), JS 93-05 (6) and one each of NRC 7 and NRC 86 have been demonstrated. The results of the demonstrations revealed that adoption of improved production technology increased the soybean yield to the tune of 27% as compared to farmer's practice (1141 kg/ha). An additional returns of Rs. 4569 per ha could be achieved with an additional expenditure of Rs. 2588. The yield gap II was 308 kg/ha.

Fig. 30. A view of DSR stall at National Agricultural Exhibition, '*Krishi Vasant* 2014'

Fig. 31. 'Soybean *Diwas'* being organized at Ambachandan village

Fig. 32. Visit to frontline demonstration fields during the 'Soybean *Diwas'*

4. TRAININGS

4.1. Trainers' Training Prgogrammes

4.1.1. Model training course (MTC)

A 'Model Training Course on Improved Soybean Production Technology' sponsored by the Directorate of Extension, Government of India was organized successfully during 16-23 September 2013 (Fig. 33). The trainees included 18 officers from the Departments of Agriculture and Krishi Vigyan Kendras belonging to the states of Madhya Pradesh, Maharashtra, Punjab and Manipur. A compendium of all the lectures was compiled in the form of a bilingual training manual.

4.1.2. Trainers' training programme

The DSR also organized a two day trainers training programme on "Improved Soybean Production Technology" for the staff of Indian Farm Forestry Development Cooperatives (IFFDC), Gurgoan. In all, 10 staff members of IFFDC were trained using participatory methodology. The participants were also provided with the compilation of different lectures and ready reckoners to solve the problems at field level.

4.2. Farmers' Training Programmes

4.2.1. Farmers' training programmes on improved soybean production technology

During this year, 106 Farmers' Training Programmes of day long duration were organized with the cumulative participation of 3558 farmers belonging to the states of Madhya Pradesh, Rajasthan, Maharashtra, Gujarat and Uttar Pradesh. All the recommended package of practices including agronomic, moisture conservation techniques during the stress period, integrated approach of managing weeds, insect pests and diseases as well as processing aspects of value added soy products were covered in these training programmes which were facilitated in participatory mode.

Fig. 33. MTC on improved soybean production technology being organized at DSR, Indore

4.2.2. Women's Training Programme on Processing and Utilization of Soybean

Three training programmes on "Processing and Utilization of Soybean for Food Uses at household level" were organized with the participation of 134 women belonging to the districts of Indore, Chhatrapur (Madhya Pradesh) and Ajmer (Rajasthan) respectively.

4.2.3. Farmers Women Training Programme under Tribal Sub-Plan (TSP)

A total of 100 frontline demonstrations were conducted along with three Field Days- "Soybean Diwas" (10 September 2013 at Nalchha village, 13 and 18 Septemeber 2013 at Lakhpura village) in Dhar and Jhabua districts of Madhya Pradesh in association with Krishi Vignan Kendras (KVK) of Dhar and Jhabua falling under the jurisdiction of RVSKVV, Gwalior. Further, a farmers training programme on 'Improved Soybean Production Technology and Processing of Soybean for Nutritional Security' was organized on 28th March 2014, at Khandwa with the participation of 306 tribal famers/farm women.

4.2.4. Farmers Training Programmes under ATMA

The DSR organized two training programmes of three day duration each (27-29 May and 4-6 June 2013) with the total participation of 86 farmers (26 from Chandrapur, Maharashtra and 60 from Khargone, Madhya Pradesh) under the aegis of ATMA scheme of state agricultural departments of Maharashtra and Madhya Pradesh. Both these training programmes are well appreciated by the sponsoring organizations (Fig. 34).

Fig. 34. Farmers Training Programme under ATMA being organized at DSR, Indore

4.3. Organization of Krishi Vigyan Kendra Workshop

A two day Training-cum-Workshop on Soybean for Krishi Vigyan Kendras (KVK) scientists was organized at DSR during 9-10 May, 2013 in collaboration with Zonal Project Directorate (ZPD), Zone VII, Jabalpur. In all, 33 subject matter specialists belonging to the KVKs of different districts of Madhya Pradesh attended the workshop. Different on farm trials (OFT) and verification trials (VT) on soybean conducted during the year were reviewed and necessary modifications were suggested for formulation of annual plan for the coming season.

4.4. Training Programme under DUS Testing on Soybean

A training programme entitled "Training Cum Awareness Programme on Protection of Plant Varieties and Farmers' Right Act (PPVFR)" under the Central Sector Scheme for PPVFR (DUS Testing) was organized at DSR, Indore on 7 Febrauay, 2014 (Fig. 35). In all 114 trainees including the progressive farmers from the neighbouring districts of Indore, scientists and officials from Madhya Pradesh State Seed Certification Agency, Madhya Pradesh Seed Federation and Madhya Pradesh State Agriculture Department have attended the programme. The objective of the training was to create awareness regarding the preservation of land races of different crops and to disseminate the information on the "Genome Savior Community Award" given to the communities involved in the conservation and maintenance of land races and germplasm.

Fig. 35. Training cum Awareness programme on protection of plant varieties and farmers' right act (PPVFR) at DSR, Indore

5. AWARDS AND RECOGNITIONS

5. 1. Awards to Institution

Nil

5. 2. Award to Individuals

Dr. B. U. Dupare, Senior Scientist (Agricultural Extension) received the Best Paper Presentation award during the National Seminar on "Social Dimensions of Extension Education in Holistic Development of Rural Livelihood" organized by the Indian Society of Extension Education, New Delhi at CBG College of Agriculture, Bakshi Ka Talab, Lucknow during 26-27 April 2013.

Research paper by Savita Kolhe and G. K. Gupta entitled 'Expert System–an effective IT tool in agriculture' was awarded the best research paper presentation in the National conference on "Recent Advances in Mechtronics and Computing Technology and Management (RAMCTM-2013)", organized by the Indore Institute of Science and Technology, Machine Intelligence Research Labs and IEEE on 16 June 2013.

Dr. M. P. Sharma received the Department of Biotechnology, Government of India, sponsored CREST (Cutting-edge Research Enhancement and Scientific Training) Award (2012-13) to undertake research on 'signature fatty acid biomarkers' at USDA-ARS, Beltsville, MD, USA from 19 October to 21 April, 2014.

Dr. S. V. Ramesh received the Department of Biotechnology, Government of India, sponsored CREST (Cutting-edge Research Enhancement and Scientific Training) Award (2012-13) to undertake research on 'Small non-coding RNAs mediated strategies to engineer antiviral resistance in crops' at Washington State University, Pullman, Washington, USA from Oct 2013 to Oct 2014.

6. LINKAGES AND COLLABORATIONS

Effective linkages and collaborations were made with the following International, National and Regional institutions/organizations for soybean research and development and extension activities.

International

1. Asian Vegetable Research and Development Centre, Taiwan.
2. International Institute of Tropical Agriculture, Ibadan, Nigeria.
3. Brazilian Agricultural Research Enterprise, National Soybean Research Center, (EMBRAPA).
4. University of Illinois, Urbana, Illinois, USA.
5. University of Arkansas, USA.
6. Soybean Production Research, USDA.
7. IOWA State University, USA.
8. International Potash Institute, Switzerland.
9. International Plant Genetic Resources Institute, Rome, Italy.
10. American Soybean Association, New Delhi
11. Japan International Co-operation Agency, Japan.
12. Chinese Academy of Agricultural Sciences, Beijing, China.
13. Soybean Institute- Julin Academy of Agricultural Sciences, Julin Province, China.
14. National Agricultural Research Centre, Kannondai, Tsukuba, Japan.

National

1. SAUs located in soybean growing states.
2. National Bureau of Plant Genetic Resources, New Delhi.
3. Indian Institute of Soil Science, Bhopal.
4. Central Research Institute for Dryland Agriculture, Hyderabad.
5. Indian Institute of Pulse Research, Kanpur.
6. Central Institute of Agricultural Engineering, Bhopal.
7. National Research Centre for Plant Biotechnology, New Delhi.
8. National Research Centre for DNA Finger Printing, New Delhi.
9. Directorate of Oilseed Research & Development, Hyderabad.
10. Indian Agricultural Research Institute, New Delhi.
11. National Academy of Agricultural Research Management, Hyderabad.
12. National Bank for Agriculture and Rural Development.
13. National Fertilizer Limited.
14. Agharkar Research Institute, Pune.
15. Directorate of Weed Sciences Research, Jabalpur.
16. Central Food Technological Research Institute, Mysore.

Regional

1. Departments of Agriculture and KVKs of soybean growing States.
2. NGOs like SOPA, OILFED.
3. State Cooperative Development Banks of respective States .
4. State Seed Corporation.
5. Department of Seed Certification.
6. Farm and seed co-operatives Limited.
7. College of Agriculture, Indore.
8. Veterinary College, Mhow.
9. Regional Wheat Station of IARI, New Delhi.

7. INTELLECTUAL PROPERTY MANAGEMENT & TECHNOLOGY TRANSFER /COMMERCIALIZATION

Following activities were undertaken by the IPM &TCC cell of DSR, Indore

1. Issuing of non exclusive license to ITC Limited for commercialization of soybean genotypes viz. high oleic acid (IC 210) and KTI free (NRC 102) is at the last stage of finalization.

2. Signed a pre-MOU for verifying the claim of DSR, Indore by Ruchi Soya Industries Limited, Indore for kunitz trypsin inhibitor free line NRC 101 and 42% (±5%) oleic acid in line IC 210 in order to have commercialization of these lines.

3. Proposals of soybean extant varieties viz. Pant Soya-1092, Pant Soybean-1347 (PS-1347) and Pant Soybean-1225 (PS-1225) have been submitted to PPV&FR Authority for registration through NBPGR, New Delhi.

4. Renewal of MOU was done for commercialization of four agricultural implements which were initially commercialized in 2012.

5. Five more agricultural implements namely BBF drill cum planter, Soybean seed planter, Ridge ferti seed drill cum planter, Soybean seed drill cum planter (DSR two in one) and Single ridge seed drill cum planter have been approved by ITMC/ITMU for commercialization.

6. Application is submitted to Deputy Registrar, Copyrights, New Delhi for obtaining following five copyrights:

   I. Expert System of Soybean Diseases

   II. Knowledge Acquisition System of Soybean Diseases

   III. Intelligent Soybean Disease Tutor System

   IV. Knowledgebase of Soybean Diseases

   V. Screens of Soybean Disease Expert System

8. ALL INDIA COORDINATED RESEARCH PROJECT ON SOYBEAN

Since 1987, All India Coordinated Research Project on Soybean (AICRP on Soybean) is an integral part of the Directorate of Soybean Research (DSR), Indore. AICRP on Soybean though established in 1967 but subsequently it was reorganized in manpower, coordinating centres and budget in each five year plans. Presently, It is comprising of 22 regular centres (8 main centers and 14 sub-centres) and 14 need based testing centres, located in the states of Andhra Pradesh, Assam, Chattisgarh, Bihar, Himachal Pradesh, Haryana, Jharkhand, Karnataka, MP, Maharashtra, Meghalaya, Manipur, Nagaland, Orissa, Gujarat, Punjab, Rajasthan, Tamil Nadu, Uttarakhand and U.P. The Objective of AICRP on Soybean is to coordinate, monitor and guide the research activities on soybean at national level with the mandate of evaluation of soybean genetic resources, development of location specific high yielding varieties with other desirable traits and improved agronomical practices, maintenance of genetic purity and production of breeder seed, refinement and validation of integrated management of nutrients, insect pests, diseases, water and weeds, basic studies on physiological and molecular aspects on seed longevity and germination, microbial aspects and value addition in soybean and technology transfer through demonstrations and trainings.

8.1. XLIV Annual Group Meeting of AICRP on Soybean

XLIV AICRP on Soybean Annual Group Meeting was organized by BAU, Ranchi, Jharkhand from May 25-27, 2014. About 125 soybean research and development workers and officials across the country from Government and Non-Government institutions, departments and organizations participated and actively deliberated in the group meeting.

Research work undertaken in the disciplines of plant breeding, agronomy, entomology, plant pathology, microbiology and food science in the year 2013-2014 was presented and critically reviewed and evaluated. With massive support, encouragement, rational direction and valuable suggestions of Dr. MP Pandey, Hon'ble Vice Chancellor and Dr SK Datta, DDG (crop science) and Dr JS Chauhan, ADG (seeds) during opening and/or plenary session, the technical programmes for 2014-15 of all the disciplines were made practical, coherent and precise. The suggestions made by Chairman, Co-chairman, eminent scientists and participants were also included in the newly developed technical programme.

8.2. Breeder Seed Production

Against the total DAC indent of 18130.96 q of 23 varieties, AICRPS centres were allotted a target of 19509.00 q for breeder seed production. The highest target of 6401.5 q was for JS 95-60 followed by 4997 q for JS 335, 4538 q for JS 93-05. The highest target (5700 q) was given to UAS, Dharwad followed by JNKVV, Jabalpur (4600 q). A total production of 8018.44 q was achieved. This was 56 % of the total indent and 59% of the target. There was major shortfall in all

the important varieties like JS 335, JS 93-05, JS 95-60 and JS 97-52. This was mainly due to the unfavourable weather conditions and rains at the harvest time. To compensate the shortfall off season production has been taken up in 288 ha at 7 centres.

8.3 Frontline Demonstration

During the year, 24 centers conducted a total of 660 FLDs on farmer's fields against the target of 700 FLDs in plot of 0.4 ha each. Directors of Agriculture of respective states were requested to visit these FLDs. Many of these trials were monitored and generally found to be satisfactory. Yield as high as 26.25 q/ha could be obtained in some farmers' fields under the improved technology.

Of the 660 FLDs, 86.99 and 13.01% were represented by men and farm women respectively. While the representation of categories wise beneficiaries were 10.15% by SC, 14.55% by ST, 41.52% by OBC and 33.33% by general respectively.

Data accrued from 640 FLDs on full package revealed that the adoption of research emanated improved soybean production technology led to an increase in yield and net returns to the tune of 23.45 and 35.20% over farmers practice which was achieved by the additional expenditure of only Rs. 3830/ha. The difference in gross returns due to improved technology and farmer's practice was 29.11%. The estimated yield gap II was 313 kg/ha.

8.4. Major Research Highlight

Three entries viz. DSb 19 for North eastern zone, SL 958 for Northern plain zone and DSb 21for Southern zone have been identified.

On the basis of three years multi-location trials yield loss (%) range observed due to major insects pests were 5.2-25.4 by Girdle beetle, 5.5-27.4 by Defoliators, 9.9-43.8 by Stem fly and 5.7-30.8 by Pod borer.

On the basis of three years' multi-location field screening various genotypes were identified as potential sources/donors for resistance/tolerance against major insects/insect groups. They were : DS 2706, DS 2708, DSb 19, DSb 21, JS 20-41, KDS 378, MACS 1340, MACS 1366, MAUS 504, RVS 2001-18, SL 900 for stem fly, DS 2708, DSb 21, SL 900 for defoliators, DSb 21, JS 20-41, RVS 2001-18, SL 958 for girdle beetle and DSb 19 for pod borer.

Lines AMS 243, AMS-MB-5-18, AMS-MB-5-19 and JS20- 29 were recommended for utilization in crossing programme as a donor for resistance to charcoal rot.

9. PUBLICATIONS

9.1. Research Papers

Agarwal, Dinesh K., Billore, S. D., Sharma, A. N., Dupare, B. U. and Srivastava, S. K. 2013. Soybean: Introduction, improvement and utilization in India-Problems and Prospects. *Agricultural Research,* 2(4): 293-300.

Aketi Ramesh, Sushil K. Sharma, Mahaveer P. Sharma, Namrata Yadav and Om P. Joshi. 2014. Inoculation of zinc solubilizing *Bacillus aryabhattai* strains for improved growth, mobilization and biofortification of zinc in soybean and wheat cultivated in Vertisols of central India. *Applied Soil Ecology,* 73: 87–96.

Aketi Ramesh, Sushil K. Sharma, Mahaveer P. Sharma, Namrata Yadav and Om P. Joshi. 2014. Plant Growth-Promoting Traits in *Enterobacter cloacae* subsp. *dissolvens* MDSR9 Isolated from Soybean Rhizosphere and its Impact on Growth and Nutrition of Soybean and Wheat Upon inoculation. *Agricultural Research,* 3(1):53-66.

Aketi Ramesh, Sushil K. Sharma, Namrata Yadav and Om P. Joshi. 2014. Phosphorus Mobilization from Native Soil P-Pool upon Inoculation with Phytate- Mineralizing and Phosphate-Solubilizing *Bacillus aryabhattai* strains for Improved P-Acquisition and Growth of Soybean and Wheat Crops in Microcosm Conditions. *Agricultural Research,*DOI 10.1007/s40003-014-0105-y.

Anita Rani, Vineet Kumar and Reena Rawal. 2013. Identification of SSR marker linked to lipoxygenase-1 gene in soybean. *Journal of Plant Biochemistry and Biotechnology*, 22(4):488-491.

Bertioli, D. J., Vidigal, B., Nielen, S., Ratnaparkhe, M. B., Lee, T. H., Leal-Bertioli, S. C. M., Kim, C., Guimarães, P. M., Seijo, G., Schwarzacher, T., Paterson, A. H., Heslop-Harrison, P. and Araujo, A. C. G. 2013. The repetitive component of the A genome of peanut (*Arachis hypogaea*) and its role in remodelling intergenic sequence space since its evolutionary divergence from the B genome. 2013. *Annals of Botany*, 112(3): 545-59.

Billore, S. D. and Srivastava, S. K. 2013. Sustainability and stability of yield of soybean varieties under various planting time in different agroclimatic regions of India. *Soybean Research,* 11(2): 8-16.

Billore, S. D. , Joshi, O. P. , Ramesh, A. and Vyas, A. K. 2013. Productivity, sustainability and stability of soybean based cropping systems under different tillage systems. *Soybean Research,* 11(1): 43-57.

Chaudhary Archana, Savita Kolhe and Raj Kamal. 2013. Machine Learning Classification Techniques: A comparative Study. *International Journal on Advanced Computer Theory and Engineering*, 2(4)**:** 21-25.

Chaudhary Archana, Savita Kolhe and RajKamal. 2013. Performance Examination of Feature Selection methods with Machine learning

classifiers on mobile devices. *International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering*, 1(8): 354-358.

Choudhary Archana., Kolhe, S. and Raj Kamal. 2013. Machine Learning Techniques for Mobile devices- A Review. *International Journal of Engineering Research and Applications,* 3(6): 913-917.

Choudhary, Archana., S. Kolhe and Rajkamal. 2013. Performance Evaluation of feature selection methods for Mobile devices. *International Journal of Engineering Research and Applications*, 3(6): 587-594.

Dupare, B. U. , Billore, S. D. and Verma, S. K. 2013. A study on farmers' seed replacement rate of soybean and related problems in major soybean growing states. *Soybean Research*, 11(1): 58-65.

Fiyaz, R. A., Ramya, K. T., Ajay, B. C., Gireesh, C. and Kulkarni. R. S. 2013. Multivariate analysis for yield and its component traits in rice (*Oryza sativa* L.) under alkaline soil condition. *Indian Journal of Genetics*, 73(4): 438-442.

Gireesh, C., Vinod, Sharma, J. B. and Prabhu, K. V. 2014. Inheritance and molecular mapping of leaf rust resistance in *Triticum turgidum* var. *durum* cv. Trinakria. *Indian Journal of Genetics*, 74(1): 10-15.

Gummagolmath, K. C., Sharma, P. and Shalendra, K. C. 2013. Assessment of Training Needs and Knowledge Level of Officers in Agricultural Marketing. *Indian Journal of Agricultural Marketing, 27(2): 152-162.*

Kolhe Savita, Raj Kamal, Harvinder S. Saini and G. K. Gupta. 2013. Knowledge Management in Expert System of Crop Disease. *International Journal on Advanced Computer Theory and Engineering*, 2(4): 1-8.

Kolhe Savita, Raj Kamal, Harvinder S. Saini and G. K. Gupta. 2013. Expert System for Disease Diagnosis in Soybean-ESDDS. Special issue – AI in Agriculture, *Journal of the Indian Society of Agricultural Statistics*, 67: 79-88.

Kumar Vineet, Anita Rani and Reena Rawal. 2013. Deployment of gene specific marker in development of kunitz trypsin inhibitor free. *Indian Journal of Experimental Biology*, 51: 1125-1129.

Meena, B. P. , Billore, S. D. and Ramesh, A. 2013. Dynamics of potassium in Vertisols under soybean-wheat cropping system. *Soybean Research*, 11(2): 35-42.

Pandey, A., Gupta, S., Kumar, A., Thongbam, P. D. and Pattanayak, A. 2013. Genetic divergence, path coefficient and cluster analysis of chickpea (*Cicer arietinum*) cultivars, in the mid-altitudes of Meghalaya. *Indian Journal of Agricultural Sciences*, 83(12): 000–00, December 013/Article.

Pavithravani, B.V., Gowda, K. R., Bhanuprakash, S. Ramesh, S., Rao, A. M., Subramanya, S. and Gireesh, C. 2013. Biochemical

components: an index of bruchid resistance in rice bean (*Vigna umbellata*). *Legume Research,* 36(6): 582-588.

Ramesh, S. V., Ratnaparkhe. M. B., Kumawat, K., Gupta, G. K. and Husain, S. M. 2014. Plant miRNAome and antiviral resistance: a retrospective view and prospective challenges. *Virus Genes*, 48:1-14.

Ramesh, S.V., Ramteke, R., Gupta, G. K., Husain, S. M. and Rajesh, S. 2013. Dolichos yellow mosaic virus coat protein (av1) gene, partial cds. Online sequence published at *http://www.ncbi.nlm.nih.gov/nuccore/KC852202*.

Rawal Reena, Vineet Kumar, Anita Rani, Gokhale, S. M. and Husain, S. M. 2014. Marker assisted backcross selection for genetic removal of lipoxygenase-2 from soybean (*Glycine max*) variety JS 97-52: Parental polymorphism survey and hybridity validation. *Indian Journal of Agricultural Sciences*, 84(3): 414-417.

Shadakshari, T. V., Yathish, K. R., Kalaimagal, T., Gireesh, C., Gangadhar, K. and Somappa. J. 2014. Morphological response of soybean under water stress during pod development stage. *Legume Research,* 37 (1): 37-46.

Shalendra, K. C., Gummagolmath, Sharma, P. and Patil, S. M. 2013. Role of Pulses in Food and Nutritional Security in India. *Journal of Food Legumes,* 26(3&4): 124-129.

Sharma P. Mahaveer and Alok Adholeya. 2013. Parameters for selecting efficient arbuscular mycorrhizal fungi for plants under microcosm conditions. *Proceedings of National academy of Sciences: Series B Biological Sciences* DOI 10.1007/s40011-013-0263-x

Sharma, P., K. C. Gummagolmath, Shalendra, N. B. Ghodake, and V. B. Nandre. 2013. ICT as a Means for Linking Farmers to Market- A Case of Banana Cultivation in Kolhapur District of Maharashtra, DYPIMS's International *Journal of Management and Research,* 2 (1): 33-40.

Singh, J., Fiyaz, R. A., Kumar, S., Ansari, M. A. and Gupta, S. 2013. Genetic variability, correlation and path coefficient analysis for yield and its attributing traits in pigeonpea (*Cajanus cajan*) grown under rainfed conditions of Manipur. *Indian Journal of Agricultural Sciences*, 83: 852-58.

Sridhar, Y. and Amar N. Sharma. 2013. Field efficacy of thiamethoxam and lambda cyhalothrin ready mix formulation (Alika 247) against major insect pests of soybean. *Indian Journal of Plant Protection,* 41**(3)**: 202-205.

Verma Kuldeep, Raman Saini, Anita Rani. 2014. Recent advances in the regeneration and genetic transformation of soybean. *Journal of Innovative Biology*, 1(1): 15-26.

9.2. Papers presented in seminars, symposia, conferences, etc.

Agnihotri Richa, Ashu Pandey, Aketi Ramesh, Patra A.K., Hazela K, and Mahaveer P. Sharma. 2014. Impact of organic and inorganic management practices on

mycorrhizal symbiosis and glomalin production in soybean-maize intercropping system. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 217.

Aketi Ramesh, Sushil K. Sharma, Mahaveer P. Sharma and Namrata Yadav. 2014. Iron and zinc biofortification in soybean through inoculation of siderophore producing and zinc solubilizing rhizobacteria: a strategy to alleviate iron and zinc malnutrition in humans. *In:* Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 224-225.

Anes K. M. and G. K. Gupta. 2013. Population analysis of plant parasitic nematodes associated with soybean cultivation at research farm of directorate of soybean research, Indore. *In*: Abstracts: National symposium on Nematode: a friend and foe of agri-horticultural crops, 2013, Non 21-23, Solan, HP, pp 79.

Anes K. M. and G. K. Gupta. 2014. Distribution and population analysis of plant parasitic nematodes in the soybean growing areas of India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 241.

Anita Rani and Vineet Kumar. 2014. Marker assisted selection for development of food grade soybean in India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 103.

Ansari, M. M. 2014. Evaluation of fungicides and bio-agents against stem blight of soybean *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 241

Ansari, M. M., G. K. Gupta and Y. Sridhar. 2014. Effect of Herbicides on Soybean Diseases caused by S.rolfsii and M. phaseolina *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 242

Arya Mamta, Bhataia, V. S., Ansari, M. M. and Husain S. M. 2014. Standerdization of screening technique and evaluation of Soybean (*Glycine max*) genotypes for water logging tolerance *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 189

Bhatia, V. S. and Jumrani, K. 2014. Potassium iodide a potential desiccant to field evaluate large Germplasm lines for terminal drought in soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 202.

Billore, S. D. 2014. Assessment of soybean based cropping system productivity trends and sustainability under various tillage systems. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 155.

Billore, S. D. 2014. Weed control efficiency evaluation of quizalofop ethyl 10 EC against grassy weeds in soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 195.

Dupare, B. U, Billore, S. D. and Verma, S. K. 2014. Soybean seed flow chain among soybean producers of India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 140.

Dupare, B. U. , Billore, S. D. and Srivastava, S. K. 2013. Processing and value addition of soybean for nutritional security. *In*: National Conference on *Making Agriculture Profitable,* RVSKVV, Gwalior, 26-27 July 2013. Pp. 195-196.

Dupare, B. U., Billore, S. D. and Srivastava, S. K. 2013. Role of women in soybean processing in mitigating protein-calorie malnutrition in tribal areas of Madhya Pradesh and Maharashtra. *In*: International Conference on Extension Education Strategies for Sustainable Agricultural Development-A Global Perspective. UAS, Bangalore, 5-8 Dec, 201. Pp. 97-98.

Dupare, B. U. , Billore, S. D. and Srivastava, S. K. 2014. Processing and utilization of soybean for nutritional security in rural and triabl area : Role of Women. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 288.

Gireesh, C. and Husain, S. M. 2014. Character association and path coefficient analysis of yield and its attributing traits in exotic collection of soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp..

Gireesh, C., Shivakumar, M. and Husain, S. M. 2014. Molecular approaches to broaden the genetic base in soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp..

Girothia, O. P. , Billore, S. D. and Kushwah, H. S. 2014. Response of sulphur levels and their application frequency to soybean-chickpea cropping system**.** *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 164.

Gupta, G. K., Ansari, M. M. and Sharma, S. K. 2014. Field efficacy of native strains of *Pseudomonas* and *Trichoderma* for the management of *Sclerotium rolfsii* causing Sclerotium blight in soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 251.

Gupta, S., Manikpuri, M., Thakur, D., Devdas, R., Bhatia, V. S., Hussain, S. M. and Pandey, S. K. 2014. Molecular polymorphism and diversity for photoperiodic genes in soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 110.

Jahagirdar, S. and Gupta, G. K. 2014. Influence of seed processing fungicides and bioagents on culturable plant growth promoting rhizobacteria in soybean ecosystem in India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 271.

Jahagirdar, S., Kulkarni, J. H., Padnad, L., Basavraja, G. T. Gupta, G. K., Patil, R. H. and Hosmath, J. A. 2014. Identification of sources of resistance and variability of *Phakopsora pachyrhizi* Syd. causing soybean rust in India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 270.

Jumrani, K., Bhatia, V. S. and Pandey, G. P. 2014. Impact of drought and heat stress on physiological, developmental, growth, photosynthesis and yield processes of soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 192.

Kolhe, Savita. 2013. A Comparative Study of Machine Learning Techniques using WEKA. *In*: National Conference on Recent Advances in Mechtronics and Computing Technology and Management (RAMCTM-2013), Indore, June 16, 2013.

Kolhe, Savita. 2013. Expert System–an effective IT tool in agriculture. *In*: National Conference on Recent Advances in Mechtronics and Computing Technology and Management (RAMCTM-2013). Indore, June 16, 2013.

Kolhe, Savita. 2013. Knowledge Based Expert System for Crop Disease Management. *In:* National Conference on Innovative Trends in Soft Computing (ITSC-2013). Indore, 25-Oct 26, 2013.

Kolhe, Savita. 2013. Performance of Machine Learning Techniques in Teaching. *In*: National Conference on Innovative Trends in Soft Computing (ITSC-2013). Indore, Oct 25-26, 2013.

Kolhe, Savita. 2014. Intelligent Soybean Disease Tutor System. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014.

Kolhe, Savita. 2014. Intelligent Systems for Agriculture Domain. *In*: 3rd National Conference on Emerging Trends in Computer Technology (NCETCT-14), Shirpur., Dhule on 28-29 March, 2014.

Kuchlan M. K., Kuchlan P., Mukesh, O. and Husain S. M. 2014. Orientation of seed coat around cotyledons, chemical and mineral composition of seed coat in relation to mechanical strength of the seed coat of soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 145.

Kuchlan P., M. K. Kuchlan and S. M. Husain. 2014. Effect of foliar application of growth activator, promoter and antioxidant on seed quality of soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014.

Kuchlan, P., Kuchlan, M. K. and Husain, S. M. 2014. Effect of foliar application of growth activator, promoter and antioxidant on seed quality of soybean. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 144.

Kumar Vineet and Anita Rani, 2014. Mapping genes for delivering specialty soybean for niche market. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 139.

Kumawat G., Singh, G., Agarwal D. K., Arya M. and Husain S. M. 2014. SSR based genetic diversity analysis of soybean germplasm lines in India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014.

Pandey Ashu, Agnihotri Richa, Ramesh A, Patra Ashok K, Hazela Krishna, Billore SD and Sharma Mahaveer P. 2014. Enhanced mycorrhizal biomass, N fixation and carbon accumulation in the soybean Rhizosphere under a long term soybean based cropping system managed with organic and inorganic practices. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 216.

Ramteke, R. and Gupta G. K. 2014. Present status of soybean rust in India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 102-103.

Ratnaparkhe B. Milind. SV Ramesh, Giriraj Kumawat, S M Husain, Saghai Maroof, Roger Innes 2014. Comparative analysis of NBS-LRR gene cluster on soybean molecular linkage group F (Chromosome 13). *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 152.

Rawal Reena, Vineet Kumar, Anita Rani, Gokhale, S. M. 2014. Marker assisted introgression of null allele of lipoxygenase-2 into a popular India soybean variety. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 103-104.

Sharma P. Mahaveer, Sandeep Singh, Sushil K. Sharma and V. S. Bhatia. 2014. Dual inoculation of niche-based AM fungi and soybean root nodulating rhizobia for enhancement of soybean growth, yield and soil health parameters in Vertisols *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 157.

Sharma Purshottam, Dupare B. U. , Billore, S. D. and Srivastava, S. K. 2013. Trends in input use and profitability of major crops in Madhya Pradesh. *In*: National Conference on *Making Agriculture Profitable,* RVSKVV, Gwalior, 26-27 July 2013. Pp. 113-114.

Sharma Purushottam, R. M. Patel and S. K. Srivastava, Comparative Advantage of Indian Soymeal vis-à-vis Major Exporters. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014.

Sharma, Purushottam. and B. U. Dupare. 2013. Nature and Causes of Growth and Instability of Soybean in Major States of India, Agricultural *Economics Research Review,* Vol. 26(Conf.); 193 (Abstract).

Shivakumar, M., Verma, K., Talukdar, A., Lal, S. K., Sapra, R. L., Singh, K. P., Kumar, A. and Mukherjee, K. 2014. Marker assisted backcross breeding (MABB) for quality improvement in soybean: A success story in India. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp.

Shivakumar, M., Husain, S. M., Gireesh, C. and Arya, M. 2014. Towards development of multiparent advanced generation intercross (MAGIC) population in soybean: progress and potentials for genetics and plant breeding research. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014.

Singh Upendra, Amit Gautam, Khushwah, H. S., A. Ramesh and S.V. Sai Prasad. 2014. Canopy temperature as a selection trait for identifying high yielding soybean genotypes. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 133.

Singh, D. V., Ramteke, R., Billore, S. D., Khan, I. R. and Singh, C. 2013. Impact of sub-soiling on conservation of soil moisture and yield of rain-fed soybean in vertisols of central India. WSRC, Durban, South Africa.

Srivastava. S. K. , Billore, S. D. and Bhatia, V. S. 2013. Improved agrotechnologies for profitable soybean production. *In*: National Conference on *Making Agriculture Profitable,* RVSKVV, Gwalior, 26-27 July 2013. Pp. 63-72.

Sharma, S. K., Aketi Ramesh, Mahaveer P. Sharma, Rajesh Khande, and Gupta, G. K. 2014. Applicationof zinc solubilizing rhizobacteria utilizing reserve soil zinc for the purpose of biofertilization and biofortification of soybean and wheat. *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 225.

Talukdar A, Harish, G. D., Shivakumar, M., Kumar, B., Khushbu, V., Vanishree, G., Samrat Gowda D. S., Reddy Y, S., Yashpal, Anil Kumar, Mukherjee, K., Lal S. K., Sapra, R. L., and Singh, K. P. 2014. Genetics of mungbean yellow mosaic India virus (MYMIV) resistance in soybean (*Glycine max* L. Merr.). *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014.

Sridhar, Y., Ansari, M. M. and Sharma, A. N. 2014. Efficacy of native *Beauveria bassiana* isolates against gram pod borer, *Helicoverpa armigera. In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 252.

Yadav Namrata, Joshi, O.P., A. Ramesh, Sharma S. K. and Iqbal, S. 2014. Influence of tillage and integrated nutrient management on carbon sequestration in vertisols under soybean based cropping systems in Central India. In: Mitigating productivity constraints in soybean for sustainable agriculture: *In*: Proceedings of International Soybean Research Conference, Indore, Feb 22-24, 2014. Pp. 171.

9.3. Technical bulletin/books/book chapters/reports

श्याम किशोर वर्मा एव ंबी.यू. दुपारे 2013. हिन्दी का साहित्यिक, ऐतिहासिक, तकनीकी एवं वैधानिक स्वरुपः अतित और वर्तमान परिदृश्य. आज की हिन्दी. (संपादक–सूरेश कुमार जिन्दल एवं फूलदीप कुमार). डेसीडॉक, मेटकॉफ हाउस, दिल्ली. पृष्ठ क्रमांक 224–239.

श्याम किशोर वर्मा, ंबी.यू. दुपारे एव जगदीशन ए.के. 2013. भारतीय कृषि में मौसम आधारित परंपरागत देशज ज्ञान– एक अध्ययन. विज्ञान एवं संस्कृति. (संपादक–सूरेश कुमार जिन्दल एवं फूलदीप कुमार). डेसीडॉक, मेटकॉफ हाउस, दिल्ली. पृष्ठ क्रमांक 228–237.

बी.यू. दुपारे एवं एस.डी. बिल्लौरे. 2014. सोयाबीन की उन्नत खेती हेतु सस्य क्रियाए. विस्तार फोल्डर क्रमांक 8. सोयाबीन अनुसंधान निदेशालय प्रकाशन.

बी.यू. दुपारे एवं एस.डी. बिल्लौरे. 2014. सोयाबीन मे कीट नियंत्रण हेतु उपयुक्त तकनीकी. विस्तार फोल्डर क्रमांक 9. सोयाबीन अनुसंधान निदेशालय प्रकाशन.

बी.यू. दुपारे एवं एस.डी. बिल्लौरे. 2014. सोयाबीन के प्रसंस्कृत खाद्य उत्पाद. विस्तार फोल्डर क्रमांक 10. सोयाबीन अनुसंधान निदेशालय प्रकाशन.

बी.यू. दुपारे एवं एस.डी.बिल्लौरे. 2014. सोयाबीन की उन्नत खेती. विस्तार बुलेटिन क्रमांक 11. सोयाबीन अनुसंधान निदेशालय प्रकाशन. पृष्ठ 40

एम्. के. कुचलान, पुनम कुचलन एवं एस. एम्. हुसैन. 2013. ''सोयाबीन के गुणवत्तापूर्ण बीज उत्पादन की उन्नत तकनीकी'' विस्तार बुलेटिन.11 प्रकाशन सोयाबीन अनुसंधान निदेशालय इन्दौर.

Dupare B. U., Billore S. D. and Sharma, P. 2013. Training Manual for Model Training Course on Improved Soybean Production Technology. Directorate of Soybean Research, Indore. (Bilingual). 96 p.

Dupare, B. U. 2013. Processing techniques of soybean for food uses. *In*: Training Manual of Model Training Course on Improved Soybean Production Technology Pp: 80-84

Dupare, B. U. 2013. TOT in soybean: Methods and approaches followed by DSR. *In*: Training Manual of Model Training Course on Improved Soybean Production Technology. Pp. 101-106.

Ratnaparkhe M. B., Ramesh S. V., Kumawat G., Husain S. M., and Gupta S. 2014. Advances in Soybean Genomics. In: S. Gupta et al. (eds.), Legumes in the Omic Era, DOI 10.1007/978-1-4614-8370-0_3, Springer Science+Business Media, New York. Pp. 41-72

9.4. Popular articles

रामटेके राजकुमार, गुप्ता गिरीश कुमार एवं सिंह देवव्रत. 2013. मध्यभारत के लिए सोयाबीन की उन्नत किस्में.खेती (अगस्त 2013) पृ.28.30.

बी.यू.दुपारे, एस.डी.बिल्लौरे एवं एस. के. वर्मा. 2013. सोयाबीन में समेकित खरपतवार प्रबंधन की विधियों का संयोजन.. कृषक प्रहरी जून 2013. पृष्ठ क्रमांक 28–30.

बी. यू. दुपारे, एस. डी. बिल्लौरे,एवं एस. के. श्रीवास्तव. 2013.सोयाबीन उत्पादन में खरपतवारों से होने वाली हानि से कैसे बचे. कृषक प्रहरी. जुलाई 2013. पृष्ठ क्रमांक 10–13.

बी. यू. दुपारे, एस. डी. बिल्लौरे, ए.एन.शर्मा एवं एस. के. वर्मा. 2013. सोयाबीन के भरपूर उत्पादन हेतु सस्य क्रियाएं. कृषि मंत्र. अगस्त 2013. पृष्ठ क्रमांक 8–11.

बी.यू.दुपारे, एस.डी.बिल्लौरे एव एस. के. श्रीवास्तव. 2013. मध्य प्रदेश के विशेष संदर्भ में भारतीय सोयाबीन की प्रमुख प्रजातियॉ एवं कृषकों के स्तर पर बीज उत्पादन हेतु सस्य क्रियाएं एवं सावधानियॉ. कृषि मंत्र. फरवरी 2014. पृष्ठ क्रमांक 6–9

बी.यू.दुपारे, विनित कुमार एवं एस के श्रीवास्तव. 2014 पोषण एवं स्वास्थ्य सुरक्षा हेतु सोयाबीन के खाद्य उपयोग. कृषि मंत्र. जनवरी 2014. पृष्ठ क्रमांक 10–12.

बी.यू. दुपारे, एस. डी. बिल्लौरे, एस.के.वर्मा एवं एस. के. श्रीवास्तव. 2013. सोयाबीन की उन्नत उत्पादन तकनीकी. भूमी निर्माण. 16 अगस्त से 15 सितम्बर पृष्ठ 14

बी.यू. दुपारे, एस. डी. बिल्लौरे एवं डी. के. अग्रवाल. 2013. सोयाबीन चे भरघोस उत्पादन. उज्जवल कृषि संपदा–2013. पृष्ठ क्रमांक 26–29

Savita Kolhe and G.K. Gupta (2013). "Online Disease Expert System for Soybean". SOPA Digest, July 2013, 5-7.

9.5 Invited lectures in workshops, summer schools, government programmes, meetings, etc.

Anes, K. M. Delivered a lecture on "Compatibility of EPNs with agrochemicals and bioagents" and "Procedure for studying compatibilitywith agri-inputs" on Feb 19, 2014 at Division of Nematology IARI, New Delhi, during the Model Training Course on Beneficial Nematodes, 18-25 Feb, 2014.

Kuchlan, M. K. delivered lecture on Technical aspects of farmers' variety protection and Genome Saviour Award for farming community at Training-cum-Awareness Programme under DUS Project on Soybean at Directorate of Soybean Research, Indore on 7 Feb, 2014.

Ratnaparkhe, M. B. delivered lecture on "Soybean Comparative Genomics" at Refresher Course, School of Biotechnology, Devi Ahilya Vishwa Vidyalaya, Indore, 14 Feb, 2014.

Ratnaparkhe, M. B. delivered lecture on "Molecular Markers in Soybean Breeding" at Refresher Course, Department of Biotechnology, Devi Ahilya Vishwa Vidyalaya, Indore, 25 Feb, 2014.

10. ON-GOING PROJECTS

Project No.	Project Title	Name of PI	Duration
Mega Project 1	**Soybean genetic resource management- Acquisition, conservation, characterization, documentation and utilization**	Dr. Dinesh K. Agarwal	
NRCS 1.1/87	Augmentation, management and documentation of soybean germplasm	Dr.Dinesh K. Agarwal	1987-LT
Mega Project 2	**Genetic amelioration of soybean for yield, wide adaptability. nutrient use efficiency, resistance to biotic and abiotic stresses and improvement in quality of soybean seed**	Dr. S. M. Husain	
NRCS 1.6/92	Genetic improvement for yields and associated characters in soybean	Dr. S. M. Husain	1992-LT
DSR1.18/10	Breeding soybean for wider adaptability using photoperiod response and growth habits	Dr. Sanjay Gupta	2010-17
DSR1.19/10	Breeding soybean for improved phosphorus uptake efficiency	Dr. Sanjay Gupta	2010-15
DSR 1.17/09	Breeding soybean varieties resistant to defoliators, stem fly and girdle beetle	Dr. Dinesh K. Agarwal	2009-14
DSR 5.6b/09	Breeding for drought resistance / tolerance varieties in soybean	Dr. Gyanesh K. Satpute	2008-19
DSR 5.6c/11	Breeding for waterlogging tolerance in soybean	Dr. Mamta Arya	2011-21
NRCS 1.9/99	Breeding for resi.stance to rust and YMV in soybean	Dr. R. Ramteke	1999-LT
DSR 1.25/13	Development of multiparent intercross population for quantitative traits improvement in soybean	Dr. M. Shivakumar	2013-20

Project No.	Project Title	Name of PI	Duration
DSR 1.26/13	Studies on impact of field weathering on soybean seed quality and its management	Dr. P. Kuchlan	2013-17
Mega Project 3	**Molecular breeding and transgenic approaches for soybean improvement**	Dr. Anita Rani	
DSR 1.22/11	Validation of yield QTLs for marker assisted breeding in soybean	Dr. G. Kumawat	2011-14
DSR 1.23/12	Molecular mapping and genomics-assisted breeding for rust resistance in soybean	Dr. Milind B. Ratnaparkhe	2012-17
DSR 1.24/12	RNAi mediated viral gene silencing of *Yellow mosaic virus* (YMV) for development of transgenic resistance in soybean	Dr. S. V. Ramesh	2012-16
Mega Project 4	**Development of specialty soybean varieties for secondary agriculture and industrial uses**	Dr. Vineet Kumar	
NRCS 1.12/02	Breeding for food grade characters and high oil content	Dr. Anita Rani	2005-LT
Mega Project 5	**Managing the impact of current and future climate variability in soybean**	Dr. V. S. Bhatia	
DSR 5.6a/09	Physiological basis of tolerance/ resistance to abiotic stresses in soybean	Dr. V. S. Bhatia	
Mega Project 6	**Development of technologies for soybean based cropping system efficiency enhancement through resource conservation technologies, nutrient management, plant growth promoting microbes and farm machineries**	Dr. S. D. Billore	
DSR 4.10/09	Optimization of rotational tillage and crop rotation in soybean based cropping system	Dr. S. D. Billore	2009-20

Project No.	Project Title	Name of PI	Duration
DSR 4.12/11	Identification of sustainable/resilient soybean production system for changing climate	Dr. S. D. Billore	2011-13
DSR 4.11/10	Growth, rhizosphere properties, P acquisition and mobilization of intercropped soybean and maize in soil amended with phosphate	Dr. A. Ramesh	2013
DSR 6.8/13	Inoculum development of niche AM fungi for application in soybean-based cropping system	Dr. M. P. Sharma	2013-18
DSR 9.8/13	Design, development and validation of tractor operated disc harrow and rotary weeder for soybean	Dr. D. V. Singh	2013-16
Mega Project 7	**Surveillance, forecasting and control strategies for insect pest complex in soybean**	Dr. A. N. Sharma	
DSR 2.10/13	Conservation and enhancement of natural enemies of insect pests of soybean	Dr. Y. Sridhar	2013-16
Mega Project 8	**Developing plant protection modules for mitigating adverse effect of plant diseases in soybean**	Dr. G. K. Gupta	
DSR 3.9/10	Interactive effect of native isolates of *Trichoderma* spp., *Pseudomonas fluorescence* and *Sclerotium rolfsii* on health and growth of soybean	Dr. G. K. Gupta	2010-15
DSR3.10/12	Biology Epidemiology and Management of Anthraconose disease in soybean	Dr. M. M. Ansari	2012-17
DST 3.11/12	Studies on distribution of plant parasitic and entomopathogenic nematodes (EPN) associated with soybean cultivation and utilization of EPN for the management of major insect pests of soybean	Dr. K. M. Anes	2012-15

Project No.	Project Title	Name of PI	Duration
Mega Project 9	**Information digitization, technology dissemination, impact analysis and socio-economic research for soybean**	Dr. B. U. Dupare	
DSR 8.10/11	An impact analysis of awareness and utilization of soybean for food preparation in Madhya Pradesh	Dr. B. U. Dupare	2011-13
DSR 8.9/11	Assessment of interaction of technological adoption and climatic variation with soybean yield	Dr. B. U. Dupare	2011-15
DSR 7.4/11	Geo-informatic analysis system of soybean	Dr. R. M. Patel	2011-14
DSR 7.4/12	On-line data entry system for AICRPS agronomy trials data	Dr. Savita Kolhe	
DSR 8.12/13	Socio-Economic Analysis of Growth in Soybean Crop Productivity and Impact of Research	Dr. P. Sharma	2013-15

EXTERNALLY FUNDED PROJECTS

S. No.	Sponsoring Agency	Project Title	P.I.	Duration
1.	DAC, Government of India	DUST Project	Dr. M. Kuchlan	Since 2002
2.	ICAR	Development of transgenic soybean for insect and herbicide resistance.	Dr. Anita Rani	2006-15
3.	DBT	Marker assisted selection for development of Kunitz Trypsin inhibitor free soybean varieties	Dr. Vineet Kumar	2009-15
4.	NFBSFARA	Use of RNAi technology in development of low phytate rice and soybean	Dr. Anita Rani	2011-15

11. IMPORTANT COMMITTEES

There are number of committees which support the R&D programme as well as management and administrative work of the Centre.

11.1. Research Advisory Committee (up to 17.9.2013)

Chairman	Dr. Satya Prakash Tiwari, Ex-Vice Chancellor, Swami Keshwanand Rajasthan Agricultural University, Beechwal, Bikaner-334006 (Rajasthan).
Member	Dr. K. V. B. R. Tilak, Ex-Head, Department of Microbiology, IARI. Mayflower Park, Mallapur, Nacharam, Hyderabad-500076.
Member	Dr. O. P. Dubey, Ex-ADG (PP) ICAR, B-9, Green view apartments, Plot No. 33, Sector – 9, Rohini, New Delhi.
Member	Dr. A. S. Chandel, Ex-Professor (Agronomy), GBPUA&T, 20/3, Gulmohar Road, Shipra Suncity, Indirapuram, Ghaziabad (U.P.).
Member	Dr. S. S. Tomar, Director of Research, JNKVV, Jabalpur -482 004 (M.P.).
Member	Dr. S. K. Srivastava, Director, Directorate of Soybean Research, Khandwa Road, Indore 452001 (M.P.).
Member	Dr. B. B. Singh, ADG (O & P), ICAR, Krishi Bhawan, New Delhi.
Member Secretary	Dr. G. K. Gupta, Principal Scientist, Directorate of Soybean Research Khandwa Road, Indore-452001.

11.1 A. Research Advisory Committee (*w. e. f.* 18.9.2013 to 17.9.2016)

Chairman	Dr. V. S. Tomar, Vice Chancellor Jawaharlal Nehru Krishi Vishwa Vidyalaya, Krishi Nagar, Adhartal Jabalpur -482 004 (M.P.).
Member	Dr. V. D. Patil, Ex. ADG (O&P), ICAR. Plot No. 5&6, Sanjeevani Hospital, Mahalaxmi Housing Society Near Kachore Lawn, Manish Nagar, Nagpur- 440015 (Maharashtra).
Member	Dr. M. A. Shankar, Director of Research, University of Agricultural Science GKVK Campus, Bangalore-560065 (Karnataka).
Member	Dr. O. P. Singh, Ex. Professor (Entomology), JNKVV, Sehore President (R&D), M/s. Dhanuka Agritek Ltd., Dhanuka House 861-862, Joshi Road, Karol Bag , New Delhi-110005.
Member	Dr. Shatrughan Pandey, Principal Scientist (Retd.) D-13A/6, Ist Floor, Platinum Green, Ardee City Colony Sector -52 Gurgaon- 122002 (Haryana).

Member	Dr. S. K. Srivastava, Director, Directorate of Soybean Research Khandwa Road, Indore 452001 (M.P.).
Member	Dr. B. B. Singh, ADG (O & P), ICAR, Krishi Bhawan, New Delhi.
Member	Shri G. P. Saxena, Secretary Society for Horti- Agro Environment Development & Research Programming 1068, Scheme No. 114, Phase-I, Vijay Nagar, Indore (M.P.).
Member	Shri J. S. Pangaria, Business Advisor & Facilitator 335, Saket Nagar, Indore- 452018 (M.P.).
Member Secretary	Dr. G. K. Gupta, Principal Scientist (Plant Pathology) Directorate of Soybean Research, Khandwa Road, Indore-452001(M.P.).

11.2. Institute Management Committee (2013-14)

Chairman	Dr. S. K. Srivastava, Director, Directorate of Soybean Research Khandwa Road, Indore-452 001 (M.P.).
Member	Joint Director (Agriculture), Government of Madhya Pradesh, Indore.
Member	Director, Soil Conservation & Water Management Department of Agriculture, Government of Rajasthan, Jaipur.
Member	Dr. S. S. Tomar, Director of Research, JNKVV, Jabalpur.
Member	Dr. S. D. Kulkarni, Project Director, APPD Central Institute of Agricultural Engineering (CIAE), Nabi Bagh Berasia Road, Bhopal.
Member	Dr. N. P. Singh, Project Coordinator, AICRP on Chickpea Indian Institute of Pulses Research, Kanpur.
Member	Dr. M. Maheshwari, Principal Scientist & Head, Division of Crop Sciences Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad.
Member	Shri G. P. Saxena, Secretary, Society for Hort-Agro Environment Development & Research Programme 1068, Scheme No. 114, Phase-I, Vijay Nagar, Indore.
Member	Shri J. S. Pangaria, Business Advisor & Facilitator 335, Saket Nagar, Indore- 452018 (M.P.).
Member	Dr. A. N. Sharma, Principal Scientist Directorate of Soybean Research, Khandwa Road, Indore-452 001 (M.P.).
Member	Finance and Account Officer, Indian Institute of Soil Science (IISS), Bhopal.

Member Secretary	Administrative Officer, Directorate of Soybean Research Khandwa Road, Indore-452 001 (M.P.).

11.3. Institute Joint Staff Council

Chairman	Dr. S. K. Srivastava, Director

Official side

Member	Dr. A. N. Sharma, Principal Scientist
Member	Dr. M. P. Sharma, Principal Scientist
Member	Dr. S. D. Billore, Principal Scientist
Member	Dr. (Smt.) Savita Kolhe, Senior Scientist
Member	Finance & Accounts Officer
Member Secretary	Administrative Officer

Staff Side

Secretary	Shri S. K. Verma, Technical Officer (T-5)
Member	Shri O. P. Vishkarma, Technical Officer (T-5)
Member	Shri R. N. Kadam, Junior Clerk

11.4. Other Committees

1. Official Language Implementation Committe

Director, DSR (Chairman)
Dr. A. N. Sharma,
Smt. Savita Kolhe
Shri S. S. Vasuniaya
Shri S. K. Pandey
Shri S. K. Verma
Administrative Officer
Finance & Accounts Officer

2. Institute Technical Management Unit (ITMU) Committee

Director, DSR (Chairman)
Dr. G. K. Gupta
Dr. V. S. Bhatia
Dr. S. M. Husain
Dr. A. N. Sharma
Dr. S. D. Billore
Dr. M. P. Sharma
Finance & Accounts Officer
Administrative Officer

3. **Prioritization Monitoring and Evaluation Cell**

   Dr. V. S. Bhatia (In charge)
   Dr. B. U. Dupare
   Dr. S. V. Ramesh

4. **Purchase Advisory Committee**

   Dr. Anita Rani (Chairperson)
   Dr. S. D. Billore
   Dr. Milind B. Ratnaparkhe
   Finance & Accounts Officer
   Administrative Officer

5. **Human Resource Development Committee**

   Dr. M. M. Ansari, (Chairman)
   Dr. S. D. Billore
   Dr. B. U. Dupare
   Dr. V. P. Singh Bundela
   Secretary, IJSC
   Finance & Accounts Officer
   Administrative Officer

6. **Consultancy Processing Cell (CPC)**

   Dr. A. N. Sharma (Chairman)
   Dr. S. D. Billore
   Dr. Vineet Kumar
   Finance & Accounts Officer
   Administrative Officer

7. **Student Affairs Committee**

   Dr. S. M. Hussain (Chairman)
   Dr. Gyanesh Satpute
   Dr. Vineet Kumar
   Dr. A. Ramesh

8. **Higher Education Committee**

   Dr. S. M. Hussain (Chairman)
   Dr. Anita Rani
   Dr. Sanjay Gupta
   Administrative Officer

9. **Foreign Deputation Committee**

   Dr. Sanjay Gupta (Chairman)
   Dr. Milind Ratnaparkhe
   Finance and Accounts Officer
   Administrative Officer

10. **Printing and Publication Committee**

    Dr. G. K. Gupta (Chairman)
    Dr. V. S. Bhatia
    Dr. Surendra Kumar

11. **Editing (Hindi Publication)**

    Dr. A. N. Sharma
    Dr. B. U. Dupare
    Dr. Rajkumar Ramteke

12. **Editing (English Publication)**

    Dr. D. V. Singh
    Dr. Vineet Kumar
    Dr. Y. Sridhar
    Dr. S. V. Ramesh

13. **Library Advisory Committee**

    Dr. M. M. Ansari (Chairman)
    Dr. A. Ramesh
    Dr. Sushil K. Sharma
    Finance & Accounts Officer
    Administrative Officer
    Dr. Surendra Kumar

14. **Hindi Cell**

    Dr. A. N. Sharma (In charge)
    Shri S. K. Verma
    Shri Avinash Kalenke

15. **Works Committee**

    Dr. M. P. Sharma (Chairman)
    Estate Officer

Finance & Accounts Officer
Administrative Officer

16. Estate Committee

Dr. M. P. Sharma (Chairman)
Shri R. N. Srivastava
Shri R. C. Shakya
Shri S. N. Verma

17. Public Information Officer

Dr. G. K. Gupta
Dr. A. N. Sharma
Administrative Officer

18. Public Relation Officer

Administrative Officer
Assistant Administrative Officer

19. ARIS Committee

Dr. A. N. Sharma (Chairman)
Dr. Savita Kolhe
Shri Ram Manohar Patel

20. House Allotment Committee

Dr. A. N. Sharma (Chairman)
Dr. Milind B. Ratnaparkhe
Secretary, IJSC
Administrative Officer

21. Centralized Public Grievance Cell and Monitoring Systems (CPGCMS)

Dr. S. M. Hussain

22. Women Harassment Complaint Committee

Dr. Anita Rani (Chairperson)
Smt. Savita Kolhe
Dr. Poonam Kuchlan
Ku. Priyanka Sawant
Administrative Officer

23. Nodal Scientist Agro biodiversity Consortium Project

Dr. S. M. Hussain

24. Nodal Officer, RFD Unit

Dr. D. K. Agarwal (up to 30.01.2014)
Dr. Anita Rani (*w.e.f.* 31.01.2014)

25. Nodal Scientist IASRI-NAIP Statistics Project

Shri Ram Manohar Patel

26. Library In Charge

Dr. M. M. Ansari

27. Guest House /Management Committee

Dr. V. P. Singh Bundela
Shri Om Prakash Vishvakarma
Shri R. C. Shakya
Shri S. N. Verma

28. Publicity Committee

Dr. M. P. Sharma (Chairman)
Dr. B. U. Dupare
Dr. Gyanesh Satpute
Shri S. K. Verma
Shri D. N. Baraskar

29. Technical Specification Committee (above Rs. 50,000.00)

Dr. Sanjay Gupta (Chairman)
Dr. S. K. Sharma
Dr. Y. Sridhar

30. Price Fixation Committee

Dr. S. D. Billore (Chairman)
Dr. Vineet Kumar
Shri S. K. Pandey
Administrative Officer

31. Farm Produce Disposal and Price Fixation Committee

Dr. S. D. Billore (Chairman)
Shri Charan Singh
Dr. V. P. S. Bundela
Finance & Accounts Officer
Administrative Officer

32. Condemnation and Auction Committee

Dr. M. M. Ansari (Chairman)
Dr. S. K. Sharma
Shri Ram Manohar Patel
Finance & Accounts Officer
Administrative Officer

33. Laboratory In Charges

Dr. M. M. Ansari - Pathology
Dr. V. S. Bhatia - Physiology
Dr. S. M. Husain - Plant Breeding, Seed Technology, DUS Testing, Germplasm
Dr. Milind B. Ratnaparkhe- Biotechnology
Dr. A. N. Sharma - Entomology
Dr. Anita Rani - Transgenics
Dr. M. P. Sharma - Microbiology
Dr. Vineet Kumar – Biochemistry
Dr. S. D. Billore - Agronomy
Dr. Savita Kolhe - Computer
Dr. B. U. Dupare - Extension

34. Security Cell

Dr. V. P. S. Bundela
Shri O. P. Vishwakarma

35. Physical Verification Committee

Dr. Vineet Kumar (Chairman)
Dr. Y. Sridhar
Dr. P. Sharma
Shri Charan Singh

36. Estate Officer

Shri R. N. Shrivastava

37. Record Officer

Assistant Administrative Officer

38. Vehicle In charge

Dr. Nikhlesh Pandya

39. Store In charge

Shri Charan Singh

40. Tofu Plant In charge

Dr. V. P. Singh Bundela

12. PARTICIPATION IN SEMINARS, SYMPOSIA, CONFERENCES, AND WORKSHOPS

Sl. No.	Participant	Event	Venue & Date
1.	Dr. Mrinal Kuchlan	8th Review Meeting of Protection of Plant Varieties and Farmers' Right Authority (DUS Project)	UAS, Dharwad, 28 Feb-1 March 2014
2.	Dr. Mrinal Kuchlan	National Training Course on Application of Nanotechnology in Agriculture	CAZRI, Jodhpur 10-19 March 2014
3.	Dr. B. U. Dupare	National Seminar on Social Dimensions of Extension Education in Holistic Development of Rural Livelihood	CBG College of Agri. Lucknow 26-27 April 2013
4.	Dr. B. U. Dupare and Dr. S. K. Srivastava	National Conference on Making Agriculture Profitable	RVSKVV, Gwalior 26-27 July 2013
5.	Dr. Purushottam Sharma	21st Annual Conference of Agricultural Economics Research Association	SKUAST, Shrinagar 10-12 Sep 2014
6.	Dr. S. V. Ramesh	International Symposium on Advances in non-coding Genomics	Institute of Bioinformatics and Applied Biotechnology (IBAB), Bengaluru 13-14 Sep 2013
7.	Dr. Purushottam Sharma	Work shop on Supply Chain Management of Soybean	NAARM, Hyderabad 8-10 Oct 2013
8.	Dr. S.V. Ramesh	Pacific Northwest Vegetable Association Conference and Trade Show	Three Rivers Convention Center, Kennewick, Washington, USA 12-13 Nov 2013
9.	Dr. Savita Kolhe	Winter School on Data Analytics	DAVV, Indore 15-18 Nov 2013

Sl. No.	Participant	Event	Venue & Date
10.	Dr. Y. Sridhar	NAIP-NABG Subject Matter Training Course on Bioinformatics-*Insilico* Approaches in Entomology	NBAII, Bengaluru 18 to 30 Nov 2013
11.	Dr. K. M. Anes	National symposium on Nematode: a friend and foe of agri-horticultural crops	Univ. H&F, Solan 21-23 November, 2013
12.	Dr. B. U. Dupare	International Conference on Extension Education Strategies for Sustainable Agricultural Development-A Global Perspective	UAS, Bengaluru 5-8 December 2013
13.	Dr. M. P. Sharma	3rd Annual BA-UMD Fall Symposium on Trends in Agriculture, Climate Change: Food and Environmental Security	Univ. Maryland, USA January 23 2014
14.	Dr. S.V. Ramesh	Dr. William R. Wiley Research Exposition	Washington State University, Pullman, Washington, USA 21 Feb 2014
15.	Dr. S. K. Srivastava	International Soybean Research Conference	Indore, 22-24 Feb 2014
16.	Dr. G. K. Gupta	International Soybean Research Conference	Indore, 22-24 Feb 2014
17.	Dr. S. M. Husain	International Soybean Research Conference	Indore, 22-24 Feb 2014
18.	Dr. V. S. Bhatia	International Soybean Research Conference	Indore, 22-24 Feb 2014
19.	Dr. M. M. Ansari	International Soybean Research Conference	Indore, 22-24 Feb 2014

Sl. No.	Participant	Event	Venue & Date
20.	Dr. A. N. Sharma	International Soybean Research Conference	Indore, 22-24 Feb 2014
21.	Dr. (Smt.) Anita Rani	International Soybean Research Conference	Indore, 22-24 Feb 2014
22.	Dr. Sanjay Gupta	International Soybean Research Conference	Indore, 22-24 Feb 2014
23.	Dr. S. D. Billore	International Soybean Research Conference	Indore, 22-24 Feb 2014
24.	Dr. M. P. Sharma	International Soybean Research Conference	Indore, 22-24 Feb 2014
25.	Dr. Vineet Kumar	International Soybean Research Conference	Indore, 22-24 Feb 2014
26.	Dr. A. Ramesh	International Soybean Research Conference	Indore, 22-24 Feb 2014
27.	Dr. B. U. Dupare	International Soybean Research Conference	Indore, 22-24 Feb 2014
28.	Dr. Y. Sridhar	International Soybean Research Conference	Indore, 22-24 Feb 2014
29.	Dr. M. B. Ratnaparkhe	International Soybean Research Conference	Indore, 22-24 Feb 2014
30.	Dr. Gyanesh Satpute	International Soybean Research Conference	Indore, 22-24 Feb 2014
31.	Dr. Purushottam Sharma	International Soybean Research Conference	Indore, 22-24 Feb 2014
32.	Dr. R. K. Ramtake	International Soybean Research Conference	Indore, 22-24 Feb 2014
33.	Dr. Savita Kohle	International Soybean Research Conference	Indore, 22-24 Feb 2014

Sl. No.	Participant	Event	Venue & Date
34.	Dr. Poonam Kuchlan	International Soybean Research Conference	Indore, 22-24 Feb 2014
35.	Shri R. M. Patel	International Soybean Research Conference	Indore, 22-24 Feb 2014
36.	Dr. Mrinal K. Kuchlan	International Soybean Research Conference	Indore, 22-24 Feb 2014
37.	Dr. Giriraj Kumawat	International Soybean Research Conference	Indore, 22-24 Feb 2014
38.	Dr. Mamta Arya	International Soybean Research Conference	Indore, 22-24 Feb 2014
39.	Dr. K. M. Anes	International Soybean Research Conference	Indore, 22-24 Feb 2014
40.	Dr. M. Shivakumar	International Soybean Research Conference	Indore, 22-24 Feb 2014

13. DISTINGUISHED VISITORS

The following are the eminent persons visited this Directorate during the year 2012-13

Sl. No.	Name and Affiliation	Date of Visit
1.	Dr. S. Ayappan, Secretary (DARE) & D.G. ICAR, Krishi Bhawn, New Delhi	22.2.2014
2.	Dr. Atonu Purskayastha, Joint Secretary (Seeds & TMOP) Deptt. of Agril. & Cooparation,Krishi Bhawan, New Delhi	30.08.2013
3.	Dr. K. D. Kokate, DDG (Agril. Extn.), ICAR, New Delhi Krishi Bhawn, New Delhi	20.04.2013

14. PERSONNEL

(As on 31 March 2014)

A.	**Research Management**		
1.	Dr. S. K. Srivastava	Director	
B.	**Scientific**		
1.	Dr. G. K. Gupta	Principal Scientist	Plant Pathology
2.	Dr. S. M. Husain	Principal Scientist	Plant Breeding
3.	Dr. V. S. Bhatia	Principal Scientist	Plant Physiology
4.	Dr. M. M. Ansari	Principal Scientist	Plant Pathology
5.	Dr. A. N. Sharma	Principal Scientist	Entomology
6.	Dr. S. S. Vinayagam	Principal Scientist	Agricultural Extension (On Deputation)
7.	Dr. (Smt.) Anita Rani	Principal Scientist	Plant Breeding
8.	Dr. Sanjay Gupta	Principal Scientist	Plant Breeding
9.	Dr. S. D. Billore	Principal Scientist	Agronomy
10.	Dr. Mahaveer P. Sharma	Principal Scientist	Microbiology
11.	Dr. Vineet Kumar	Principal Scientist	Biochemistry
12.	Er. (Dr.) Dev Vrat Singh	Senior Scientist	Farm Machinery and Power
13.	Dr. A. Ramesh	Senior Scientist	Soil Science
14.	Dr. Sushil K. Sharma	Senior Scientist	Microbiology (upto 31 Aug 2013)
15.	Dr. B. U. Dupare	Senior Scientist	Agricultural Extension
16.	Dr. D. K. Agarwal	Senior Scientist	Plant Breeding (upto 31 Jan 2014)
17.	Dr. (Smt.) Savita Kohle	Senior Scientist	Computer Application
18.	Dr. Y. Sridhar	Senior Scientist	Entomology
19.	Dr. Milind B. Ratnaparkhe	Senior Scientist	Biotechnology
20.	Dr. Gyanesh Satpute	Senior Scientist	Genetics
21.	Dr. Purushottam Sharma	Senior Scientist	Agricultural Economics
22.	Dr. Rajkumar Ramtake	Scientist (Senior Scale)	Genetics
23.	Dr. (Smt.) Poonam Kuchlan	Scientist (Senior Scale)	Seed Technology
24.	Dr. S. V. Ramesh	Scientist	Biotechnology
25.	Dr. C. Gireesh	Scientist	Plant Breeding
26.	Dr. Mirinal Kumar Kuchlan	Scientist	Seed Technology
27.	Shri Ram Manohar Patel	Scientist	Agril. Statistics
28.	Dr. K. M. Anes	Scientist	Nematology
29.	Dr. Giriraj Kumawat	Scientist	Biotechnology

30.	Dr. Mamta Arya	Scientist	Genetics
31.	Dr. M. Shivakumar	Scientist	Plant Breeding
C.	**Technical**		
1.	Dr. Surendra Kumar	Chief Technical Officer	(T-9)
2.	Shri Charan Singh	Asst. Chief Technical Officer	(T-7-8)
3.	Shri S. K. Pandey	Asst. Chief Technical Officer	(T-7-8)
4.	Shri R. N. Singh	Asst. Chief Technical Officer	(T-7-8)
5.	Dr. V. P. S. Bundela	Asst. Chief Technical Officer	(T-7-8)
6.	Dr. Nikhlesh Pandya	Asst. Chief Technical Officer	(T-7-8)
7.	Dr. Yogendra Mohan	Asst. Chief Technical Officer	(T-7-8)
8.	Shri S. S. Vasunia	Senior Technical Officer	(T-6)
9.	Shri D. N. Baraskar	Senior Technical Officer	(T-6)
10.	Dr. S. K. Sharma	Senior Technical Officer	(T-6)
11.	Shri R. N. Srivastava	Senior Technical Officer	(T-6)
12.	Shri S. K. Verma	Technical Officer	(T-5)
13.	Shri O. P. Vishwakarma	Technical Officer	(T-5)
14.	Shri R. C. Shakya	Technical Assistant	(T-3)
15.	Shri Mahaveer Singh	Technical Assistant	(T-3)
16.	Shri Devendra Singh Yadav	Technical Assistant	(T-3)
17.	Shri I. R. Khan	Technical Assistant	(T-3)
18.	Shri Gorelal Chouhan	Technical Assistant	(T-3)
19.	Shri Francis Yunis	Technical Assistant	(L/V) (T-3)
20.	Shri Bilbar Singh	Senior Technician	(L/V) (T-2)
21.	Shri Shambhu Nath Verma	Senior Technician	(T-2)
D.	**Administration and Accounts**		
1.	Shri A. K. Maheshwari	Finance and Account Officer	
2.	Shri S.P.Singh	Assistant Administrative Officer	
3.	Shri Lokendra Soni	PA to Director. *w. e. f.* 27.07.2013	
4.	Shri Ajay Kumar	Assistant	
5.	Ku. Priyanka Sawan	Assistant	
6.	Shri. Ravishankar Kumar	Assistant	
7.	Shri Avinash Kalanke	Senior Clerk	
8.	Shri Anil Kumar Carrasco	Senior Clerk	
9.	Shri R. N. Kadam	Junior Clerk	
10.	Shri Sanjeev Kumar	Duplicating Operator	

Skilled Supporting Staff		
1.	Shri Gulab Singh	SSG III
2.	Shri Dhan Singh	SSG III
3.	Shri Roop Singh	SSG II
4.	Shri Nirbhay Singh	SSG II
5.	Shri Bhav Singh	SSG II
6.	Shri Janglia	SSG II
7.	Shri Surla	SSG I
8.	Shri Sur Singh	SSG I
9.	Smt. Prakaswati Sura	SSG I
10.	Shri Balbeer Singh	SSG I
11.	Shri Prahlad Singh	SSG I

15. APPOINTMENTS, PROMOTIONS, TRANSFERS, ETC.

15.1. Appointments

S. No.	Name	Post	Date of joining
1.	Shri Lokendra Soni	P.A. To Director	27 July 2013

15.2. Promotions

S. No.	Name	Post	*w. e. f.*
1.	Dr. Vineet Kumar	Principal Scientist	26 Aug 2012
2.	Dr. Savita Kolhe	Senior Scientist	08 Dec 2008
3.	Dr. Surendra Kumar	Chief Documentation Officer	06 July 2011
4.	Dr. Punam Kuchalan	Scientist (Senior Scale)	29 June 2011

15.3 Deputations/ Selection

S. No.	Name	As	*w. e. f.*
1.	Dr. S. S. Vinayagam	Professor & Project Director, Rural Technology Park, NIRD, Hyderabad.Currently with MANAGE, Hyderabad.	22 Feb 2007
2.	Dr. S. K. Sharma	Principal Scientist, National Biodiversity Board, Shillong	08 Dec 2008

15.4. Transfers

S. No.	Name	From	To	*w. e. f.*
1.	Dr. Sushil K. Sharma	DSR, Indore	NBAIM, Kushmaur, Mau	31 Aug 2013
2.	Dr. D. K. Agarwal	DSR, Indore	DSR, Kushmaur, Mau	31 Jan 2014
3.	Shri G. F. Shahir	DSR, Indore	NIASM, Baramati	02 July 2013

15.5. Retirement

Nil

15.6. Higher education

S. No.	Name	Degree Awarded	University/Institute
1.	Dr. C. Gireesh	Ph. D.	Indian Agricultural Research, New Delhi

15.7. Obituary

Nil

16. INFRASTRUCTURAL DEVELOPMENT (2012-13)

16.1. Works

Nil

16.2. Equipments

The following major equipments costing above Rs.50, 000 were purchased.

1.	Refrigerated centrifuge
2.	Deep freezer
3.	Gradient thermal cycler (3X32 well block)
4.	Gradient thermal cycler (96 well block)
5.	Insect growth chamber
6.	Stereo zoom microscope with image analysis system
7.	BOD incubator
8.	Laminar air flow
9.	Spectrophotometer
10.	Nitrogen analyzer

17. राजभाषा कार्यान्वयन

(1) हिन्दी पखवाड़ा आयोजन (सितम्बर 2013)

सोयाबीन अनुसंधान निदेशालय , इन्दौर में प्रतिवर्षानुसार इस वर्ष भी दिनांक 2–13 दिसमबर के दौरान हिन्दी पखवाडे का आयोजन पूरे हर्षोल्लास के साथ किया गया । इस के अन्तर्गत निम्नलिखित विभिन्न गतिविधियों आयोजित की गई :–

- हिन्दी पखवाडे का उद्घाटन दिनांक 2 सितम्बर 2013 को निदेशालय के डॉ.एस.के. श्रीवास्तव , निदेशक एवं अध्यक्ष राजभाषा कार्यान्वयन समिति , डॉ. ओमप्रकाश जोशी , पूर्व प्रधान वैज्ञानिक तथा डॉ. जी.के गुप्ता प्रधान वैज्ञानिक एवं अनुभाग फसल संरक्षण ,डॉ. एस.एम.हुसैन , प्रधान वैज्ञानिक एवं अनुभाग प्रभारी फसल सुधार , डॉ. विरेन्द्रसिंह भाटिया , प्रधान वैज्ञानिक एवं अनुभाग प्रभारी फसल उत्पादन डॉ. ए.एन. शर्मा प्रधान वैज्ञानिक एवं प्रभारी (राजभाषा) सोयाबीन अनुसंधान निदेशालय इन्दौर, ने माँ सरस्वती को माल्यार्पण कर उनके समक्ष दीप प्रज्जवलित कर कार्यक्रम कर विधिवत शुभारंभ किया। इस समारोह के दौरान वक्ताओ ने निदेशालय में राजभाषा के प्रगामी प्रयोग एवं अनुसंधान के प्रचार प्रसार एवं सप्रेषण तथा राजभाषा श्शोधपत्रों एवं तकनीकी लेखन का कार्य शत प्रतिशत हिन्दी में करने के लिये आव्हान किया गया। हिन्दी के निरन्तर प्रयोग एवं उसके प्रति समर्पण के द्वारा उसे और अधिक समृद्ध करने की आवश्यकता पर बल दिया। प्रभारी अधिकारी (राजभाषा द्वारा हिन्दी पखवाडे के दौरान आयोजित की जानी वाली विभिन्न गतिविधियों की विस्तार पूर्वक जानकारी प्रदान की। समारोह का संचालन श्री श्यामकिशोर वर्मा सदस्य सचिव, राजभाषा कार्यान्यवन समिति एवं आभार प्रदर्शन डॉ. एस.डी.बिल्लौरे , प्रधान वैज्ञानिक (सस्य विज्ञान) द्वारा किया गया ।

- दिनांक 3 सितम्बर 2013 को निदेशालय के कुशल सहायक ग्रेड कर्मचारियों के लिये श्रुतिलेख प्रतियोगिता आयोजित की गई ।

- दिनांक 3 सितम्बर 2013 को निदेशालय के समस्त कर्मचारियों के लिये निबंध प्रतियोगिता का आयोजन किया गया ''जन संचार माध्यमों से हिन्दी का बदलता स्वरूप एक विवेचना '' था । प्रतियोगिताओ ने इस विषय पर अपने आप विचार प्रस्तुत किये ।

- दिनांक 6 सितम्बर 2013 को ''राजभाषा का अतीत एवं वर्तमान परिदृश्य'' विषय पर हिन्दी कार्यशाला का आयोजन किया गया । जिसम श्री श्याम यादव, जनसम्पर्क

अधिकारी भारतीय जनसंचार निगम लिमिटेड़, ने अपने व्याख्यान से श्रोताओं में हिन्दी राजाभाषा के प्रति समर्पण एवं सवैधांनिक दायित्व की भावना जाग्रत की। कार्यक्रम का संचालन डॉ. पुरूषोत्तम शर्मा , वरिष्ठ वैज्ञानिक (कृषि अर्थशास्त्र) ने किया एवं आभार प्रदर्शन श्री संजय कुमार पाण्डे ,तकनीकी अधिकारी ने किया ।

- दिनांक 10 सितम्बर 2013 को निदेशालय के समस्त कर्मचारियों के लिये ''प्रश्न मंच'' प्रतियोगिता आयोजित की गई जिसमें कर्मचारियों ने बढ–चढकर भाग लिया और प्रतियोगिता में अधिकारियो/कर्मचारियों में हिन्दी के प्रति और अधिक कार्य करने के लिये उत्साह जागृत हुआ ।

- 11 सितम्बर 2013 को निदेशालय के समस्त कर्मचारियों के ''प्रस्तुतीकरण कुशलता '' प्रतियोगिता का आयोजन किया गया ।

- हिन्दी पखवाडे का समापन एवं पुरूस्कार वितरण समारोह 13 सितम्बर 2013 को आयोजित किया गया । इस अवसर पर समारोहक मुख्य अतिथि श्री मुकेश चौहान , मुख्य अभियंता नर्मदा नियत्रंण प्राधिकरण इन्दौर एवं सचिव केन्दीय सरकारी कर्मचारी कल्याण समन्वयन समिति इन्दौर एवं अध्यक्ष निदेशालय के निदेशक डॉ. एस. के.श्रीवास्तव थे। कार्यक्रम में स्वागत भाषण एवं हिन्दी पखवाडे की रिपोर्ट डॉ.अमरनाथ शर्मा, प्रधान वैज्ञानिक एवं प्रभारी अधिकारी (राजभाषा) ने प्रस्तुत की । मुख्य अतिथि द्वारा समारोह के दौरान विभिन्न प्रतियोगिताओं के 22 विजेताओं को पुरस्कार प्रदान किये गये। मुख्य अतिथि द्वारा निदेशालय से किये जा रहे हिन्दी के प्रगामी विकास कार्यो की सराहना की । कार्यक्रम का संचालक डॉ.बी.यू.दुपारे वरिष्ठ वैज्ञानिक (कृषि विस्तार) एवं आभार प्रदर्शन डॉ.एस डी. बिल्लौरे, प्रधान वैज्ञानिक (सस्य विज्ञान) ने किया ।

(2) हिन्दी कार्यशालाओं का आयोजन

दिनांक	विषय	अतिथि वक्ता
2 मार्च 2013	राजभाषा विभाग के कार्य और कार्यक्षक	श्री पारसनाथ शर्मा, उपमहाप्रबंधक पश्चिम रेल्वे मुम्बई
15 जून 2013	वित्तिय कार्य निष्पादन हेतु महत्वपूर्ण जानकारियॉ	श्री अजय कुमार माहेश्वरी, वित्त एवं लेखा अधिकारी सोयाबीन अनुसंधान निदेशालय इन्दौर
6 सितम्बर 2013	राजभाषा का अतीत एवं वर्तमान परिदृश्य	श्री श्याम यादव, जनसंपर्क अधिकारी भारतीय दूरसंचार निगम लिमिटेड, इन्दौर
24 सितम्बर 2013	राजभाषा निति एवं कार्यान्वयन	श्री आर.एन. शिन्दे, निदेशक भारतीय विमानतल प्राधिकरण इन्दौर

राजभाषा कार्यान्यन समिति की बैठकें

- प्रथम बैठक – दिनांक 18 फरवरी 2013
- द्वितिय बैठक – दिनांक 7 जून 2013
- तृतीय बैठक – दिनांक 16 अगस्त 2013
- चतुर्थ बैठक – दिनांक 31 अक्टूम्बर 2013

हर कदम, हर डगर
किसानों का हमसफर

भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch