भाकृअनुप
ICAR

# वार्षिक प्रतिवेदन
# ANNUAL REPORT
# 2018-19


## भाकृअनुप–मूँगफली अनुसंधान निदेशालय
(आई.एस.ओ 9001 : 2015 प्रमाणित संस्थान)
इवनगर रोड, पोस्ट बॉक्स नं. 5, जूनागढ 362 001, गुजरात, भारत

## ICAR-Directorate of Groundnut Research
(An ISO 9001 : 2015 Certified Institute)
Ivnagar Road, PO Box No. 5, Junagadh-362 001, Gujarat, India

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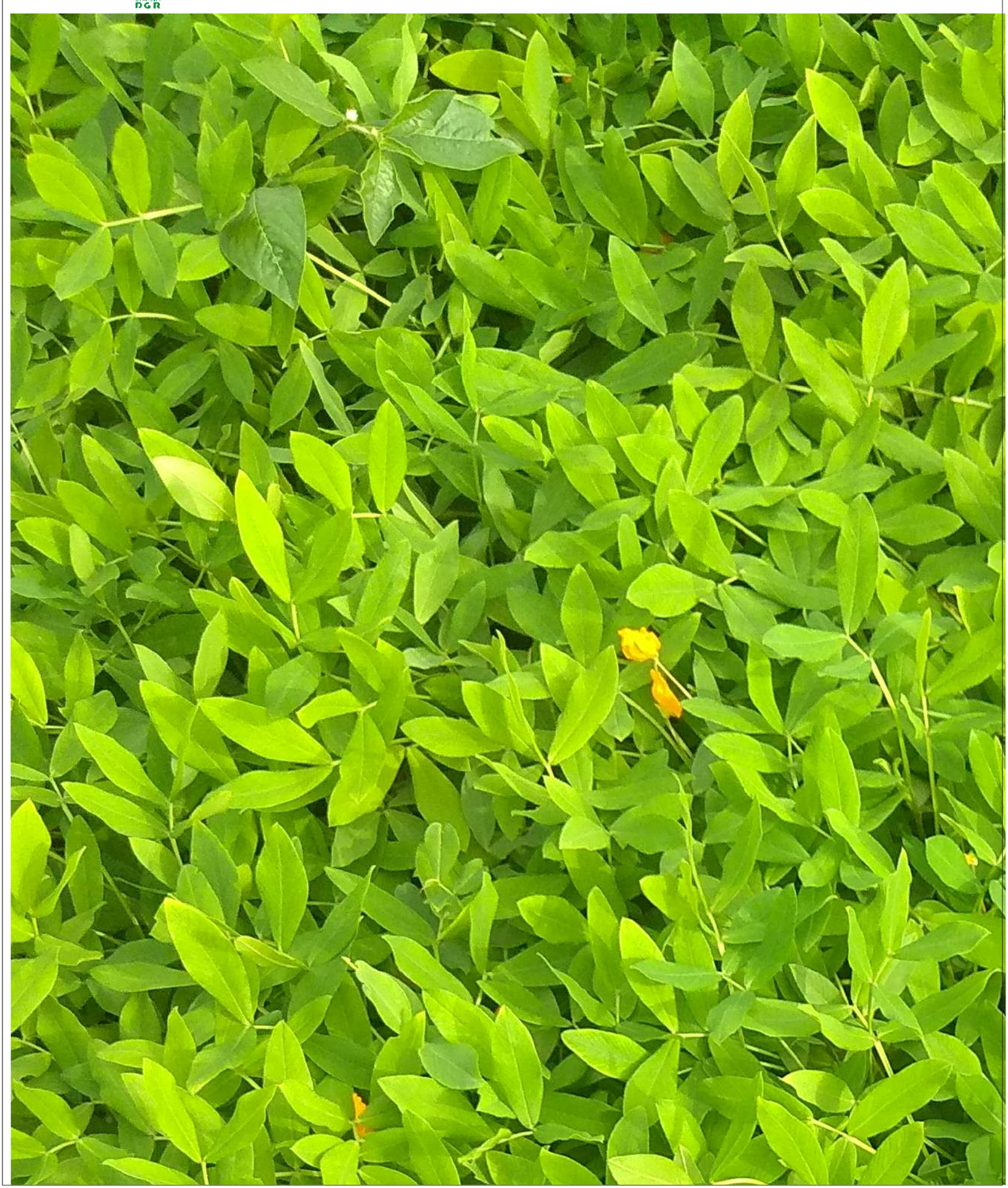
# Contents



In addition to the prominent role as an oilseed, groundnut has been gaining popularity as snacks food due to its nutritive value. Though there was a reduction in the production of groundnut during the year, India's groundnut export stood at 4.89 lakh tones amounting to Rs 3298.33 crore.

ICAR-DGR developed two high oleic acid containing lines Girnar 4 and Girnar 5. Oil of these lines has longer shelf life and heart friendly. These lines have about 80 per cent oleic acid content, while normal verities contain 40-60 per cent oleic acid. The commercialization of high oleic groundnut varieties in India may become a boon to the food industry by providing longer shelf life and improved health benefits. We have identified germplasm accessions NRCG 5203, 2419, 4343, 4874 and CSMG 2014 for early maturity (95 to 105 days). Identified four cultivated verities i.e. JL 220, JGN 3, ICGV 87846 and ICGV 00348 for growing under low temperature conditions while one germplasm accession, NRCG 14480 was found promising for both low and high temperature tolerance. Groundnut is a good source (2.93-7.13µg/g) of resveratrol, an anti-ageing and antioxidant compound. It was observed that application of endophyte could reduce 4-5 irrigation for summer groundnut. Groundnut pod equivalent yield was found higher with 3:1 ratio in groundnut + pigeonpea relay cropping. Straw mulch improved pod yield of groundnut under salinity condition. Organic formulation DGROF2 was found to inhibit stem rot and supported yield. During the year, a total of 10458.91q breeder seeds comprising 48 varieties were produced. To demonstrate the new and improved technologies on groundnut production on the farming community we have organized 557 front line demonstration.

Three farmers' fairs were organized on 1$^{tst}$ October, and 27$^{th}$ December 2018 and 24$^{th}$ February 2019 to familiarize farmers for the latest production technologies, in which about 1000 farmers including women participated. During 2017-18, the DGR Scientists published 47research articles and presented 45 papers in conference and symposia. Under capacity building program for employees, 15 scientists, three technical and one administrative personnel attended various trainings. In order to bring awareness about general service rules among the staff two training programmes were formulated and implemented for SSS and TSLs of ICAR-DGR from 22-27$^{th}$ October 2018. Utilization of the grants was to the tune of Rs 1821 lakhs out of Rs 1854.44 lakhs allocated for DGR and Rs. 830.60 lakhs out of 849.54 lakhs allocated for AICRP-Groundnut. The funds received through the externally funded projects were also utilized effectively.

I congratulate the members of my DGR team for the achievements and appreciate the editorial committee for compiling and editing this report in time.

(Radhakrishnan T)

# Executive summary

## Crop Improvement

- 59 single plant progenies selected from different segregating generations
- 120 promising advanced breeding lines multiplied.
- 40 promising genotypes identified with pod yield higher than check K6 after screening more than 700 genotypes.
- Sixteen crosses were effected in *kharif* 2018 to develop improved varieties resistance of *Alternaria* leaf blight, leaf spot and rust, stem rot.
- A total 212 single plants have been identified as hybrids in sixteen crosses during summer 2018 (95) and *kharif* 2018 (117).
- Progenies of 74 crosses were advanced to different filial generations ($F_2$-$F_6$) during summer 2018 (11) and *kharif* 2018 (63).
- Ten new advanced high yielding breeding lines (three of Spanish and seven of Virginia habit group) were developed during summer 2018 (2) and *kharif*-2018 (8).
- An advanced breeding line, PBS-12218 (pod yield: 3809; kernel yield: 2734 kg/ha and SOT: 72%) significantly surpassed the best check variety TG-37A for pod yield (2877kg/ha) and Dh-86 for kernel yield and shelling outturn (pod yield: 1943 kg/ha, SOT: 68%) during summer 2018.
- Two advanced breeding lines *viz.*, PBS-12223 (pod yield: 2457 and kernel yield: 1816 kg /ha) and PBS-12225 (pod yield:2354 and kernel yield: 1661kg/ha) significantly surpassed the best check variety TG 37A for pod yield (1788 kg/ha) and JL 501 for kernel yield (1308kg/ha) during *kharif*-2018..
- Based on two summer season (2017, 2018) screening results revealed five cultivars *viz.*, Kaidiri 9, Kadiri Haritendra, ICGV-00348, ICGS-44 and GJG-17; five advanced advanced breeding lines *viz.*, PBS-12185, PBS-12190, PBS-22131, PBS-22132 and PBS-22133 and five interspecific derivatives *viz.*, NRCGCS-176, NRCGCS-180, NRCGCS-186, NRCGCS-96 and NRCGCS-298 recorded a disease score 3 on 1-9 scale.
- An advanced breeding line PBS-22092 recorded less than 15% collar rot incidence in four consecutive *kharif* season (2015-2018) at DGR-RRS, Bikaner. Hence genotype has been identified as novel genetic stock for resistant to collar rot.
- Three advanced breeding lines *viz.*, PBS-18038, PBS-18064 and PBS-22089 recorded low plant mortality 7.8%, 8.8% and 5.9% respecti-vely as compared to genotype OG-52-1 (13.2%) and J-11 (18.7%) during *kharif* 2018 at DGR-RRS, Bikaner.

- Germplasm accessions NRCG 5203, 2419, 4343, 4874, CSMG 2014 were matured between 95 to 105 days. Yield per plant was higher in accessions NRCG 955, NRCG 6063 and RTHRG 6063. Accessions NRCG 8954, 2746, and 9356 exhibited higher kernel length to width ratio (>2) during both *Kharif* 2017 and *Kharif* 2018 seasons.
- From Virginia bunch advanced breeding lines trials, advanced breeding lines PBS 24134, 24139, 26048, 24135, 25028, 25089, 25049 and 26052 had maturity duration of 110 to 115 days. Shelling per cent (>70%) was higher in advanced breeding lines PBS 24137, 24136, 24135, 24138, 24142 and 25091. Advanced breeding lines exhibited higher kernel length than GG20 are PBS 251095, 21108, 21105 and 21092.
- Advanced breeding lines PBS 14060, 14068,15019 and 16023 for SCMR; PBS 14066 and 30037 were found superior with respect to pod yield per plant from Spanish breeding line evaluation trials. Advanced breeding lines PBS 15018, 15047, 15057, 16025 and 30080 were matured in 100 days. Shelling per cent age (>70%) was found higher in breeding lines PBS 11093, 15038 and 16024, whereas kernel length to width ratio (2) was higher in PBS 16052,15026 and 15031.
- Screening of germplasm collections and advanced breeding lines for late leaf spot and early leaf spot during *kharif* 2017 and *kharif* 2018 respectively. Breeding lines and accessions showed moderate tolerance to LLS and ELS are: PBS 11085, 11092, NCRG CS 313 and PBS 11073. Accessi-ons RHRG 6063, RSB 87, NRCG 2615, 8954, 13262 and advanced breeding lines PBS 24102, 24103, 24104 and 16053 showed tolerance levels to ELS during *kharif* 2018. Screening of 62 Spanish breeding lines for fresh seed dormancy during *kharif* 2018, advanced breeding lines PBS14060, 14068, 16033,16044, 11077, 11092, 15014, 15022, 15027, 15028, 16022, 16023 and 16038 exhibited more than 20 days fresh seed dormancy.
- A total of 108 accessions representing six sections *vizArachis* (54), *Caulorhizae*(1), *Erectoides* (7), *Heteranthae* (7), *Procumbentes* (6) and *Rhizomatosae* (40) were maintained in the field gene bank. Seeds from annual species of section *Arachis* were harvested and conserved. Seven amphidiploid derivatives have also been maintained for further use in crop improvement programme.
- A total of 161 accessions were multiplied in summer 2018 andin *kharif*, altogether 1848 germplasm accessions have been multipliedwhich included: Crop Cafeteria (45), Composite collection for drought tolerance (196), Released Varieties (217), Bolivian accessions(99), accessions of Argentina (100) accessions with low Carbon Isotope Discrimination (30), interspecific derivatives (170) and accessions for rejuvenation (1187).
- To assess the effect of low and high temperature tolerance on germination reproductive traits and yield, 36 released varieties and 25 mini-core accessions (pre-identified to be cold tolerant under lab conditions) were evaluated in the field under two different sowing dates viz. early (19 Jan 2018) and late (25 March 2018). The key traits affected due to low temperature have been found to be seed germi-nation, seedling emergence, and crop stand leading to delay in maturity. While high temperature influenced the flowering duration, and pollen fertility. In both the cases the pod yield was drastically reduced (35%-65%). The experiment was conducted at ICAR-Junaga-dh and HAU Bawal.
- For early sown low temperature conditions of Junagadh,

seven mini-core accessions NRCGs 14480, 14374, 14480, 14324, 14367, 14414, 14333 were found promising based on rapid germination, flowering behavior and yield. Whereas for late sown high temperature conditions, five mini-core accessions NRCGs 14480, 14324, 14367, 14414, 14333 were found promising. Thus, for low and high temperature tolerance, four accessions NRCGs 14324, 14367, 14414, 14333 were identified as promising.

- Among the released varieties, seven (TAG 24, ICGV 00350, JGN 3, GJG 9, JL 220, LGN 1, ICGV 87846) varieties were found promising for early sown low temperature conditions of Junagadh based on rapid germination, flowering behavior and yield. For late sown and high temperature conditions eight varieties KRG 1 GG 8, GJG 17, OG 52-1, GAUG 1, Dh 86, ICGV 00350, JGN 3 were found promising. Promising varieties identified for both low, high temperature tolerance at Junagadh conditions were ICGV 87846, LGN 1, TAG 24, JGN 3, GJG 9, TG 17, JL 220, ICGV 00350, TG 1, and Narayini.
- At Bawal, five accessions NRCGs 14454,14480,14481, 14484, 14492 for early sown (low temperature) conditions; seven (NRCGs 14454, 14480, 14492, 14419,14328, 14424,14339) for high temperature conditions and three accessions (NRCGs 14454,14480, 14492) were found promising for both high and low temperature conditions. In the same location eleven varieties (ALR 3, Somnath, GG 13, KRG 1, ALR 2, TG 17, JGN 3, ICGV 87846, Utkarsh, Narayani, ICGV 00348)for both low and high temperature tolerance were found promising.
- At both the locations Junagadh and Bawal, among the released varieties four (JL 220, JGN 3, ICGV 87846, ICGV 00348) for low temperature conditions and among germplasm one accession, NRCG 14480 was found promising for both low and high temperature tolerance at both Junagadh and Bawal. These genotypes can be used as donors for imparting thermo tolerance in varieties targeted for rabi, summer and Spring groundnut areas.
- Oil, protein and sugar contents were measured in 956 accessions of working collection in kharif 2018. The oil content in these6 accessions ranged from 44.1%-54.9%; protein content ranged from 23.2%-36.4% and sugar content ranged from 5.2% to 9.0%.
- Two Valencia accessions NRCG 10969 (44.1% oil; 36.2% protein; 6.99% sugar content) and NRCG 10836 (44.7% oil; 35.5% protein; 6.70% sugar content); two Virginia Runner accessions NRCG 10187 (44.1% oil; 35.6% protein; 8.1% sugar content) and NRCG 10173 (44.1% oil; 35.7% protein; 7.8% sugar content); and two Virginia Bunch accessions NRCG 14569 (44.8% oil; 35.2% protein; 6.3% sugar content) and NRCG 14592 (44.6% oil; 35.6% protein; 6.3% sugar content) exhibited low oil with high protein and high sugar content and can be used as donors in breeding confectionery type groundnuts.
- Two viz. NRCG 14245 (54.9% oil; 23.2% protein; 6.01% sugar content) and NRCG 11049 (52.3% oil; 26.4% protein; 6.180% sugar content) exhibited high oil, low protein and high sugar contents which can be used as donors for improvement of oil content in groundnut.
- Two other Valencia accessions viz. NRCG 14245 (54.9% oil; 23.2% protein; 6.01% sugar content) and NRCG 11049 (52.3% oil; 26.4% protein; 6.180% sugar content); one Spanish bunch accession NRCG 14182 (52.2% oil; 26.4% protein; 5.3% sugar content); two Virginia Runner accessions,

NRCG 10201 (51.4% oil; 27.0% protein; 8.6% sugar content) and NRCG 10185 (51.1% oil; 27.3% protein; 8.0% sugar content); and two Virginia Bunch accessions, NRCG 11780 (52.3% oil; 26.2% protein; 8.0% sugar content) and NRCG 14264 (51.8% oil; 26.6% protein; 6.4% sugar content) had high oil with low protein and high sugar content. These accessions can be used as donor in breeding high oil groundnut genotypes.

- One candidate variety, Western Vardan, and six farmers varieties JHUMKUL (REG/ 2017/1132), INDOORI (REG/ 2017/1133), MANOHAR MOONGFALI (REG/ 2017/ 1134), BHADELIFALLI (REG/ 2017/1278), SOTHAFALLI (REG/2017/1285), and JEET BADAM (REG/2017/2310) received were characterized in *kharif* season 2019 along with suitable reference varieties have been characterized for 13 qualitative 5 quantitative descriptor traits.
- Total 1399 crossed pods were harvested from eight crosses related to seed size, oil, protein and sugar content improvement with a range of 98 (PBS 29146 x PBS 29148) to 353 (TG 37A x Mallika) pods.
- Two genotypes viz., PBS 29079 B and PBS 29069 recorded >70 gm hundred kernel weight and superior over checks.
- Genotypes, PBS 19013, PBS 19015, PBS 19018, PBS 29079 B, PBS 29082, PBS 29124, PBS 29167, PBS 29196, PBS 29197, PBS 29212 and PBS 29219 were found having good confectionery quality traits viz., large seediness (KL: >1.5 cm and KW: >0.7 cm), good protein (>32%), good sugar (>5 %), moderate oil (42- 48% ), uniform pod size and shape, good pod yield per plant (>10 gm) and good shelling percentage (>60 %).
- Twelve lines recorded >12gm of PW/plant of which SPP 4 of 0.6% EMS treatment of TPG 41 was the highest (15.58 gm). SPP 3 and SPP 4 of 0.6% EMS treatment of TPG 41 recorded highest shelling percentage of 76.69 and 76.50 %, respectively.
- Total 60 single plant progeny (SPP) of $F_4$, $F_5$ and $F_6$ segregating material were raised and advancement of generations was done based on uniform pod, seed size and pods per plant during kharif, 2018.
- Total 17 advanced breeding lines (PBS 19035, PBS 19036, PBS 19037, PBS 19038, PBS 19039, PBS 29236, PBS 29237, PBS 29238, PBS 29239, PBS 29240, PBS 29241, PBS 29242, PBS 29243, PBS 29244, PBS 29245, PBS 29246, PBS 29247) of large seed project were multiplied during kharif, 2018.
- A total of three crosses using Synthetic amphidiploids were made to introgress desirable traits.
- A total of 167 single plant selections were made from five different crosses namely, TG37A// J11/*A. diogoi,* TG37 A//J11/*A. duranensis*, TG37A //J11/*A. pusilla*, JL x24 NRCGCS 85 and ICG 4747 x TMV2NLM.
- Four hundred and sixty-one RILs have been characterized for resistance to stem rot and pod yield. Similarly, 378 RILs have been characterized for resistance to PBND and pod yield. Besides, 152 RILs have been characterized for tolerance to drought and pod yield
- A promising breeding line GG-20×CS-19-PL-4-6, resistant to stem rot has been identified. The breeding line GG-20×CS-19-PL-4-6 significantly out yielded than GG-20 in both 2017 and 2018.
- Seeds of five promising prebreeding lines were multiplied for further testing in AICRPG.
- Fresh eight crosses were made to introgress high oleic acid content into different genotypes with desirable traits.

- A total of 15 $BC_1F_1$ plants from four crosses namely, GG-20 × SunOleic 95R TG37A × SunOleic 95R GG-7 × SunOleic 95R and TKG19A × SunOleic 95R were selected using MAS for high oleic content
- A total of 43 $F_1$ plants from four crosses namely, GG-20 × SunOleic 95R, TG37A × SunOleic 95R, GG-7 × SunOleic 95R and TKG19A × SunOleic 95R were selected using MAS for high oleic content
- A total of 28 $F_2$ plants from four crosses namely, GG-20 × SunOleic, 95R TG37A × SunOleic 95R GG-7 × SunOleic 95R and TKG19A × SunOleic 95R were selected using MAS for high oleic content
- Furthermore, 347 lines, selected for high oleic content from two crosses namely GG-7 × SunOleic 95R and TKG19A × SunOleic 95R, were advanced for further characterization
- A total of 21 breeding lines with high oleic acid were tested for yield. Pod yield of two breeding lines were found on par with best check cultivar, KDG-128.
- A total of four lines with more than 55% oil contentwere evaluated for yield.Pod yield of HOS-30 was on par with GG-20
- A total of 45 promising breeding lines with 50-53% oil content were evaluated for yield. Pod yield of HOS-724 was found significantly higher than check cultivar KDG-128. While pod yield of HOS-1185 was on par with KDG-128
- Seeds of 23 high oleic groundnut genotypes were multiplied for further testing in AICRP
- A total of six high oleic lines have been proposed for AIRCP testing in 2018 *kharif* season

**Basic Sciences**

- The Fe and Zncontent in cultivars their Pod morphology and seed size studied.
- Zn solubilizing microbes enhances Zn and Fe in seed through biofortification.
- The seed of high Zn cultivars analysed for phytic acid
- Zn sources increased Zn as well as Fe in groundnut seed
- 100 groundnut cultivars and 114 breeding line screened for iron chlorosis
- Physiological efficiencies of Indian groundnut cultivars determined
- Pod zone moisture contents decides the yields losses and aflatoxin contamination
- Wide elasticity among groundnut cultivars for various drought situations
- Growth regulator sinhenced the seed size and pod yield of groundnut
- Salt tolerance mechanism and groundnut cultivars identified
- Cinnamic acid, syringic acid, catechol, kaempferol and catachin are predominant phenolicsin groundnut kernels.
- Groundnut is a good source of resveratrol, cultivar GG7 possess highest resveratrol content (7.13 µg/g) followed by TAG 24 (4.54 $\mu g^{-1}g$) and GG20 (2.93 $\mu g^{-1}g$).
- Cultivars JL 776, GG7 and TG26 have more than 4.0 $g^{-1}$100g Zn content.
- TG 51, Kadiri 7 and GJG 22 have more than 8.0 $g^{-1}$100g Fe content.
- Dietary intake of 100 gm of groundnut kernels can ful fill 33% of Zn and Fe RDA.
- Formulations of DAPG-producing *Pseudomonas putida* DAPG4, which has been recommended for enhancing growth, yield and nutrient uptake in groundnut, besides development of suppressive soils for management of stem and collar rot diseases of groundnut, were developed in different combinations. The population count in formulation 4 and 8 was 1.76 x $10^8$ and 4.2 x $10^8$ cfu, respectively after storage

in room temperature for 1 year.

- Seed inoculation with five new competitive strains of groundnut rhizobia resulted in significant enhancement of pod yield (13–20%) of groundnut, cultivar TG37A.
- Five groundnut rhizobacterial isolates were identified for Zn solubilization and 16 for K solubilization.
- Leaf epiphytic bacterial isolates antagonistic to *Alternaria* and late leaf spot pathogen were identified.
- Application of endophytes and 5 irrigations can provide as much pod yield (average 2604 kg/ha) that can be obtained with 10 supplementary irrigations after emergence (2494 kg/ha) without endophytes.
- It would be feasible to reduce quantity (30-50%) and frequency of irrigations (4-5 irrigations) substantially for raising summer groundnut with endophytes
- Application of endophytes like *Bacillus firmus* J22, *Pseudoxanthomonas mexicana*REN47 and *Bacillus subtilis* REN51 prevented the reduction in yield losses by improving the yield by 10%, 14%, and 11%, respectively (1566 kg/ha in control and 1724-1793 kg/ha with these endophytes) at soil EC of around 4.87 at harvest
- Modulation of pathways leading to expression of CAM has been found to be the major factor in alleviation of drought and salinity stress in groundnut by endophytes
- Yield evaluation of C3-CAM variants of TG37A shows that whereas reduction of biomass was around 42% in TG37A with two supplementary irrigations, C3-CAM transited variants showed biomass reduction from 25-32% in similar conditions. Least reduction in biomass was obtained with DGRMB5.
- Over-expressive C3-CAM transited variants of TG37A (which are otherwise drought tolerant) like DGRMB5 minimized the biomass reduction (5736 kg/ha) and maintained at 25% level of reduction at 4.87 EC at harvest.

**Crop Production**

- Groundnut pod yield, haulm yield, pigeonpea grain yield and groundnut pod equivalent yield (GPEY) was found higher with 3:1 ratio in groundnut+pigeonpearelay cropping system in both Spanish and Virginia bunch varieties. Pod yield of groundnut was recorded higher when pigeonpea was relay sown at 30 and 50 days after sowing in Virginia bunch and Spanish varieties, respectively. Pigeonpea grain yield and GPEY was found significantly higher with relay sowing of pigeonpea at 30 days after sowing of groundnut in both the varieties.
- Paclobutrazol spray at 25 DAS and 30 DAS gave significantly higher pod yield and haulm yield, respectively.
- Groundnut pod and haulm yield was found highest with normal tillage, pigeonpea grain yield and stover yield was highest under conventional tillage while seed cotton yield and stalk yield was higher under MT. Groundnut pod equivalent yield (GPEY) was significantly higher with NT, being at par with MT. Application of crop residues failed to significantly affect crop yields. Groundnut+pigeonpea cropping system was found to give significantly higher groundnut pod yield, haulm yield and GPEY over groundnut+cotton intercropping system.
- Pod yield increased with increasing level of N doses and highest significant yield was found at 35 kg N/ha (2013 kg/ha) and 30 kg/ha (2271 kg/ha) in GG 22 and TG37A respectively.
- The higher pod yield was recorded at 2 dS/m (60 %) as compared to 6 dS/m saline irrigation water.
- The higher pod yield was recorded under straw mulch

> polythene mulch as compared to without mulch (control)

- Interaction effect of salinity x mulching revealed that pod yield under polythene mulch and straw mulch was recorded 49 and 55%, higher at 6 $dSm^{-1}$, respectively as compared to control.
- BM-8 culture was found to have maximum P solubilization (35.8 ppm) in Pikovskaya broth.
- Application of PSB+75% RDP has significantly improved groundnut dry pod yield (2258 kg/ha) by 136% compared to No P control (955 kg/ha)
- Total P uptake (kg/ha) was significantly high in PSB + 25% RDP treatment, which is 2.18-fold more than no-P treatment.

## Crop Protection

- Variety JSP-19 and Kadiri-3 were found promising for resistance to stem rot.
- Organic formulation DGR-OF2 gave maximum inhibition of stem rot and supported yield.
- Module-M17A was effective in inhibition of stem rot and supporting yield in refinement.
- Module-M17A & M4A were effective in inhibition of stem rot and supporting yield while validation.
- Damage of sucking pests especially jassids, at all the stages of groundnut invites the *Alternaria* leaf blight.
- High temperature of 37°C and above, salt-stress because of saline soil or because of saline irrigation water and water-stress for the period of a month predispose the groundnut crop to *Alternaria* leaf blight in groundnut.
- *Phyllognathusdionysius* was the major species of white-grub causing damage to the groundnut during *kharif*
- Twenty insecticides were available in the market, among them imidacloprid was the popular one
- Sweet flag rhizome powder above 2% was found to be effective in managing bruchid beetles

## Social Sciences

- The study on farm-managerial abilities, resource-use efficiency and technical efficiencies among small and marginal farmers revealed that the determinants of output among these groups are land preparation, seed and post-harvest handling practices. Resources used were more on these components. Farmers use more seeds, machineries and labours at the time of land preparation and post-harvest practices.
- The frontier function model on technical efficiency expressed per cent of output lose due to in efficiency among small and marginal farmers. It revealed, about 27 to 32.5 per cent of output lose noted small and marginal farmers.
- As far as farm managerial abilities were concerned most them (76 per cent marginal farmers and 80 per cent of small farmers) fell in medium categories. Though in other components farmers performed well in managerial abilities, but knowledge on scientific practices was concerned, most fell on medium categories, thus this may, and along with other factors are responsible for low resource and technical efficiency of small and marginal farmers.

# कार्यकारी सारांश

## फसल सुधार

- विभिन्न पृथक्कृत वंशों से 59 एकल पौध वंशों का चयन किया गया।
- 120 आशातीत प्रोन्नत प्रजनन लाइनों का गुणन।
- 700 से अधिक जीन प्रकारों की जॉच के पश्चात् नियंत्रण के6 की तुलना में अधिक फली उपज युक्त 40 आशातीत जीन प्रकारों की पहचान।
- खरीफ 2018 के दौरान अल्टरनेरिया पत्ती झुलसा, पत्ती धब्बा तथा रतुआ एवं तना सड़न के विरूद्ध प्रतिरोधिता के लिए सुधारित किस्मों के विकास हेतु सोलह संकरन प्रयासों को संपन्न किया गया।
- ग्रीष्म 2018 (11) तथा खरीफ 2018 (63) के दौरान सोलह संकरों में से संकरों के रूप में कुल 212 एकल पौधों की पहचान की गई।
- ग्रीष्म 2018 (11) तथा खरीफ 2018 (63) के दौरान विभिन्न फिलियल वंशों में 74 संकरों के वंशों को प्रोन्नत किया गया।
- ग्रीष्म 2018 (2) तथा खरीफ 2018 (8) के दौरान दस नये प्रोन्नत उच्च उपज प्रजनन लाइनों (स्पेनिश बंच के तीन तथा वर्जीनिया स्वभाव समूह के सात) को विकसित किया गया।
- उत्कृष्ट चेक किस्म टीजी–37ए के फली उपज (2877 किग्रा/हे) से अधिक उपज तथा डीएच–86 के बीज उपज तथा छिलका उतराई (फली उपज : 1943 किग्रा/हे) एसओटी : 68 प्रतिशत) को प्रोन्नत प्रजनन लाईन पीबीएस–12218 (फली उपजः 3809, बीज उपज 2734 किग्रा/हे तथा एसओटी : 72 प्रतिशत) ने सार्थक पार किया।
- दो उन्नत प्रजनन लाईनों अर्थात, पीबीएस–12223 (फली उपज : 2457 तथा बीज उपजः 1661 किग्रा/हे) तथा पीबीएस–12225 (फली उपजः 2354 तथा बीज उपजः 1661 किग्रा/हे) को उत्कृष्ट नियंत्रण किस्म टीजी37ए से फली उपज (1788 किग्रा/हे) तथा जेएल–501 से बीज उपज (1308 किग्रा/हे) से खरीफ–2018 के दौरान श्रेष्ठ पाया गया।
- दो ग्रीष्म कालों (2017–18) में परीक्षण परिणामों के आधार पर पॉच कृषिजोप जातियों अर्थात, कादीरी–9, कादीदी हरितेन्द्र, आईसीजीवी–00348, आईसीजीएस–44 तथा जीजेजी–17; पॉच उन्नत प्रजनन लाईनों अर्थात, पीबीएस–12185, पीबीएस–12190, पीबीएस–22131, पीबीएस–22131 तथा पीबीएस–22133 तथा पॉच अंतरविशिष्ट उत्पादों अर्थात, एनआरसीजीसीएस–176, एनआरसीजीसीएस–180, एनआरसीजीसीएस–186, एनआरसीजीसीएस–96 तथा एनआरसीजीसीएस–298 में 1 से 9 पैमाने पर दर्ज किये गये रोगों का मान 3था।
- एन उन्नत प्रजनन लाइन पीबीएस–22092 में डीजीआर–आरआरएस बिकानेर पर लगातार चार खरीफ कालों में 15 प्रतिशत से कम कॉलर सड़न की घटनायें दर्ज की गई। अतएव इन जीन प्रकार का कॉलर सड़न प्रतिरोधिता के लिए अनोखे आनुवंशिक संग्रह के रूप में पहचान की गयी।
- तीन उन्नत प्रजनन लाइनों अर्थात पीबीएस–18038, पीबीएस–18064 तथा पीबीएस–22089 में कम पादप मृत्यु क्रमशः 7.8 प्रतिशत, 8.8 प्रतिशत तथा 5.9 प्रतिशत जीन प्रकार

ओजी–52–1 (13.2 प्रतिशत) तथा जे–11 (18.7 प्रतिशत) की तुलना में डीजीआर–आरआरएस, बिकानेर एनआरसीजी5203, 2419, 4343, 4874, सीएसएमजी2014 , 90 से 105 दिनों में परिपक्व हुई। प्रति पौध उपज प्रविष्टियों एनआरसीजी955, एनआरसीजी 6063 तथा आरटीएच.आरजी 6063 में उच्च था। प्रविष्टियों एनआरसीजी 8954, 2746 तथा 9356 ने बीज लंबाई: चौड़ाई अनुपात (>2) के संदर्भ में उच्च प्रदर्शन खरीफ 2017 तथा खरीफ 2018 में दर्शाया।

- वर्जीनिया बंच उन्नत प्रजनन परीक्षणों में से उन्नत प्रजनन लाइनें पीबीएस 24134, 24139, 26048, 24135, 25028, 25089, 25049 तथा 26052 में परिपक्वता अवधि 110 से 115 दिन था। छिलका उतराई प्रतिशत (>70 प्रतिशत) प्रोन्नत प्रजनन वंशों पीबीएस24137, 24136, 24135, 24138, 24142 तथा 25091 में उच्च पाया गया। उन्नत प्रजनन लाइनों नें जीजी20, पीबीएस251095, 21108, 21105 तथा 21092 से बीज लंबाई के संदर्भ में अच्छा प्रदर्शन किया।
- उन्नत प्रजनन लाइनों पीबीएस14060, 14068, 15019 तथा 16023 ने एससीएमआर के लिये; पीबीएस14066 तथा 30037 को स्पेनिश प्रजनन लाइन मूल्यांकन परीक्षण में प्रति पौधा फली उपज के संदर्भ में उत्कृष्ट पाया गया। उन्नत प्रजनन लाइनें पीबीएस15018, 15047, 15057, 16025 तथा 30080 100 दिनों में परिपक्व हुई। प्रजनन लाइनों पीबीएस11093, 15038 तथा 16024 को छिलका उतराई प्रतिशत (>70 प्रतिशत) उच्च पाया गया, जबकि बीज लंबाई: चौड़ाई अनुपात का मान पीबीएस16052, 15026 तथा 15031 में अधिक था।
- पछेती पत्ती धब्बा तथा अगेती पत्ती धब्बा के लिए खरीफ 2017 तथा खरीफ 2018 के दौरान क्रमशः जननद्रव्य संग्रह तथा उन्नत प्रजनन लाइनों का परीक्षण। प्रजनन लाइनों तथा प्रविष्टियों द्वारा एलएलएस तथा ईएलएस के विरूद्ध मध्यम सहनशीलता दर्शानें वाली लाइनों में पीबीएस 11085, 11092, एनआरसीजीसीएस313 तथा पीबीएस 11073 सम्मिलित हैं। प्रविष्टियां आरएचआरजी6063, आरएसबी87, एनआरसीजी2615, 8954, 13262 तथा उन्नत प्रजनन लाइनें पीबीएस24102, 24103, 24104 तथा 16053 में इएलएस के प्रति सहनशीलता स्तर खरीफ 2018 में दर्शाया। ताजे बीज के सुसुप्ता के लिए परीक्षण किये 62 स्पेनिश प्रजनन लाइनों तथा उन्नत प्रजनन लाइने पीबीएस 14060, 14668, 16033, 16044, 11077, 11092, 15014, 15022, 15027, 15028, 16022, 16023 तथा 16038 में ताजे बीजों में 20 दिनों से अधिक की बीज सुसुप्तता दर्शाई। छः अनुभागों का प्रतिनिधित्व करने वाले 115 प्रविष्टियों अर्थात अरेचिस (54), काउलोराइजे (1), इरेक्टोइडस (7), हेटेरेनथे (7), प्रोकेमबेनटस् (6) तथा राइजोमेटोसे (40) को प्रक्षेत्र जीन बैंक में पोषित किया गया। अरेचिस अनुभाग के वार्षिक प्रजातियों से प्राप्त बीजों की कटाई के पश्चात् संरक्षित किया गया। सात एम्फीद्विगुणित उत्पादों को भी भविष्य में फसल सुधार कार्यक्रमों के लिए परिपालित किया गया।
- कुल 161 प्रविष्टियों को ग्रीष्म 2018 तथा खरीफ में गुणन किया गया, कुल मिलाकर 1848 जननद्रव्य प्रविष्टियों का गुणन किया गया जिसमें क्राप केफेटेरिया (45), शुष्कता सहनशीलता के लिए समग्र संग्रह (196), विमोचित किस्में (217), बोलीवियन प्रविष्टियों (99), अर्जेंटीना की प्रविष्टियॉ (100) कम कार्बन आईसोटोप भेद युक्त प्रविष्टियों (30), अंतरविशिष्ट उत्पाद (170) तथा पुनर्जीवन के लिए प्रविष्टियॉ (1187) सम्मिलित हैं।
- अंकुरण, प्रजनन गुणों तथा उपज पर कम तथा अधिक तापमान सहनशीलता के प्रभाव के आंकलन हेतु 36 विमोचित किस्मों तथा 25 मिनीकोर प्रविष्टियों (प्रयोगशाला अवस्था में शीत सहनशीलता के लिए पहले से ही पहचाने गये) का प्रक्षेत्र में मूल्यांकन दो अलग–अलग बुवाई तिथियों अर्थात अगेती (19 जनवरी, 2018) तथा पछेती (19 मार्च, 2018) पर किया गया। कम तापमान से प्रभावित होने वाले महत्वपूर्ण गुणों में बीज अंकुरण, अंकुरण प्रस्फुटन तथा फसल बढ़वार से परिपक्वता में देरी पाई गई। जबकि अधिक तापमान से पुष्पन अवधि तथा पराग, उपजाऊपन पर प्रभाव पड़ा। दोनों ही अवस्था में फली उपज में अत्याधिक कमी हुई (35 प्रतिशत से 65 प्रतिशत) यह प्रयोग भा.कृ.अनु.प. –जूनागढ़ तथा एचएयू, बावल पर आयोजित किये गये थे।
- जूनागढ़ के कम तापमान अवस्था में अगेती बुवाई के लिए सात मिनीकोर प्रविष्टियों एनआरसीजीएस 14480, 14374, 144324, 14367, 14414 तथा

14333 को त्वरित अंकुरण, पुष्पन स्वभाव तथा उपज के आधार पर आशाजनक पाया गया। पछेती बुवाई एवं उच्च तापमान अवस्था के लिए पॉच मिनी कोर प्रविष्टियों एनआरसीजीएस 14480, 14324, 14367, 14414 को आशातीत पाया गया। इस प्रकार कम तथा उच्च तापमान सहनशीलता के लिए प्रविष्टियों एनआरसीजीएस 14324, 14367, 14414 एवं 14333 को आशाजनक के रूप में पहचाना गया।

- विमोचित किस्मों में से (टीएजी24, आईसीजीवी00350, जेजीएन3, जीजेजी9, जेएल220, एलजीएन1, आईसीजीवी87846) सात किस्मों को जूनागढ़ में अगेती बुवाई, कम तापमान अवस्था के लिए त्वरित अंकुरण पुष्पन स्वभाव तथा उपज के आधार पर आशाजनक पाया गया। देर से बुवाई तथा अधिक तापमान अवस्था के लिए आठ किस्मों केआरजीआईजीजी8, जीजेजी17, ओजी52, जीएयूजी1, डीएच86, आईसीजीवी00350, जेजीएन3 को प्रभावकारी पाया गया। जूनागढ़ के जलवायु स्थिति में कम एवं उच्च तापमान दोनों के लिए पहचानी गई आशातीत किस्मों में आईसीजीवी 87896, एलजीएन1, टीएजी24, जेजीएन3, जेजीजे9, टीजी17, जेएल220, आईसीजीवी 00350, टीजी1 तथा नारायणी सम्मिलित हैं।
- बावल में पॉच प्रविष्टियों एनआरसी जीएस 14454, 14480, 124481, 14484, 14492 को अग्रिम बुवाई (कम तापमान अवस्था); सात प्रविष्टियों को उच्च तापमान अवस्था तथा तीन प्रविष्टियों (एनआरसीजीएस 14454, 14480, 14492) को कम तथा उच्च तापमान अवस्था दोनों के लिए आशाजनक पाया गया। इसी स्थान के लिए ग्यारह किस्मों (एएलआर3, सोमनाथ, जीजी13, केआरजी1, एसीआर2, टीजी17, जेजीएन3, आईसीजीवी 87846, उत्कर्ष, नारायणी, आईसीजीवी 00348) को कम तथा उच्च तापमान दोनों के सहनशीलता के लिए आशातीत पाया गया।
- जूनागढ़ एवं बावल दोनों स्थानों पर विमोचित किस्मों में से चार (जेएल220, जेजीएन3, आईसीजीवी87846, आईसीजीवी 00348) को कम तापमान अवस्था के लिए तथा जननद्रव्यों में से एक प्रविष्टि एनआरसीजी 14480 को जूनागढ़ तथा बावल दोनों स्थानों पर कम तथा उच्च तापमान सहनशीलता के लिए आशाजनक पाया गया। इन जननद्रव्यों को रबी, ग्रीष्म तथा वसंत मूँगफली क्षेत्रों के लिए लक्षित किस्मों मे उष्मीय सहनशीलता प्रदान करने के लिए दाता के रूप में उपयोग किया जा सकता है।
- खरीफ 2018 के कार्यरत संग्रह में से 956 प्रविष्टियों में वसा, प्रोटीन तथा शर्करा की मात्रा की गणना की गई। इन 956 प्रविष्टियों में वसा की मात्रा का मान 44.1 प्रतिशत से 54.9 प्रतिशत, प्रोटीन की मात्रा 23.2 प्रतिशत से 36.4 प्रतिशत तथा शर्करा की मात्रा 5.2 प्रतिशत से 9. 0 प्रतिशत के मध्य पाया गया।
- दो वेलेंसिया प्रविष्टियों एनआरसीजी 10969 (44.1 प्रतिशत तेल; 36.2 प्रतिशत प्रोटीन; 6.99 प्रतिशत शर्करा की मात्रा) तथा एनआरसीजी 10836 (44.7 प्रतिशत तेल; 35.5 प्रतिशत प्रोटीन; 6.70 प्रतिशत शर्करा की मात्रा); दो वर्जीनिया रनर प्रविष्टियों एनआरसीजी10187 (44.7 प्रतिशत तेल; 35.7 प्रतिशत प्रोटीन; 7.8 प्रतिशत शर्करा की मात्रा); तथा दो वर्जीनिया बंच प्रविष्टियों एनआरसीजी 14569 (44.8 प्रतिशत तेल; 35.2 प्रतिशत प्रोटीन; 6.3 प्रतिशत शर्करा की मात्रा); तथा एनआरसीजी 14592 (44.6 प्रतिशत तेल; 35.6 प्रतिशत प्रोटीन; 6.3 प्रतिशत शर्करा की मात्रा) ने कम तेल के साथ उच्च प्रोटीन तथा उच्च शर्करा की मात्रा प्रदर्शित किया। इनका उपयोग कन्फेक्शनरी प्रकारी की मूँगफली के प्रजनन के लिए दाता के रूप में किया जा सकता है।
- दो प्रविष्टियों अर्थात एनआरसीजी 14245 (54.9 प्रतिशत तेल; 23.2 प्रतिशत प्रोटीन; 6.01 प्रतिशत शर्करा की मात्रा) तथा एनआरसीजी 11049 (52.3 प्रतिशत तेल; 26.4 प्रतिशत प्रोटीन; 6.18 प्रतिशत शर्करा की मात्रा) ने उच्च तेल, कम प्रोटीन तथा उच्च शर्करा की मात्रा प्रदर्शित किया अतएव इनका उपयोग मूँगफली में तेल की मात्रा में सुधार करने के लिए दाता के रूप में किया जा सकता है।
- दो अन्य वेलेंसिया प्रविष्टियों अर्थात एनआरसीजी 14245 (54.9 प्रतिशत तेल; 23.2 प्रतिशत प्रोटीन; 6.01 प्रतिशत शर्करा की मात्रा) तथा एनआरसीजी 11046 (52.3 प्रतिशत तेल; 26.4 प्रतिशत प्रोटीन; 6.18 प्रतिशत शर्करा की मात्रा); एक स्पेनिश बंच प्रविष्टि एनआरसीजी 14182 (52.2 प्रतिशत तेल; 26.4 प्रतिशत प्रोटीन; 5.3 प्रतिशत शर्करा की मात्रा); दो वर्जिनिया

प्रविष्टियॉ एनआरसीजी10201 (51.4 प्रतिशत तेल; 27.0 प्रतिशत प्रोटीन; 8.6 प्रतिशत शर्करा की मात्रा) तथा एनआरसीजी 10185 (51.1 प्रतिशत तेल; 27.3 प्रतिशत प्रोटीन; 8.0 प्रतिशत शर्करा की मात्रा) तथा दो वर्जिनिया बंच प्रविष्टियां, एनआरसीजी 11780 (52.3 प्रतिशत तेल; 26.2 प्रतिशत प्रोटीन; 8.0 प्रतिशत शर्करा की मात्रा) तथा एनआरसीजी 14264 (51.8 प्रतिशत तेल; 26.6 प्रतिशत प्रोटीन; 6.4 प्रतिशत शर्करा की मात्रा) में अधिक तेल की मात्रा, कम प्रोटीन तथा उच्च शर्करा की मात्रा थी। अतएव इन प्रविष्टियों का उपयोग मूँगफली में तेल की मात्रा में सुधार करने के लिए दाता के रूप में किया जा सकता है।

- एक सदस्य किस्म, वेस्टर्न वरदान तथा प्राप्त की गई 6 किसानों की किस्में झुमकुल (आरइजी/2017/1132), इन्दुरी (आरइजी/2017/1133), मनोहर मूँगफली (आरइजी/2017/1134), भदेलीफल्ली (आरइजी/2017/1278), सुथाफल्ली (आरइजी/2017/1285) तथा जीत बादाम (आरइजी/2017/2310) को खरीफ काल 2019 के दौरान उपयुक्त संदर्भ किस्मों के साथ 13 मात्रीकरण तथा पॉच गुणवत्ता विवरणात्मक गुणधर्मो के लिए अध्ययन किया गया।
- आठ संकरणों में से कुल 1399 फलियॉ प्राप्त हुई जिसकी फलियों में बीज आकार, तेल, प्रोटीन एवं शर्करा की मात्रा से संबंधित सुधारों का मान 98 (पीबीएस 29146 x पीबीएस 29148) से 353 (टीजी37ए x मलिका) था।
- दो जीन प्रकारों अर्थात पीबीएस 29079 बी तथा पीबीएस 29069 ने >70 ग्राम प्रति 100 बीज भार दर्ज किया एवं सभी नियंत्रणों की तुलना में उत्कृष्ट थां
- जीन प्रकार पीबीएस 19013, पीबीएस 19015, पीबीएस 19018, पीबीएस 29079बी, पीबीएस 29082, पीबीएस 29124, पीबीएस 29167, पीबीएस 29196, पीबीएस 29197, पीबीएस 29212 तथा पीबीएस 29219 को उत्तम कन्फेक्शनरी गुणवत्ता गुणों अर्थात बड़े बीज (केएलः >1.5 सेमी.तथा केडब्लयूः >0.7 सेमी.), उचित प्रोटीन (>32 प्रतिशत) अच्छी शर्करा की मात्रा (>5 प्रतिशत) मध्यम तेल (42 से 48 प्रतिशत), समान फली आकार, अच्छी उपज प्रति पौध (>10 ग्राम) तथा अच्छी छिलका उतराई प्रतिशत (>60 प्रतिशत) उपलब्ध थे।
- बारह लाइनों में >12 ग्राम पीडब्ल्यू प्रति पौध दर्ज की गई जिसमें टीपीजी 41 का 0.6 प्रतिशत इएमएस उपचार का एसपीपी अधिकतम था। टीपीजी 41 का 0.6 प्रतिशत इएमएस उपचार का एसपीपी 3 एवं एसपीपी 4 में अधिकतम छिलका उतराई प्रतिशत क्रमशः 76.69 एवं 76.50 प्रतिशत था।
- एफ4, एफ5 एवं एफ6 पृथक्कृत सामग्री से प्राप्त कुल 60 एकल पौध वंशों (एसपीपी) को उगाया गया तथा वंशों को समान फली, बीज आकार तथा फली प्रति पौध के आधार पर खरीफ 2018 के लिए आगे बढ़ाया गया।
- कुल 17 बड़े बीज प्रकल्प की उन्नत प्रजनन लाइनों (पीबीएस 19035, पीबीएस 19036, पीबीएस 19037, पीबीएस 19038, पीबीएस 19039, पीबीएस 29236, पीबीएस 29237, पीबीएस 29238, पीबीएस 29239, पीबीएस 29240, पीबीएस 29241, पीबीएस 29242, पीबीएस 29243, पीबीएस 29244, पीबीएस 29245, पीबीएस 29246, पीबीएस 29247) का खरीफ 2018 के दौरान गुणन किया गया।

## आधारभूत विज्ञान

- किस्मों में लौह एवं जस्ते की मात्रा, इनकी फली आकारिकी तथा बीज आकार का अध्ययन किया गया।
- जैव सशक्तीकरण के अंतर्गत जिंक विलेयकारी सूक्ष्मजीवों ने बीज में जस्ते एवं लौह की मात्रा में वृद्धि की।
- अधिक जस्ता युक्त किस्मों के बीजों का फाइटिक अम्ल के लिए विश्लेषण किया गया।
- जस्ता के स्त्रोंतों ने मूँगफली के बीजों में जस्ते के साथ–साथ लौह की मात्रा में भी वृद्धि की।
- लौह हरितद्रोग के लिए 100 मूँगफली किस्मों तथा 114 प्रजनन लाइनों का परीक्षण किया गया।
- भारतीय मूँगफली किस्मों की पादप कार्यिकी कुशलता निर्धारित की गई।
- फली क्षेत्र आर्द्रता की मात्रा, उपज में हानि तथा एफलाटॉक्सिन संदुक्षण को सुनिश्चित करता है।
- विभिन्न शुष्कता अवस्थाओं के लिए मूँगफली किस्मों में अधिक लचीलापन।
- विकास नियंत्रकों ने मूँगफली में बीज आकार तथा फली उपज में वृद्धि की।
- लवण सहनशीलता तंत्र ज्ञान तथा मूँगफली किस्मों की पहचान की गई।

- सिनेमिक अम्ल, सिरिंजिक अम्ल, केटेचोल, कैम्पफेरॉल तथा केटेचिन मूँगफली के बीजों में प्रमुख फिनोल पाये गये।
- मूँगफली रेसवेरट्राल का एक उत्कृष्ट स्त्रोत है, किस्म जीजी7 ने रेसवेरेट्राल की मात्रा (7.13 माइक्रोग्राम प्रति ग्राम) तथा इसके पश्चात् टीएजी24 (4.54 माइक्रोग्राम प्रति ग्राम) तथा बीजी20 में (2.93 माइक्रोग्राम प्रति ग्राम) पाई गई।
- किस्म जेएल 776, जीजी7 तथा टीजी26 में जिंक की मात्रा अधिक (4.0 ग्राम प्रति 100 ग्राम) पाई गई।
- टीजी51, कादीरी7 तथा जीजेजी22 में लौह की मात्रा अधिक (8.0 ग्राम प्रति 100 ग्राम) पाई गई।
- 100 ग्राम मूँगफली के बीज को खाद्य आहार के रूप में उपयोग से 33 प्रतिशत जिंक तथा लौह आरडीए की आपूर्ति करती है।
- डीएपीजी उत्पादक सुडोमोनास पुटिडा डीएपीजी4 सूत्रीकरण जिसे मूँगफली में विकास, उपज एवं पोषक उद्ग्रहण की वृद्धि हेतु संस्तुत किया गया है इसका उपयोग मूँगफली तना एवं कॉलर सड़न रोगों के प्रबंधन के लिए दमनकारी मृदाओं के विकास हेतु विभिन्न संयोजनों में विकसित किया गया है। सूत्रीकरण 4 एवं 8 में संख्या की गणना $1.76 \times 10^8$ तथा $4.2 \times 10^8$ सीएफयू क्रमशः सामान्य तापमान पर एक वर्ष भंडारण पश्चात् प्राप्त हुई।
- मूँगफली के राइजोबिया के पॉच नये प्रतियोगी किस्मों के द्वारा बीज टीकाकरण से सार्थक फली उपज वृद्धि का परिणाम (13 से 20 प्रतिशत) मूँगफली की किस्म टीजी37ए में प्राप्त हुई।
- जिंक विलेयकारिता के लिए पॉच मूँगफली राइजोबैक्टिरियल पृथक्कृतों तथा पोटेशियम के लिए 16 विलेयकारकों की पहचान की गई।
- अल्टरनेरिया तथा पछेती पत्ती धब्बा रोग जनक के विरूद्ध पत्ती अधोपादप जीवाणु पृथक्कृतों की पहचान की गई।
- अंतःपादप तथा पॉच सिंचाईयों के उपयोग द्वारा बीना अंतःपादप के बीज उगने के पश्चात् 10 आपूरक सिंचाईयों की तुलना में उपज (2494 किग्रा/हे) के बराबर फली उपज (औसत 2604 किग्रा/हे) प्रदान कर सकता है।
- अंतःपादप के साथ मूँगफली की फसल उगाने से सिंचाई की मात्रा (30 से 50 प्रतिशत) तथा सिंचाई बारंबारता (4 से 5 सिंचाई) में कमी करना संभव होता है।
- बेसिलस फिरमस जे22, सुडोजेन्थोमोनास मैक्सिकाना आरईएन47 तथा बेसिलस सपटेलिस आरईएन51 जैसे अंतःपादपों के उपयोग द्वारा उपज की कमी में सुधार क्रमशः 10 प्रतिशत, 14 प्रतिशत एवं 11 प्रतिशत (1566 किग्रा/हे नियंत्रण में तथा इन अंतःपादपों के साथ 1724 से 1793 किग्रा/हे) कटाई के समय लगभग 4.87 तक किया जा सकता है।
- अंतःपादपों द्वारा सीएएम की अभिव्यक्ति हेतु मार्ग में उतार–चढाव को मूँगफली में शुष्कता तथा लवणता प्रतिबल के उपशमन का प्रमुख कारक पाया गया।
- टीजी37ए के सी3–सीएएम रूपान्तरों के उपज मूल्यांकन से ज्ञात हुआ कि टीजी37ए के जैव द्रव्यमान में दो आपूरक सिंचाईयों के साथ 42 प्रतिशत के आस–पास कमी हुई, सी3–सीएएम प्रेरित रूपान्तरों द्वारा इसी अवस्था में 25 से 32 प्रतिशत जैव द्रव्यमान में कमी दर्शायी गई। जैव द्रव्यमान में न्यूनतम कमी डीजीआरएमबी5 में प्राप्त हुई।
- टीजी37ए के अतिअभिव्यक्त सी3–सीएएम प्रेरित रूपान्तरों जैसे डीजीआरएमबी5 के द्वारा जैव द्रव्यमान में कमी को न्यूनतम किया (5736 किग्रा/हे.) तथा कटाई के समय 4.87 ईसी पर इसे 25 प्रतिशत के स्तर बनाये रखा।

### फसल उत्पादन

- स्पेनिश तथा वर्जिनिया बंच दोनों किस्मों के 3:1 अनुपात में मूँगफली + अरहर के अनुपद फसल प्रणाली के अंतर्गत मूँगफली फली उपज, भूसा उपज, अरहर दाना उपज तथा मूँगफली फली तुल्यांक उपज (जीपीईवाय) को उच्च पाया गया। वर्जिनिया बंच तथा स्पेनिश किस्मों में क्रमशः 30 एवं 50 दिन बुवाई पश्चात् अरहर की अनुपद फसल बुवाई में मूँगफली की फली उपज उच्च दर्ज की गई। दोनों किस्मों में मूँगफली के 30 दिन बुवाई पश्चात् अरहर की अनुपद बुवाई से अरहर दाना उपज तथा जीपीईवाय को सार्थक अधिक पाया गया।
- 25 डीएएस तथा 30 डीएएस पर पेक्लोब्युट्राजोल के छिड़काव से क्रमशः सार्थक उच्च फली उपज तथा भूसा उपज प्राप्त हुआ।

- सामान्य जुताई के साथ मूँगफली फली तथा भूसा उपज सार्थक अधिक थी, पारंपरिक जुताई के अंतर्गत अरहर दाना उपज तथा भूसा उपज अधिकतम था, जबकि कपास उपज एवं डंठल उपज एमटी के अंतर्गत उच्च था। मूँगफली फली तुल्यांक उपज (जीपीईवाय) एमटी के साथ सार्थक अधिक, परन्तु एमटी के बराबर पाया गया। फसल अवशेष के उपयोग से फसल उपज पर नगण्य प्रभाव था। मूँगफली + कपास अंतःसस्यन प्रणाली की तुलना में मूँगफली + अरहर फसल प्रणाली को सार्थक अधिक मूँगफली फली उपज, भूसा उपज तथा जीपीइवाय प्रदान करते पाया गया।
- नत्रजन की मात्रा में वृद्धि से फली उपज में वृद्धि तथा अधिकतम सार्थक उपज 35 किग्रा नत्रजन प्रति हेक्टेयर (2013 किग्रा/हे) तथा 30 किग्रा/हे (2271 किग्रा/हे) द्वारा क्रमशः जीजी22 एवं टीजी27ए में प्राप्त हुआ।
- 6 डेसीसिमन प्रति मीटर लवणता सिंचाई जल की तुलना में अधिकतम फली उपज 2 डेसीसिमन प्रति मीटर (60 प्रतिशत) पर दर्ज किया गया।
- अधिकतम फली उपज पुवाल पलवार > पॉलीथिन पलवार से बिना पलवार (नियंत्रण) की तुलना में दर्ज किया गया।
- लवणता x पलवार के परस्पर प्रभाव से ज्ञात होता है कि 6 डेसीसिमन प्रति मीटर पर पॉलीथिन पलवार तथा पुवाल पलवार में क्रमशः 49 एवं 55 प्रतिशत अधिक फली उपज नियंत्रण की तुलना में प्राप्त हुई।
- पीएम–8 संवर्ध को पिकोव्यस्क्या ब्राथ में अधिकतम फास्फोरस विलेयकारिता (35.8 पीपीएम) दर्शाते पाया गया।
- पीएसबी + 75 प्रतिशत आरडीपी के उपयोग द्वारा बिना फास्फोरस के नियंत्रण (955 किग्रा/हे) की तुलना में मूँगफली शुष्क उपज में सार्थक सुधार (2258 किग्रा/हे), जो कि लगभग 136 प्रतिशत तक था।
- पीएसबी + 25 प्रतिशत आरडीपी उपचार में कुल फास्फोरस उद्ग्रहण (किग्रा/हे) सार्थक अधिक था, जो कि बिना फास्फोरस उपचार की तुलना में 2.18 गुणा अधिक था।

### फसल सुरक्षा

- किस्म जेएसपी–19 तथा कादीरी–3 को तना सड़न के प्रतिरोधिता के लिए आशाजनक पाया गया।
- जैविक सूत्रीकरण डीजीआरओएफ2 द्वारा तना सड़न में अधिकतम रोकथाम तथा उपज वृद्धि में सहायता प्रदान करते पाया गया।
- मॉडयूल–एम17ए को तना सड़न में कमी तथा उपज में सुधार के लिए प्रभावी पाया गया।
- मॉडयूल–एम17ए तथा एम4ए को तना सड़न में कमी तथा उपज में सुधार के लिए मान्यकरण पर प्रभावी पाया गया।
- सफेद ग्रब की प्रमुख प्रजाति फाइलोनेथस डायोनिसियस थी, जो खरीफ के दौरान मूँगफली को हानि पहुँचाती है।
- बाजरा में 20 कीटनाशी उपलब्ध थे, जिसमें से इमिडाक्लोप्रिड सर्वाधिक प्रचलन में थी।
- 2 प्रतिशत से अधिक स्वीट फ्लैग राइजोम पाउडर को ब्रचिड बिटल के प्रबंधन में प्रभावकारी पाया गया।

### सामान्य विज्ञान

- छोटे एवं सीमान्त किसानों पर फार्म प्रबंधन क्षमता, संसाधन उपयोग कुशलता एवं तकनीकी कुशलता के अध्ययन से ज्ञात हुआ कि इन समूहों में से भूमि तैयारी, बीज तथा सस्योत्तर रख–रखाव विधियां उपज का निर्धारण करती हैं। इन घटकों पर संसाधनों का उपयोग अधिक किया गया। किसानों ने भूमि तैयारी तथा सस्योत्तर विधियों के समय पर अधिक बीज, यंत्रों तथा श्रमिकों का उपयोग किया।
- तनकीनी कुशलता पर फ्रंटीयर फंक्शन मॉडल ने लघु तथा सीमान्त किसानों में कुशलता के कारण उपज हानि प्रतिशत को व्यक्त किया। इससे ज्ञात हुआ कि लगभग 27 से 32.5 प्रतिशत प्राप्ति में हानि लघु तथा सीमान्त किसानों में हुई।
- जहॉ तक फार्म प्रबंधन क्षमता का संबंध है अधिकतर किसान (76 प्रतिशत सीमान्त किसान तथा 80 प्रतिशत लघु किसान) मध्यम वर्ग में आते हैं। हालांकि, अन्य घटकों के तहत किसानों ने अच्छी प्रबंधन कुशलता दर्शायी, परन्तु जहॉ तक वैज्ञानिक विधियों के ज्ञान का संबंध है, अधिकतर किसान मध्यम वर्ग के अंतर्गत थे, अतएव इसी प्रकार अन्य घटकों के साथ लघु एवं सीमान्त किसानों में कम संसाधन तथा तकनीकी कुशलता इसके लिए उत्तरदायी है।

# 01 Genetic improvement of groundnut

## Breeding groundnut varieties for drought tolerance to enhance productivity in arid regions

*Ajay BC, Gangadhar K, Nataraj KC, Malleswari Sadhneni*

## Hybridization, selection and generation of advancement in segregating generations

Nine fresh crosses were attempted in *kharif* 2018 to enhance yield under drought stress and more than 1865 hybrid pods were harvested with 46% crossing success. In summer 18 probable hybrid pods ($F_1$ generation) from six crosses attempted in *kharif* 2017 were raised and $F_2$ hybrid pods were harvested as single plants. Six crosses in $F_2$ generation were raised in Anantapur under rainfed conditions and 42 and 17 single plant progenies (SPP) belonging to Spanish and Virginia group were selected. Segregating generation consisting of 177 SPP belonging to F3 generation and 137 SPP belonging to F5 generation were advanced to their next generation.

## Multiplication of promising breeding lines

Around 120 most pro-mising advanced breeding lines identified from different drought screening trials for yield under rainfed conditions of Anantapur were raised for seed multiplication.

## Screening of germplasm accessions for drought tolerance

One hundred and eighty-six germplasm accessions were screened for drought tolerance at Anantapur in along with six checks i.e ICGS 44, ICGS 76, ICGV 91114, K6, M 13 and TMV 2. Experiment was sown during last week of July 2017. Analysis of variance indicated significant genotypic differences for relative water content (RWC), pod yield per plant, haulm yield per plant and harvest index. Genotypes ICR 5, ICR 29, CS 166 and NRCG 14351 had high pod yield than the superior check ICGS 44.

## Screening Spanish DSN for drought tolerance at Anantapur

Spanish DSN (drought screening nursery) consisting of 111 genotypes along with six checks (K6, M13, ICGS 76, ICGS 44, ICGV 91114 and TMV2) were screened for drought tolerance under rainfed conditions using Augmented design. Analysis of variance indicated significant differences among test genotypes for pod yield per plant and harvest index under rainfed conditions. Genotypes PBS 16032, PBS 30016, PBS 30037, PBS 15041, PBS 16023 had high pod yield per plant when compared to superior check.

## Screening Virginia DSN for drought tolerance at Anantapur

Virginia DSN (drought screening nursery) consisting of 170 genotypes along with six checks (K6, M13, ICGS 76, ICGS 44, ICGV 91114 and TMV2) were screened for drought tolerance under rainfed conditions without any protective irrigation using Augmented design. Analysis of variance indicated

significant differences among test genotypes and checks varieties for RWC, pod yield per plant, haulm yield per plant and harvest index. Among the checks K6 had high pod yield and M 13 had high haulm yield. Genotypes PBS 21116, 25102, 25119, 21098, 25094, 21089, 25081, 25031, 21092 and 25104 had high pod yield when compared to superior check.

### Screening of inter-specific derivatives for drought tolerance

A set of 171 inter-specific derivatives were screened for drought tolerance along with six checks (K6, M13, ICGS 76, ICGS 44, ICGV 91114 and TMV2) under rainfed conditions without any protective irrigation using augmented design. Analysis of variance indicated significant differences among test genotypes and check varieties for RWC, pod yield per plant, haulm yield per plant and harvest index. Among the checks K6 had high pod yield and M 13 had high haulm yield. Genotypes NRCGCS 174, 398, 123, 297, 194, 133, 254, 191, 397, 326 and 429 had high pod yield per plant;

### Screening of new set of DSN for drought tolerance at Anantapur

A set of 76 new DSN were screened for drought tolerance along with six

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A set of 76 new DSN were screened for drought tolerance along with six checks (K6, M13, ICGS 76, ICGS 44, ICGV 91114 and TMV2) under rainfed conditions without any protective irrigation using augmented design. Analysis of variance indicated significant differences among test genotypes and check varieties for RWC, pod yield per plant, haulm yield per plant and harvest index. Cultivar R 2001-2 and ICGV 86031 had pod high yield when compared to K6 and K9.

### Advanced Yield evaluation trials

A set of 20 genotypes consisting of 14 advanced breeding lines from cross NRCG 4747 x TMV2NLM, PBS 15022 and PBS 24126, 24147, 24085, 24092, 24102, 24129, 24018, 24130, 24133, 14066 and 14056 had high pod yield per plant when compared to superior check.

### Screening of reported drought tolerant genotypes at Anantapur

A set of 27 reported drought tolerant genotypes were screened under rainfed at Anantapur during July 2017 by following RCB design. Analysis of variance indicated significant differences among test genotypes and check varieties for RWC, pod yield

**Fig.** Promising genotypes identified under drought conditions at Anantapur

PBS 15044 and 4 check varieties (Girnar 2, GG 20 Kadiri 9 and Kadiri 6) were evaluated for their yield performance under drought conditions of Anantapur. Among checks Kadiri 6 had high pod yield. Genotypes PBS 15044 had pod yield compared to best check.

### Spanish Initial yield evaluation trial

A set of 30 genotypes consisting of 28 Spanish advanced breeding lines and 2 check varieties (Kadiri 6 and R 2001-2) were evaluated for their yield performance under drought conditions of Anantapur. Genotypes NRCGCS 320, PBSA 11164, PBS 30027, NRCGCS 39, PBS 16040, NRCGCS 322 and NRCGCS 369 had high pod yield when compared to check. These lines could be forwarded to advanced yield evaluation trials.

### Virginia Initial Yield evaluation trial

A set of 23 genotypes consisting of 21 Virginia advanced breeding lines and 2 check varieties (Kadiri 9 and KDG 128) were evaluated for their yield performance under drought conditions of Anantapur. Genotypes PBS 25102, 21116, 25119, 21098, 25094, 21089, 25081, 25031, 21092 and 25104 had pod yield compared to check varieties and they could be further evaluated under advanced yield evaluation trials.

## Breeding for *Alternaria* leaf blight resistance in groundnut

*Narendra Kumar, Rathnakumar AL, Praveen Kona*, Dutta R and Chandramohan Sangh*

*Associated from 09th May 2018.

### 1. Hybridization

Ten crosses were effected in *kharif* 2018 to develop improved varieties resistant of *Alternaria* leaf blight. The number of harvested crossed pods varied from 73 (TPG 41 × CS-298) to 200 (GG 2 × CS-298). The mean success rate (%) of the hybridization programme was 37.2, which ranged from 19.6 to 46.9%. In addition to that ten crosses were made by PI of this project, in which average success rate of hybridization was 72.7%, which ranged from 49.7 to 86.5%.

### 2. Identification of hybrids

Six different crosses were raised in summer 2018 to identify $F_1$'s effected for developing resistant/ tolerant genotypes to *Alternaria* leaf blight. A total 95 single plants have been identified as hybrids in six crosses and it was ranged from 9-35. A maximum number of $F_1$'s have been identified in the cross TG37A × NRCGCS74 (35) followed by TPG41 × NRCGCS 74(19) andTG37A × NRCGCS186 (14).

Ten crosses were raised in *kharif* 2018 to identify $F_1$'s effected for developing resistantgenotypes to leaf spot and rust and stem rot. A total 117 probable single plants had been identified in all the crosses. A maximum number of $F_1$'s have been identified in the cross TG37A × PBS 18037 (30) followed by GG20 × PBS 18037 (27).

### 3. Advancement of different filial generations

The breeding materials developed for *Alternaria* leaf blight resistance were advanced to next filial generation. Progenies of 11 crosses ($F_3$:4, $F_4$:5, $F_5$:1, $F_6$:1) were advanced in summer 2018 to different filial generations ($F_3$-$F_6$), among them 09 crosses in early generations (up to $F_4$) and 02 in advanced generation. Individual plant progenies of one cross were raised in $F_6$ generation. Among them two new advanced high yielding stable breeding lines *viz.*, PBS-22154 and PBS-12230 of Virginia bunch and Spanish bunch respectively identified during summer 2018.

The breeding materials generated earlier were advanced to next filial generation. Progenies of 63 crosses were advanced in kharif 2018 to different filial generations ($F_2$-$F_6$), among them 34 crosses in early generations (up to $F_4$) and 29 in advanced generation. Six cross were rejected at the time of harvesting due to large proportion of poor recombinants and absence of desirable trait in

**Table 1a.** Crosses were effected in *kharif* 2018 (Hybridization block)

| SN | Name of crosses | Purpose of crosses | Pollination made (No.) | $F_1$ pods harvested (No.) | Success rate (%) |
|---|---|---|---|---|---|
| 1 | TG-37A × CS-298 | High yield and resistance of *Alternaria* leaf blight | 560 | 139 | 24.8 |
| 2 | GG 2 × CS-298 | High yield and resistance of *Alternaria* leaf blight | 656 | 200 | 30.5 |
| 3 | Dh-86 × CS-298 | High yield and resistance of *Alternaria* leaf blight | 515 | 199 | 38.6 |
| 4 | GJG 31 × CS-298 | High yield and resistance of *Alternaria* leaf blight | 414 | 133 | 32.1 |
| 5 | TPG 41 × CS-298 | High yield and resistance of *Alternaria* leaf blight | 373 | 73 | 19.6 |
| 6 | Kadiri-6 × CS-298 | High yield and resistance of *Alternaria* leaf blight | 288 | 135 | 46.9 |
| 7 | Narayani × CS-298 | High yield and resistance of *Alternaria* leaf blight | 430 | 187 | 43.5 |
| 8 | TG-37A × PBS 22131 | High yield and resistance of *Alternaria* leaf blight | 480 | 189 | 39.4 |
| 9 | TPG 41 × PBS22131 | High yield and resistance of *Alternaria* leaf blight | 292 | 64 | 21.9 |
| 10 | Kadiri 6 × PBS 22131 | High yield and resistance of *Alternaria* leaf blight | 377 | 126 | 33.4 |
| | | | **4385** | **1445.00** | **37.2** |

the recombinants.In $F_6$ generation, individual plant progenies of 12 crosses were raised to identify high yielding stable genotypes, among these five crosses was rejected and eight new advanced high yielding stable breeding lines (SB-2, VB-6) were identified from the remaining seven crosses and given nomenclature according to the objective and their bota

## 4. Yield evaluation of advanced breeding lines

### A. Summer 2018

A total 26 Spanish bunch advanced breeding lines with four checks (TAG 24, TG-37A, Dh 86 and TPG 41) were evaluated in RBD with three replications for yield and its component traits during summer 2018. The results revealed that an advanced breeding line,PBS-12218 (pod yield: 3809; kernel yield: 2734kg/ha and SOT: 72%) significantly surpassed the best check variety TG-37A for pod yield(2877kg/ha) and Dh-86 for kernel yield (1943kg/ha) and shelling outturn (68%). One advanced breeding line, PBS-12200(pod yield: 3955kg/ha;

**Table 1b.** Crosses were effected in kharif 2018 in Nethouse and P-II glass house

| SN | Name of crosses | Purpose of crosses | Pollination made (No.) | $F_1$ pods harvested (No.) | Success rate (%) |
|---|---|---|---|---|---|
| 1 | TG 37 A × CS 298 | High yield and resistance of Alternaria leaf blight | 203 | 143 | 70.4 |
| 2 | TPG 41 × CS 298 | High yield and resistance of Alternaria leaf blight | 152 | 111 | 73.0 |
| 3 | TG 37 A × PBS 22131 | High yield and resistance of Alternaria leaf blight | 149 | 74 | 49.7 |
| 4 | TPG 41 × PBS 22131 | High yield and resistance of Alternaria leaf blight | 104 | 90 | 86.5 |
| 5 | PBS 18037 × CS 19 | High yield and stem rot resistance | 199 | 155 | 77.9 |
| 6 | PBS 18037 × CS 319 | High yield and stem rot resistance | 267 | 200 | 74.9 |
| 7 | GG 20 × BC2F1 (TG 37 A × (TG 37 A x GPBD 4)) | To produce BC2F1, High yield and foliar disease resistance | 269 | 193 | 71.7 |
| 8 | TG-37A × BC2F1 (TG-37A × (TG 37 A × GPBD-4) | To produce BC3F1, High yield and foliar disease resistance | 498 | 393 | 78.9 |
| 9 | GG-20 × BC2F1 (GG-20 × (GG 20 × GPBD-4) | To produce BC3F1, High yield and foliar disease resistance | 685 | 376 | 54.9 |
| 10 | TG 37 A × BC2F1 (GG-20 × GPBD-4) | To produce BC2F1, High yield and foliar disease resistance | 217 | 172 | 79.3 |
| | | | 2743 | 1917.0 | 72.7 |

SN 1-10 crosses made by Dr. Narendra Kumar, Scientist, Plant Breeding

kernel yield: 2441) significantly surpassed the best check variety TG-37A for pod yield (2877kg/ha) and at par with best check variety Dh-86 for kernel yield (1943kg/ha). Advanced breeding line PBS-12200 is already under multi-location testing in AICRP-G *kharif* trials. Hence, this could be proposed for *rabi*-summertesting under AICRP -G trials and breeding line PBS-12218 needs one more year of testing under station trial.

### B. *Kharif* 2018

**Spanish bunch (first year):**

A total eleven genotypes of Spanish bunch including with four high yielding recommended checks *viz.* GG-7, TG-37A, JL-501 and GG -9 were used for evaluation in five rows of 5m length for yield and its component traits in RBD with three replications during *kharif* 2018. The results revealed

**Table 2a.** Details of $F_1$'s raised and hybrids isolated in summer 2018

| SN | Name of cross | Purpose of cross | Hybrids identified (SPP) |
|---|---|---|---|
| 1 | TG 37A × NRCGCS 186 | High yield and resistance of *Alternaria* leaf blight | 14 |
| 2 | TG 37A × NRCGCS 74 | High yield and resistance of *Alternaria* leaf blight | 35 |
| 3 | Dh 86 × NRCGCS 186 | High yield and resistance of *Alternaria* leaf blight | 09 |
| 4 | Dh 86 × NRCGCS 74 | High yield and resistance of *Alternaria* leaf blight | 09 |
| 5 | TPG 41× NRCGCS 74 | High yield and resistance of *Alternaria* leaf blight | 19 |
| 6 | Kadiri 6 × NRCGCS 74 | High yield and resistance of *Alternaria* leaf blight | 09 |
| | | | **95.0** |

**Table 2b. Details of $F_1$'s raised hybrids isolated in *kharif* 2018**

| SN | Name of cross | Purpose of cross | Hybrids identified |
|---|---|---|---|
| 1 | TG 37 A × PBS 18037 | High yield and resistance to stem rot | 30 |
| 2 | GG 20 × PBS 18037 | High yield and resistance to stem rot | 27 |
| 3 | GG 20 × KDG 128 | High yield | 4 |
| 4 | TG 37 A × KDG 128 | High yield | 7 |
| 5 | TG 37 A × CS 19 | High yield and resistance to stem rot | 4 |
| 6 | GG 20 × CS 19 | High yield and resistance to stem rot | 6 |
| 7 | TG 37 A × CS 186 | High yield and resistance of *Alternaria* leaf blight | 14 |
| 8 | TPG 41 × CS 74 | High yield and resistance of *Alternaria* leaf blight | 15 |
| 9 | GG 20×(GG 20×(GG 20×GPBD 4))$BC_2F_1$ | High yield and foliar disease resistance | 3 |
| 10 | TG 37 A×(TG 37 A×(TG 37 A×GPBD 4))$BC_2F_1$ | High yield and foliar disease resistance | 7 |
| | | | **117** |

that two advanced breeding lines viz., PBS-12223 (pod yield:2457 and kernel yield : 1816kg/ha) and PBS-12225 (pod yield: 2354 and kernel yield: 1661kg/ha) significantly surpassed the best check variety TG 37A for pod yield (1788 kg/ha) and JL 501 for kernel yield (1308kg /ha) respectively. These breeding lines need to be tested one more year for testing under AICRP-G trials.

**Spanish bunch (Second year):**

A total nine Spanish bunch genotypes includingfour high yielding checks varieties GG 7, TG-37A, JL-501and GG 9were evaluated in five rows of 5m row length for yield and its component traits in a RBD with three replications during *kharif*-2017 and *kharif*-2018. The results revealed that none of the genotype significantly superior over best check for pods/plants, pod and kernel yield (Kg/ha) and SOT (%).

**Virginia bunch (First year):**

A total fourteen genotypes of Virginia bunch including with four high yielding

**Table 3a.** Details of advancement of different filial generations in summer 2018

| Sr. No. | Generation | Crosses | | |
|---|---|---|---|---|
| | | Sown | Rejected | Available |
| 1 | $F_2$ | | | |
| 2 | $F_3$ | 4 | 0 | 4 |
| 3 | $F_4$ | 5 | 0 | 5 |
| 4 | $F_5$ | 1 | 0 | 1 |
| 5 | $F_6$ | 1 | 0 | 2ABL (PBS 22154, 12230) |
| | **Total** | **11** | **0** | **10** |

**Table 3b.** Details of advancement of different filial generations in kharif 2018

| Sr. No. | Generation | Crosses | | |
|---|---|---|---|---|
| | | Sown | Rejected | Available |
| 1 | $F_2$ | 18 | 0 | 18 |
| 2 | $F_3$ | 08 | 0 | 08 |
| 3 | $F_4$ | 08 | 01 | 07 |
| 4 | $F_5$ | 17 | 0 | 17 |
| 5 | $F_6$ | 12 | 05 | 07 (SB-2,VB-6ABLs) |
| | **Total** | **63** | **06** | **50** |

recommended checks *viz.* GG-20, KDG-123, KDG-128 and GJG-22 were used for evaluation in five rows of 5m length for yield and its component traits in RBD with three replications for *kharif* 2018. The results revealed that none of the genotype significantly surpass the best check variety KDG-123 for no. of pods/plant (20), pod and kernel yield (3386, 2348kg / ha) and GJG-22 for shelling outturn (76%).

**Virginia bunch (Second year):**

A total fifteen genotypes of Virginia bunch including with four high yielding recommended checks *viz.* GG-20, KDG-123, KDG-128 and GJG 22 were evaluated in five rows of 5m length for yield and its component traits in RBD with three replications for *kharif* 2017 and *kharif* 2018. The results revealed that none of the genotype significantly surpass the best check variety KDG-123 for pod and kernel yield (3286, 2254kg/ha) and GJG-22 for shelling outturn (73%).

**5. Development, multiplication, maintenance and distribution of breeding materials to different AICRP -G centres**

**I. Development of new advanced breeding lines**

A total two new advanced high yielding breeding lines were developed from advanced materials during summer2018, of which one lines belongs to Spanish bunch(PBS-12230)and one lines belongs to Virginia bunch(PBS-22154). During *kharif* 2018, eight new advanced breeding lines were developed, of which two line belongs to Spanish Bunch (PBS-12231, PBS-12232) and six lines belongs to Virginia bunch habit group (PBS-22155, PBS-22156, PBS


Shri Chhabilendra Roul, Special Secretary, DARE & Secretary, ICAR interacting with DGR Scientists


Practising selection in segregating generation


Yield evaluation trials in summer 2018 (left) and Kharif-2018 (right)

| Genotype | Summer-2018 | | Sub Total | *Kharif*-2018 | | Sub Total | Total |
|---|---|---|---|---|---|---|---|
| | SB | VB | | SB | VB | | |
| ABLs for conducting trials | 7 | 11 | 18 | 03 | 18 | 21 | 39 |
| ABLs for maintenance | 16 | 01 | 17 | 00 | 00 | 00 | 17 |
| New ABLs | 02 | 16 | 18 | 00 | 00 | 00 | 18 |
| Cultivars/Minicore | 19 | 00 | 19 | 50 | 70 | 120 | 139 |
| AICRP-G lines | 00 | 00 | 00 | 02 | 00 | 02 | 02 |
| | 44 | 28 | 72 | 55 | 88 | 143 | 215 |

22157, PBS-22158, PBS-22159, PBS-22160).

## II. Multiplication and maintenance of breeding materials

### A. Summer-2018:

A total 72 advanced breeding lines (new and existing), cultivars were mass multiplied during summer-2018 to get sufficient seed for conducting yield and screening trials.

### B. *Kharif*-2018:

A total 143 advanced breeding lines, cultivars, germplasm lines and new advanced breeding lines were mass multiplied during *kharif*-2018 to got sufficient seed for


conducting yield and screening trials.

## III. Multiplication and status of AICRP-G lines

During *kharif*-2018, seed of two elite breeding lines (PBS-12196 and PBS-12201) were mass multiplied to get sufficient seed required for AICRP-G trials and among them, one elite breeding line PBS12196 was evaluated in IVT-II (SB) in *kharif*-2018. Unfortunately, it was not


promoted in AVT (SB) of Zone-I due to marginal difference of 4% below kernal yield as compared to best check variety TG-37A. One elite breeding line PBS 12200 will be testing under IVT-II (SB) of AICRP-G trials in *kharif*-2019. One elite breeding line PBS 12201 will be proposed for testing under IVT-I (SB) of AICRP-G trials in *kharif*-2019.


## IV. Distribution of breeding materials to different AICRP-G centres

The breeding material of 45 different crosses from three segregating and two advanced generations ($F_6$ and $F_7$) was selected in *kharif*-2018 and supplied to seven AICRP-G centres to effect location specific selections for different biotic stresses for *kharif* 2019.

## 6. Screening of advanced breeding lines for foliar disease resistance

### A. Summer 2018

A total 179 groundnut minicore germplasm were screened in the augmented design for resistant to *Alternaria* leaf blight by infector row technique during summer-2018. Artificial Inoculum of

## List of segregating materials supplied to different AICRP-G centers for *kharif*-2019

| SN | Name of crosses | Purpose of crosses | Wt. (gm) | AICRP-G Centre |
|---|---|---|---|---|
| **Segregating generation: $F_3$** | | | | |
| 1 | TG-37A × CS-186 | High yield and resistance of foliar disease resistance | 350 | Mainpuri |
| 2 | TG-37A × CS-74 | High yield and resistance of foliar disease resistance | 2440 | Hiriyur Mainpuri |
| 3 | Dh-86 × CS-186 | High yield and resistance of foliar disease resistance | 120 | Mainpuri |
| 4 | Dh-86 × CS-74 | High yield and resistance of foliar disease resistance | 230 | Mainpuri |
| 5 | TPG-41 × CS -74 | High yield and resistance foliar disease resistance | 160 | Mainpuri |
| 6 | GG-7 × KDG-128 | High yield and foliar disease resistance | 720 | Udaipur |
| 7 | TG-37A × CS-574 | High yield and foliar disease resistance | 680 | Raichur |
| 8 | TG-37A × CS-319 | High yield and stem rot resistance | 830 | Latur |
| 9 | KDG-128 × CS-19 | High yield and stem rot resistance | 160 | Raichur |
| 10 | TG 37A × CS 319 | High yield & stem rot resistance | 1420 | Latur Bhubaneswar |
| 11 | KDG 128 × CS 19 | High yield & stem rot resistance | 1250 | Raichur Bhubaneswar |
| 12 | GG 20 × PBS 18037 | High yield & stem rot resistance | 2000 | Latur Bhubaneswar |
| 13 | TG 37 A × PBS 18037 | High yield & stem rot resistance | 2050 | Udaipur Bhubaneswar |
| 14 | KDG 128 × PBS 18037 | High yield & stem rot resistance | 1170 | Hiriyur Bhubaneswar |
| 15 | GG20×F1(TG 37 A× GPBD 4) | High yield & foliar disease resistance | 580 | Hiriyur |
| 16 | GG 20 × GPBD 4 | High yield & foliar disease resistance | 840 | Gwalior Udaipur |
| 17 | TG 37 A × GPBD 4 | High yield & foliar disease resistance | 15500 | Hiriyur, Latur Mainpuri, Udaipur Gwalior, Raichur, Bhubaneswar |
| **Segregating generation: $F_4$** | | | | |
| 1 | GG 20 × GPBD 4 | High yield & foliar disease resistance | 1530 | Raichur Gwalior |
| 2 | TG 37 A × GPBD 4 | High yield & foliar disease resistance | 1350 | Udaipur Gwalior |
| 3 | TG 37A × CS 319 | High yield and stem rot resistance | 1700 | Latur Hiriyur |
| 4 | CS 319 × TG 37A | High yield and stem rot resistance | 390 | Latur |

Cont.

Cont.

| | | | | |
|---|---|---|---|---|
| 5 | JL-776 × OG-52-1 | High yield and tolerance of collar rot, Spodoptera and thrips | 1000 | Gwalior Bhubaneswar |
| 6 | KDG-123 × J-11 | igh yield and tolerance of collar rot | 950 | Hiriyur Bhubaneswar |
| 7 | KDG-128 × J-11 | High yield and tolerance of collar rot | 900 | Hiriyur Bhubaneswar |
| 8 | GG-7 × KDG-123 | High yield and foliar disease resistance | 1150 | Udaipur Hiriyur |
| **Segregating generation: $F_5$** | | | | |
| 1 | CS 319 × TG 37A | High yield and stem rot resistance | 470 | Latur |
| 2 | JL 776 × KDG 123 | High yield, FDR and tolerance of *Spodoptera* andthrips | 1940 | Gwalior, Hiriyur Raichur |
| 3 | GG 7 × RHRG 06083 | High yield and foliar disease resistance | 190 | Hiriyur |
| 4 | TG 37A × CS 319 | High yield and stem rot resistance | 1291 | Latur |
| 5 | TG 37 A × CS 186 | High yield and resistance of *Alternaria* leaf spot | 1130 | Mainpuri |
| 6 | Dh 86 × CS 74 | High yield and resistance of *Alternaria* leaf spot | 830 | Mainpuri |
| 7 | GJG 17 × GPBD 4 | High yield & foliar disease resistance ($BC_1F_5$) | 720 | Raichur |
| **Segregating generation: $F_6$** | | | | |
| 1 | TG 37 A × ALR 1 | High yield and foliar diseases resistance | 400 | Udaipur |
| 2 | GG 7 × GPBD 4 | High yield and foliar diseases resistance | 530 | Udaipur |
| 3 | GG 2 × RHRG 06083 | High yield and foliar diseases resistance | 1240 | Udaipur Raichur |
| 4 | GG 2 × ICG 1697 (NCAc 17090) | High yield and foliar diseases resistance | 800 | Gwalior |
| 5 | GG 20 × CS 319 | High yield & Stem rot resistance | 610 | Latur |
| 6 | TG 37A × CS 319 | High yield & Stem rot resistance | 980 | Latur |
| 7 | GPBD 4 × CS 196 | High yield & foliar disease resistance | 120 | Raichur |
| 8 | TG 37 A × CS 186 | High yield & foliar disease resistance | 670 | Udaipur Mainpuri |
| 9 | Dh 86 × CS 74 | High yield & foliar disease resistance | 350 | Mainpuri |
| 10 | CS 74 × Dh 86 | High yield & foliar disease resistance | 220 | Raichur |
| **Segregating generation: $F_7$** | | | | |
| 1 | GG20 × JCG 88 | High yield & foliar disease resistance | 300 | Gwalior |
| 2 | BAU 13 × CS 196 | High yield & foliar disease resistance | 190 | Gwalior |
| 3 | GG 20 × GBPD 4 | High yield & foliar disease resistance | 180 | Gwalior |


Screening of genotypes for resistance to *Alternaria* leaf blight in summer 2018 (left) and spraying of disease inoculum (right)

pathogen was sprayed after 30 days and there after 15 days interval of crop growth in the evening (06:00PM) on infector as well as test entries for uniform spread of disease in screening trial. Maximum disease incidence was observed in the germplasm NRCG 14344 and NRCG 14490 (score 7.0 on 1-9 scale). Results revealed that 60 mini-core germplasm had a score 2 on 1-9 scale. These genotypes need to be screen at least three more season/year to confirm their resistance stability to *Alternaria* leaf blight across the years.

A total 34 groundnut genotypes including advanced breeding lines, cultivars and inter-specific derivatives were screened in the replicated design for by infector row technique for two consecutive summer 2017 and 2018. Maximum disease incidence was observed in the cultivar Dh 86 (score 7.0 on 1-9 scale). Based on two year data revealed that five cultivars *viz.*, Kaidiri 9, Kadiri Haritendra, ICGV 00348, ICGS 44 and GJG 17; five advanced advanced breeding lines *viz.*, PBS 12185, PBS 12190, PBS 22131, PBS 22132 and PBS 22133; five interspecific derivatives *viz.*, NRCGCS 176, NRCGCS 180, NRCGCS 186, NRCGCS 196 and NRCGCS 298 recorded a disease score 3 on 1-9 scale. These genotypes need to be screen at least two more season/year to confirm their resistance stabilityfor *Alternaria* leaf blight across the years.

### B. *Kharif* 2018

A total 41 genotypes along with resistant check *viz.*, KDG-123 and KDG-128 (high yielding leaf spot and rust resistant variety) were screened in replicated trial under natural condition for resistance of foliar diseases (late leaf spot and rust) during *kharif*, 2018. The maximum disease pressure for late leaf spot (LLS) and rust was 8.3 and 3.7 respectively on modified 1- 9 point scale.In general in *kharif* season, the rust incidence was low in all the genotypes. Hence, it was not high enough for disting-uishing genotypes based disease score. Results showed two advanced breeding lines PBS-12220 and PBS 22123 had a score 3.0and 4.0 of LLS and a score 1.3 and 2.0 of rust respectively. Genotypes *viz.*, KDG 123 and KDG 128 both showed a LLS score 3 and score 2.0 and 1.3 of rust respectively.

### 7. Screening of genotypes for resistance/tolerance of collar rot

A total 24 advanced breeding lines along with two tolerant genotypes OG-52-1 and J-11 were screened in replicated trial for resistance/tolerance to collar rot at DGR-RRS, Bikaner during *kharif* 2018. Data were recorded on plant mortality up to 30 DAS. The average collar rot incidence ranged from0 and 46.3% during studied period. Results revealed that four advanced breeding lines*viz.*, PBS-18038, PBS-18064, PBS-22089 and PBS-22092 recorded an average 7.8%, 8.8%, 5.9% and 14.4% plant mortality, which was at par with disease incidence in resistance genotype OG-52-1 (13.2%) and J-11(18.7%). Advanced breeding line PBS-22092 also recorded lower collar rot incidence as compared to resistant genotype during 2015 (8.5%), 2016 (6.6%), 2017 (10.0%) and 2018 (14.4%). This breeding line could be registered as a novel genetic stock for resistance to collar rot in groundnut.

### Breeding for Fresh seed dormancy and reducing Maturity duration in groundnut

*Gangadhara K, Rathnakumar AL, Ajay BC, Chandramohan S, Sushmita and Praveen Kona**
*Associated from 9th May 2018

#### Hybridization and generation advancement

Eight crosses were effected for short duration, fresh seed dormancy and foliar disease resistance during *kharif* 2018. A total of 246 pods were harvested from eight crosses (KDG 128 × VG 13110, KDG × VG 13113, KDG 123 × VRI 3, GJG 31 × VRI 3, GG 20 × DH 86, GG 2 × NRCG 368, TG 37A × NRCG 14338 and SG 99 × ICGV 06099). The success rate was highest in cross GJG 31× VRI 3 (41.3%) and lowest success rate was in KDG 123 × VRI 3 (26.15%).

$F_1$s from ten crosses generated during *kharif* -2017, were raised along with their parents during summer-2018 and total of 505 hybrid plants were identified from ten crosses and harvested individually for further generation advancement. The parents involved in the crosses are TAG 24, TG 26, Girnar 1, JL 24, NRCG 6255, NRCG 14368, NRCG 14338, Chico, PBS 15044, PBS 19022 for short duration and fresh seed dormancy. Generation mean analysis for compo-nents of pod maturity and yield related traits was carried out using five parameter generation models in five crosses.

### Evaluation of Germplasm collec-tions for early maturity and *Alternaria* incidence

In summer 2018, 60 diverse germplasm collections consists of ICAR-DGR gene bank collections and released varieties were evaluated for early maturity and yield contributing traits by following Augmented RBD design with five checks. Significant differences found in the germplasm collections for reproductive and yield contributing traits. Genotypes : NRCG 10447, NRCG 10620, NRCG 8424, ICGV 91114, Girnar 1, GJG 17, TG 26, Girnar 3, TG 37 A, Spanish Improved and Gangapuri matured within 115 days. Other genotypes NRCG 5187, NRCG 10447, NRCG 5012, NRCG 8424 and GPBD 4 were found to be tolerant to *Alternaria* incidence.

### Evaluation of Germplasm collections for maturity duration and productive traits (GPEMT)

A set of 97 germplasm collections consists of released varieties and gene bank collections were evaluated for maturity and productive traits during *kharif* 2017 and *Kharif* 2018 by following RCBD design in two replications. Promising germplasm identified for different traits are TG 39,TGLPS 3, TLG 45 and TPG 41 for hundred kernel weight and sound mature kernel (%); NRCG 14386, 14463, HNG 69, TG 39 and TPG 41 for kernel length; NRCG 14386, 14463, 14467, 13407, TG 39 and TGLPS 3 for kernel length to width ratio.

Another set of 60 NRCG germplasm collections evaluated for maturity and physical traits for two seasons (*Kharif*

**Fig.** Evaluation of Germplasm accessions, varieties and advanced breeding lines for maturity duration

**Fig.** Screening of advanced breeding lines fresh seed dormancy

2017 and *Kharif* 2018) following augmented RBD design. Germplasm accessions NRCG 5203, 2419 4343 4874, CSMG 2014 were matured between 95 to 105 days. Yield per plant was higher in accessions NRCG 955, NRCG 6063 and RTHRG 6063. Shelling per cent (>70%) was found high in accessions NRCG 5203, 4119,3778, 7085, 2310, 4343 and 2510. Kernel length (16mm) was higher in accessions NRCG 8954, 955, 3026, 5511, 2265 and 2746. Accessions NRCG 8954, 2746, and 9356 exhibited higher kernel length to width ratio (>2) during both *Kharif* 2017 and *Kharif* 2018 seasons.

Twelve interspecific derivatives evaluated for late leaf spot incidence and yield contributing traits in RBD design with three replications during *kharif* 2017 and *Kharif* 2018. NRCG CS 62, 446 and 254 were flowered at par with Chico. Another interspecific derivative NRCG CS 313 was found tolerant to ELS and LLS.

### Evaluation of Spanish bunch advanced breeding lines for early maturity (SBEMT)

About 55 Spanish bunch advanced breeding lines were screened for pod maturity and water use efficiency related traits for two seasons (*Kharif* 2017 and *Kharif* 2018) following augmented RBD design. Advanced breeding lines PBS 15018, 15047, 15057, 16025 and 30080 were matured in 100 days. SCMR was higher in in advanced breeding lines PBS 16039 and 16024, whereas low SLA was observed in PBS 15034 and 15053. Shelling per cent age (>70%) was found higher in breeding lines PBS 11093, 15038 and 16024, whereas kernel length to width ratio (2) was higher in PBS 16052,15026 and 15031.

### Evaluation of Virginia bunch advanced breeding lines for kernel maturity characteristics (AUGVB)

About 215 *Virginia* bunch advanced breeding lines were evaluated maturity duration and large seeded traits for two seasons (*Kharif* 2017 and *Kharif* 2018). Advanced breeding lines PBS 24134, 24139, 26048, 24135, 25028, 25089, 25049 and 26052 had maturity duration of 110 to 115 days. Shelling per cent (>70%) was higher in advanced breeding lines PBS 24137, 24136, 24135, 24138, 24142 and 25091. Advanced breeding lines exhibited higher kernel length than GG20 are PBS 251095, 21108, 21105 and 21092. Kernel length to width ratio (2) was found high in advanced breeding lines PBS 21084, 21087, 21108, 21115 and 25022.

### Evaluation of Spanish and Virginia bunch advanced breeding lines productive and duration characteristics (AUGSB and AUGVB)

About 62 Spanish breeding lines and 31 Virginia bunch advanced breeding lines were screened for days to maturity and yield contributing traits in three replication (RBD) during *Kharif* 2017 and *Kharif* 2018 respectively. Superior advanced breeding lines identified for different traits are: Advanced breeding lines PBS 14060,14068,15019 and 16023 for SCMR; PBS 14066 and 30037 for pod yield per plant; PBS 14060,14080, 16035 and 25085 for hundred kernel wait; PBS14060 and 15033 for Sound mature kernel (50%); PBS 14080, 15050 and 16033 and 25085 for kernel length (>15mm).

### Screening of Germplasm and advanced breeding collections and advanced breeding lines for LLS and ELS

Screening of germplasm collections and advanced breeding lines for late leaf spot and early leaf spot during *kharif* 2017 and *kharif* 2018 respectively. Breeding lines and accessions showed moderate tolerance to LLS and ELS are: PBS 11085, 11092, NCRG CS 313 and PBS 11073. Accessions RHRG 6063, RSB 87, NRCG 2615, 8954, 13262 and advanced breeding lines PBS 24102, 24103, 24104 and 16053 showed tolerance levels to ELS during *kharif* 2018.

### Screening of advanced breeding lines for fresh seed dormancy

Screening of 62 Spanish breeding lines for fresh seed dormancy during *kharif* 2018, advanced breeding lines PBS14060, 14068, 16033, 16044, 11077, 11092, 15014, 15022, 15027, 15028, 16022, 16023 and 16038 exhibited more than 20 days fresh seed dormancy.

### Maintenance of Advanced breeding lines

Twenty four elite advanced breeding lines (PBS 25105, PBS 25127, PBS 26046, PBS 29092, PBS 29224, Jun 2, Jun 4, Jun 9, Jun 13, Jun 18, Jun 21, Jun 23, Jun 27, Jun 28, Jun 29, Jun 30, Jun 32, Jun 33, Jun 37, Jun 38, Jun 43, Jun 48 and SE 8) for drought tolerance and foliar disease resistance were multiplied and maintained for further breeding programmes.

### Multiplication of promising elite advanced breeding lines for AICRP-G trials

Two advanced breeding lines PBS 15022 (IVT-I) and PBS 15044 (IVT-II) were multiplied for seed supply for AICRP-G trials.

## Enhancement and Management of Groundnut Genetic Resources

*Rathnakumar AL, Gangadhara K, Bera SK, Ajay BC and Harish G*

### 1. Field maintenance of Wild *Arachis* germplasm

A total of 108 accessions under 6 sections *viz Arachis* (54), *Caulorhizae* (1), *Erectoides* (7), *Heteranthae* (7), *Procumbentes* (6) and *Rhizomatosae* (40) were maintained in the field gene bank. Seeds from annual species of section *Arachis* were harvested and conser-ved. Seven amphidiploid derivatives have also been maintained for further use in crop improvement programme.

### 2. Acquisition, distribution and utilization of germplasm accessions

During 2018, five farmers' varieties and one market type (Dhanlaxmi) were acquired. A total of 284 germplasm accessions of groundnut were supplied to 27 indenters for use in the crop improvement programme.

### 3. Multiplication and conservation of germplasm accessions

A total of 161 accessions (South American collection) were multiplied in summer 2018 and 1848 germplasm accessions have been multiplied in *kharif* 2018 which included: Crop Cafeteria (45), Composite collection for drought tolerance (196), Released Varieties (217), Bolivian accessions (99), accessions of Argentina (100) accessions with low Carbon Isotope Discrimination (30), interspecific derivatives (170) and accessions for rejuvenation (1187).

### 4. Screening for low and high temperature tolerance under field conditions

The low temperatures (<18°C) at sowing in the winter (*Rabi*, Summer, Spring) groundnut crop in India result in slow seedling emergence and poor plant stand. Delay in seedling emergence affects flowering, pod filling, shelling and yield. It also extends crop duration beyond 120 days, exposing the crop to high temperatures at reproductive phase and pod damage due to early onset of monsoon rains. Identification and incorporation of cold tolerance is therefore an important groundnut breeding objective.

Hence, to assess the low temperature tolerance at germination36 released varieties and 25 mini-core accessions identified to be cold tolerant were planted in the field under two different sowing dates viz. early (19 Jan 2018) to evaluate effect of low temperature on germination and reproductive traits and late (25 March 2018) to evaluate the effect of high temperature on germination and reproductive traits besides yield. For effective comparison, these two set of material were sown during normal date of sowing i.e. 5 Feb 2018.

The temperature was in the range of 12° to 29°C during the week followed by sowing. Subsequently, the tempera

ture regime during the crop growth were: February (17°C-34°C); March (21°C-36°C); April (25°C- 41°C) and May (28°C-42°C). The temperature was in the range of 21° to 41°C during the weeks followed by sowing of accessions meant for screening for high tempera-ture tolerance.

It was observed that due to low temperature, the germination was found progressively delayed and reached the maximum in most (17 out of 25 accessions; 12 out of 36 varieties) by 31 DAS. Four accessions (NRCGs 14324, 14414, 14333, 14367) and 12 (TAG 24, Dh 86, ICGV 00350, JGN 3, GJG 9, ICGV 00348 , ICGV 87846, JL 220, Kisan, Kadiri 71-1, KRG 1) varieties exhibited complete germination by 22 daysafter sowing.

In case of late sown conditions, 14 germplasm accessions (NRCGs 14339, 14424, 14453, 14454, 14324, 14383, 14405, 14328, 14367, 14403, 14480, 14481, 14484, 14492) and 19 (Dh 86, TAG 24, JL 220, OG 52-1, ICGV 00350, JGN 3 ICGV 87846, Kadiri 71-1, GG 8, ALR 3, GG 13, KRG 1, Tirupati 4, MH 4, GAUG 1, GPBD 5, GG 16, GJG 17, Somnath) released varieties exhibited complete germination within 15 DAS. Among the released varieties OG 52-1 and GPBD 4 expressed very low germination even by 31 DAS. Pollen stainability in these two varieties was only 50%, indicating high temperature effect on pollen abortion.

For early sown low temperature conditions of Junagadh, seven mini-core accessions NRCGs 14480, 14374, 14480, 14324, 14367, 14414, 14333 were found promising based on rapid germination, flowering behavior and yield. Whereas for late sown high temperature conditions, five mini-core accessions NRCGs 14480, 14324, 14367, 14414, 14333 were found promising. Thus, for low and high temperature tolerance, four accessions NRCGs 14324, 14367, 14414, 14333 were identified as promising.

Among the released varieties, seven (TAG 24, ICGV 00350, JGN 3, GJG 9, JL 220, LGN 1, ICGV 87846) varieties were found promising for early sown low temperature conditions of Junagadh based on rapid germination, flowering behavior and yield. For late sown and high temperature conditions— eight varieties KRG 1 GG 8, GJG 17, OG 52-1, GAUG 1, Dh 86, ICGV 00350, JGN 3 were found promising. Promising varieties identified for both low, high temperature tolerance at Junagadh conditions were ICGV 87846, LGN 1, TAG 24, JGN 3, GJG 9, TG 17, JL 220, ICGV 00350, TG 1, and Narayini.

At Bawal, five accessions NRCGs 14454,14480,14481, 14484, 14492 for early sown (low temperature) conditions; seven (NRCGs 14454, 14480, 14492, 14419, 14328, 14424,14339) for high temperature conditions and three accessions (NRCGs 14454, 14480, 14492) were found promising for both high and low temperature conditions.

At Bawal, among the released varieties (ALR-3, Somnath, GG-13, Kisan, KRG-1, TG-17, ALR-2, Tirupati-4, JL-220, GJG-17, JGN-3, ICGV87846, Uttakarsh, Narayani, ICGV348) for low temperature conditions; 28 varieties of different habit groups (ALR 3, Punjab 1, Somnath, GG 3, Kadiri 71-1, KRG 1, TAG 24, ALR 2, Tirupati 4, JL 220, OG 52-1, TG 1, GAUG 1, Dh 86, GG 8, GG 16, GG 17, LGN 1, TGLPS 3, ICGV 00350, JGN 3, GJG 9, GJG 31, ICGV 86031, Narayini, Utkarsh, GPBD 5, ICGV 00348) for high temperature tolerance and 11 varieties (ALR 3, Somnath, GG 13, KRG 1, ALR 2, TG 17, JGN 3, ICGV 87846, Utkarsh, Narayani, ICGV 00348)for both low and high temperature tolerance were found promising.

At both the locations Junagadh and Bawal, among the released varieties four (JL 220, JGN 3, ICGV 87846, ICGV 00348) for low temperature conditions; 28 varieties (ALR 3, Punjab 1, Somnath, GG 3, Kadiri 71-1, KRG 1, TAG 24, ALR 2, Tirupati 4, JL 220, OG 52-1, TG 1, GAUG 1, Dh 86,

GG 8, GG 16, GG 17, LGN 1, TGLPS 3, ICGV 00350, JGN 3, GJG 9, GJG 31, ICGV 86031, Narayini, Utkarsh, GPBD 5, ICGV 00348) of different habit groups for high temperature tolerance and ten varieties for both low and high temperature tolerance were found promising. Among germplasm one accession, NRCG 14480 was found promising for both low and high temperature tolerance at both Junagadh and Bawal.

### 5. Characterization of South American collection

In *kharif* 2018, a set of 107 accessions belonging to Argentina (HYB: 08; HYR: 08; VUL: 68 and FST: 23) have been characterized for 16 qualitative and 28 quantitative traits. The maturity duration of these collections ranged from 105-125 d. Eleven accessions matured early (105d). Pod yield in these accessions was low (2.0g-10.7g per 100 kernels) due to small seed size in these accessions (15.4 g-47.0 g). Despite small size of the seeds the shelling outturn varied from 27.8% to 85.3%. The promising trait specific germplasm identified were: NRCG 13375 (10.7g/plant) and NRCG 13040 (10.2g/plant) for pod yield; NRCG 13037 (85.3%) and NRCG 4206 (83.3%) for shelling outturn; and NRCG 13127 (47.0 g/100kernels) and NRCG 11631 (46.0 / 100 kernels for medium bold seeds. Among the 107 accessions NRCG 14368 was found early (105d), with high pod yield (8.0 g/plant) and high shelling (72.5%).

Another set of 103 (HYB: 71; HYR: 11; VUL: 05 and FST: 16) accessions originating from Argentina has been characterized for 16 qualita-tive and 28 quantitative traits. The maturity duration of these collections ranged from 105-135 d. The pod yield in these accessions was low (0.5g-5.5 g/plant). Eleven accessions matured early (105d). Pod yield in these accessions was low (2.0g-10.7g per 100 kernels) and were found inferior for specific traits.

### 6. Analysis of quality (oil, protein) of working collection accessions

956 accessions of working collection have been evaluated for oil, protein and sugar contents in kharif 2018. The oil content in 956 accessions ranged from 44.1%-54.9%; protein content ranged from 23.2%-36.4% and sugar content ranged from 5.2% to 9.0%.

The oil content in 189 Valencia accessions ranged between 44.1% (NRCG 10969) to 54.9% (NRCG 14245) in oil content; 23.2%-36.2% in protein content and 5.2%-8.4% in sugar content; Two accessions NRCG 10969 (44.1% oil; 36.2% protein; 6.99% sugar content) and NRCG 10836 (44.7% oil; 35.5% protein; 6.70% sugar content) were found to have low oil high protein and high sugar (6.5%) contents. Two accessions viz. NRCG 14245 (54.9% oil; 23.2% protein; 6.01% sugar content) and NRCG 11049 (52.3% oil; 26.4% protein; 6.180% sugar content) exhibited high oil, low protein and high sugar contents which can be used as donors for improvement of oil content in groundnut.

The oil content in 473 Spanish Bunch accessions ranged between 44.8% (NRCG 10544) to 52.2% (NRCG 14182); protein content ranged from 26.4% (14518) to 36.4% (NRCG 14182) and sugar content varied between 5.3% (NRCG 14182) to 8.5% (NRCG 10672). Among the Spanish Bunch germplasm accessions, one accession NRCG 14182 exhibited high oil (52.2%) with low protein (26.4%) and low sugar (5.3%) content. This accession can be used as donor in breeding high oil genotypes. Twenty-four accessions had low oil (44%-45%), high protein (35%) and high sugar (35%-36%) contents and can be used as donors in breeding confectionery types.

In 128 Virginia Runner accessions, the oil content ranged between 44.1% (NRCG 10173) to 51.4% (NRCG 10201); protein content ranged from 27.0%

(NRCG 10201) to 36.3% (NRCG 14532) and sugar content varied between 5.2% (NRCG 14668) to 9.0% (NRCG 10245). Among the Virginia Runner germplasm accessions, two accessions NRCG 10187 (44.1% oil; 35.6% protein; 8.1% sugar content) and NRCG 10173 (44.1% oil; 35.7% protein; 7.8% sugar content) exhibited low oil with high protein and high sugar content. These accessions can be used as donor in breeding confectionery groundnuts. Two accessions, NRCG 10201 (51.4% oil; 27.0% protein; 8.6% sugar content) and NRCG 10185 (51.1% oil; 27.3% protein; 8.0% sugar content), had high oil with low protein and high sugar content. These accessions can be used as donors in breeding high oil genotypes

Among 165 Virginia Bunch accessions, the oil content ranged between 44.6% (NRCG 14592) to 52.3% (NRCG 11780); protein content ranged from 26.2% (NRCG 11780) to 35.6% (NRCG 14592) and sugar content varied between 5.6% (NRCG 10143) to 8.9% (NRCG 10607). Among the Virginia Bunch germplasm accessions, two accessions NRCG 14569 (44.8% oil; 35.2% protein; 6.3% sugar content) and NRCG 14592 (44.6% oil; 35.6% protein; 6.3% sugar content) exhibited low oil with high protein and high sugar content. These accessions can be used as donors in breeding confectionery groundnuts. Two accessions, NRCG 11780 (52.3% oil; 26.2% protein; 8.0% sugar content) and NRCG 14264 (51.8% oil; 26.6% protein; 6.4% sugar content) had high oil with low protein and high sugar content. These accessions can be used as donors in breeding high oil genotypes

### 7. Testing of the five candidate varieties of groundnut under DUS project

One candidate variety, Western Vardan, and six farmers varieties JHUMKUL (REG/2017/1132), INDOORI (REG/2017/1133), MANOHAR MOONGFALI (REG/2017/-1134), BHADELIFALLI (REG / 2017/1278), SOTHAFALLI (REG / 2017 / 1285), and JEET BADAM (REG/2017/2310) received were characterized in *kharif* season 2019 along with suitable reference varieties.

The eight reference varieties used were: Spanish Bunch: GG 2 and SG 84 Valencia: Kopergaon 3 and Gangapuri (4 rows each); Virginia Bunch: GG 20 and BAU 13; Virginia Runner: Punjab 1 and Somnath (6 rows each). All the recommended practices have been followed to raise a successful crop. Observations on 13 qualitative 5 quantitative descriptor traits have been recorded at appropriate growth stages in the format given by PPV and FRA, New Delhi under DUS Test guidelines.

## Marker assisted breeding for fungal disease resistance and high oil quality in groundnut

*Chandramohan S, Bera SK and Narendra Kumar*

### I. RIL mapping population development and evaluation of RILs for LLS and rust resistance (GJG17 x GPBD4 and GJG 22 x ICGV 86590)

#### Generation advancement of development RIL population

The $F_8$ lines (1025 lines) of the cross GJG 17 x GPBD 4 were sown in the field in *Kharif* 2018 and subse-quently taken for generation advancement by single seed descent method (SSD). Similarly the $F_7$ lines (507 lines) of the cross GJG 22 x ICGV 86590 were sown in the field in Kharif 2018 and subsequently taken for generation advancement by single seed descent method (SSD). These lines will be used as RIL mapping population for LLs and rust and also for other morphologically important traits. Similarly F3 lines (360 lines) of the cross TMV 2 x CS196 were sown in the field in *Kharif* 2018 and subsequently taken for generation advancement by single seed descent method (SSD). The seeds were sown in the field and artificial disease epiphytic conditions were created by "spreader row technique" using susceptible lines (TMV 2). Similarly generation advancement of the new cross TG 37A x ABIL 5841 was

| Sr. No. | LG | No. of markers | Size (cM) | Average distance (cM) |
|---|---|---|---|---|
| 1 | LG_A01 | 5 | 74.96 | 14.99 |
| 2 | LG_A03 | 27 | 186.04 | 6.89 |
| 3 | LG_A04 | 5 | 81.5 | 16.30 |
| 4 | LG_A05 | 3 | 27.59 | 9.20 |
| 5 | LG_A06 | 2 | 12.7 | 6.35 |
| 6 | LG_A07 | 2 | 5.25 | 2.63 |
| 7 | LG_A08 | 3 | 43.34 | 14.45 |
| 8 | LG_B02 | 3 | 12.45 | 4.15 |
| 9 | LG_B03 | 4 | 76.89 | 19.22 |
| 10 | LG_B04 | 5 | 138.59 | 27.72 |
| 11 | LG_B05 | 2 | 17.78 | 8.89 |
| 12 | LG_B06 | 2 | 21.43 | 10.72 |
| 13 | LG_B08 | 2 | 20.36 | 10.18 |
| 14 | LG_B10 | 5 | 78.67 | 15.73 |
| | **Total** | **70** | **797.55** | **11.39** |

undertaken for high oleate and foliar disease resistance traits.

Phenotyping data was recorded for both LLS and rust performed at the time of harvesting using modified 9-point scale from the cross GJG 17 x GPBD 4 and other important morphological traits for which parents were diverse viz. LLS, Rust, Leaf shape, Leaf tip, Stem color, Stem hairs, Pod constriction, Pod beak, Pod reticulation, Leaf size, Node interval, Stem thickness, Plant height, No. of Pri. Branches, No. of Sec. branches, Dry pod weight, Kernel weight, No. of immature pods, No. of single seeded pods, No. of double seeded pods and Shelling percentage.

## II. QTL mapping for foliar fungal disease resistance

Out of 1311 SSR markers screened in GJG 17 x GPBD 4, 84 (6.40%) markers were found as polymorphic between the parents and subsequently used in mapping foliar fungal disease resistance. The genotyping data generated from all 84 SSR markers was used to test the expected segregation ratio (1:2:1) by using chi-square test ($\chi 2$). Out of 84 polymorphic markers tested, seventy markers were mapped on 14 linkage groups (LGs) covering total map distance of 797.55 cM with an average inter-marker distance of 11.39 cM (Table) and remaining were unlinked markers.

The mapping data obtained from 70 SSR markers assigned to genetic maps and phenotypic data from $F_2$ mapping population consisting of 328 lines was used for QTL analysis with the help of QTL IciMapping version 4.1.As a results, two major QTLs, $LLS_{QTL1}$ and $LLS_{QTL2}$, were detected for LLS resistance explained >10 % phenotypic variance (PV). Out of these two QTLs for LLS, one major QTL $LLS_{QTL1}$ identified on A03 chromosome (LG-A03) in fine map interval of 1.41 cM flanked by markers SSR_GO340445 and FRS72contributed 47.45 PVE and LOD value was 50.39. Another major QTL ($LLS_{QTL2}$) explained 29.06 % PV, was found on same chromosome (LG_A03) very close to $LLS_{QTL1}$ at a distance of 4.63 cM from

marker FRS72 with an LOD value of 34.53 and flanked by the marker DGR259 and FRS56. Whereas, one major QTL ($Rust_{QTL}$) was identified for rust flanked by markers SSR_GO340445 and FRS72. This is the same QTL region where major QTL for LLS ($LLS_{QTL1}$) was detected. $Rust_{QTL}$ contributed 70.52 % PV of the total variance and LOD value of 87.81.

### Validation of newly developed markers:

24 markers were used for validation in LLS and Rust resistant varieties. The main aim was to find if there is any alleles other than alleles from GPBD 4 which can be utilized for breeding. All markers were able to distinguish resistant varieties justified by their phenotypes (disease score). 12 varieties resistant to both LLS and rust, 9 varieties resistant to rust only were used in this study. These varieties were tested with 24 markers from LLS and rust resistance QTL region on A03 chromosome. After screening collection of peanut varieties with all the markers of targeted genomic region ranging from GM1954 to GM2009, it was observed that all the twelve varieties, which are resistant to both LLS and rust, carries resistant allele of marker DGR2409, DGR329, RS103, RS78, RS74, SSR_GO340445, FRS72, FRS49, DGR259, FRS56, RS50, RS51, RS42, gi56931710 and DGR 800 like GPBD 4. These markers including the markers flanking major rust and LLS QTL were able to clearly differentiate resistant and susceptible varieties specified by their allelic pattern. On the other hand, eight markers (RS5, DGR312, DGR361, GM2079, GM2301, DGR508, IPAHM103 and GM1954) flanking left side of this genomic region and three markers (DGR329, DGR2409 and GM2009) present towards right side of this major QTL region could not clearly d discriminate resistant and susceptible varieties specified by their allelic patterns.

## III. Marker-assisted gene pyramiding for foliar diseases and high oleic acid content in groundnut

### Screening of introgression lines for foliar disease resistance:

Introgression lines (ILs) developed from cross *viz.*, GJG17 x GPBD4 were tested for foliar diseases resistance in *Kharif*. A total of 90 ILs from GJG17 x GPBD4 were sown in 1 meter row along with their parents. The artificial disease epiphytotic condition was created for both the diseases using the "spreader row technique". Spreader rows of TMV2 (national susceptibility check for both diseases) were sown at every second row as well as in a border around the field to maintain the effective inoculum load. Artificial infection of the disease inoculum was also spread after 45 days of sowing. The infected leaves were taken from the field for LLS and rust and soaked in water for 1-2 hour. Then the LLS conidia and rust urediniospores were collected by rubbing the infected leaves in the water. The inoculum contained conidia / urediniospores in water and mixed with Tween 80 (0.2 ml/-1000ml of water) as a mild surfactant and atomi-zed on the plants using hand knapsack sprayer. The plants were uniformly inoculated with LLS and rust inoculum for twice a week in the evening.

The mean disease score of parent GPBD 4 for LLS (3.0) and rust (2.0) showed lower disease incidence than their parents GJG17 (LLS-8, rust: 7.0) and SunOleic95R (LLS-8.5, rust: 7.0). These introgression lines showed good resistance to LLS ranging from 1.0 to 6.0 on a 1–9 scale while recurrent parents recorded a disease score of 8.0. Whereas for rust it was ranged from 1.0 to 6.0 with the overall mean of 04 for the season. Most of the ILs showed on par resistance to the donor parent genotype ('GPBD 4'), i.e., disease score of 2.0, while recurrent parent

| ENTRIES | Diseases Severity (1-9 scale) | | ENTRIES | Diseases Severity (1-9 scale) | |
|---|---|---|---|---|---|
| | LLS | Rust | | LLS | Rust |
| RL 19 | 1 | 1 | MAS 13 | 2 | 3 |
| RL 16 | 2 | 1 | MAS 12 | 1 | 1 |
| RL 15 | 3 | 2 | MAS 8 | 1 | 1 |
| RL 10 | 3 | 2 | MAS 6 | 1 | 1 |
| RL 7 | 1 | 2 | MAS 47 | 1 | 4 |
| RL 1 | 3 | 1 | MAS 44 | 1 | 1 |
| RL 26 | 1 | 1 | MAS 41 | 1 | 1 |
| RL 25 | 1 | 1 | MAS 40 | 1 | 2 |
| RL 24 | 1 | 1 | MAS 39 | 4 | 1 |
| RL 23 | 4 | 2 | MAS 37 | 1 | 1 |
| RL 22 | 3 | 3 | MAS 35 | 1 | 1 |
| RL 20 | 1 | 2 | MAS 14 | 1 | 1 |
| RL 80 | 1 | 1 | MAS 66 | 1 | 1 |
| RL 79 | 1 | 1 | MAS 65 | 2 | 1 |
| RL 73 | 2 | 1 | MAS 59 | Seed were not germinated | |
| RL 53 | 1 | 1 | MAS 55 | 1 | 1 |
| RL 49 | 1 | 1 | MAS 54 | 1 | 1 |
| RL 28 | 1 | 1 | MAS 52 | 1 | 1 |
| RL 88 | 2 | 1 | MAS 49 | 3 | 1 |
| RL 87 | 1 | 1 | MAS 48 | 1 | 1 |
| RL 86 | 1 | 1 | | | |
| RL 85 | 1 | 1 | Co2 | 5 | 5 |
| RL 84 | 1 | 1 | GG17 | 3 | 3 |
| RL 82 | 1 | 1 | GPBD4 | 1 | 1 |
| RL 104 | 1 | 1 | | | |
| RL 103 | 1 | 1 | | | |
| RL 102 | 1 | 1 | | | |
| RL 101 | 3 | 1 | | | |
| RL 100 | 3 | 1 | | | |
| RL 90 | 2 | 3 | | | |

**Table 1.** Crosses effected in *kharif*

| SN | Name of crosses | Purpose of crosses | F1 pods harvested | Success rate (%) |
|---|---|---|---|---|
| 1 | TG-37A × GPBD-4 | High yield and resistance to LLS and rust | 377 | 70.0 |
| 2 | GG-20 × GPBD-4 | High yield and resistance to LLS and rust | 254 | 62.9 |
| 3 | TG-37A × F1 (TG-37A × GPBD-4) | High yield and resistance to LLS and rust | 227 | 79.6 |
| 4 | GG-20 × F1 (GG-20 × GPBD-4) | High yield and resistance to LLS and rust | 447 | 63.0 |

recorded score of 6.5 (LLS) and 6.0 (rust) and susceptible check recorded score of 7.5 for both diseases at that time.

**Screening of introgression lines for foliar disease resistance:**

Introgression lines obtained from MAS were screened at aliyarnagar for foliar disease resistance and score recorded were as follows:

**Sub-Project: MAS for foliar disease resistance in Groundnut**

1. **Fresh crosses effected in *kharif*:**

Four crosses were effected to develop high yielding improved varieties resistant of leaf spot and rust. The number of harvested crossed pods varied from 227 (TG-37A × $F_1$ (TG-37A × GPBD-4) to 377 (TG-37A × GPBD-4). The mean success rate (%) of the hybridization programme was 69, which ranged from 62.9 to 79.6%.

2. **Identification of hybrids:**

Two hybrids (TG-37A × GPBD-4) and (GG-20 × GPBD-4) effected in summer were raised in *kharif* to identify $F_1$'s for developing resistant genotypes to leaf spot and rust. These hybrids were identified using diagnostic marker for leaf spot and rust and these crosses were used to develop backcross generations ($BC_1$) for transferring the resis-tance gene in recurrent parent background and rest of hybrids were used to produced $F_2$ for generation advancement.

**Development of pre-breeding lines resistant to biotic stresses and tolerance of abiotic stress using interspecific hybridization and mutation breeding in groundnut**

*Bera SK, Meena HN*, Thirumalaisamy PP and Narendra Kumar*

*Associated till 23rd June 2018

**Hybridization**

In 2018 *kharif* season, a total of three crosses were attempted between cultivated groundnut and wild *Arachis* species as well as Synthetic amphidiploids. Maximum probable cross pods were harvested in a cross between NRCGCS- 401 × *A. glabrata* followed by 18 and 14 in J11 × Synthetic amphidiploids-1 and J11 × Synthetic amphidiploids-2, respectively. Probable cross pods will be planted in 2019 *kharif* season for identification of true $F_1$s

**Single plant selection**

Bulked segregating population ($F_4$) of three interspecific crosses, TG37A//J11/*A. diogoi,* TG37A//J11/*A. duranensis* and TG37A//J11/*A. pusilla* were planted during 2018 *kharif* season. Single plant selection was made based on number of pods per plant as well as resistance to major foliar diseases. Forty four, 28 and 42 single plant selections were made from TG37A//J11/*A. diogoi,* TG37A//J11/*A. duranensis* and TG37A//J11/*A. pusilla,* respectively. Furthermore, 15 and 38 single plant selections were made from two separate crosses JL 24 x NRCGCS 85 and ICG 4747 x TMV2NLM, respectively.

Initial yield evaluation of stem rot resistant breeding lines

Hybridization was made between cultivar GG-20,

susceptible to stem rot and breeding line CS-19, resistant to stem rot. RILs were developed following SSD method and screened for resistance to stem rot over five seasons. Based on less plant mortality percent over five seasons, a total of 72 RILs were finally selected and were evaluated along with check cultivars for yield during 2018 *kharif* season. Selected RILs were planted in augmented design in four blocks vid four checks. Each RIL was plant ted in two lines on five meter bed. Pod yield per plot was recorded at harvest. No significant block effect was observed between blocks. KDG-128 (822 g) and GG-20 (873 g) recorded statistically on par pod yield per plot among than GG-20 and KDG-123. In terms of pod yield plot, RIL- 2-16 (1127 g) and RIL-9-12 (1131 g) were found superior with significant higher pod yield than GG-20.

### Initial yield evaluation of RILs

#### *i) RILs developed for resistance to stem rot*

Hybridization was made between cultivar GG-20, susceptible to stem rot and breeding line CS-19, resistant to stem rot. RILs, 268, in number were developed following SSD method. These RILs were evaluated in augmented design in three blocks. Each RIL was planted in single line of three meter bed. Among checks, maximum pod yield was observed in GG-20 and a total 51 RILs were found superior than GG-20 in term of pod yield per line. Yield of these RILs will be confirmed further.

Similarly, hybridization was made between cultivar GG-20, susceptible to stem rot and breeding line NRCGCS-319, resistant to stem rot. RILs, 193, in number were developed following SSD method. These RILs were evaluated in augmented design in three blocks. Each RIL was planted in single line of three meter bed. Among checks, maximum pod yield was observed in GG-20 and a total 90 RILs were found superior than GG-20 in term of pod yield per line. Yield of these RILs will be confirmed further

#### *ii) RILs developed for resistance to PBND*

Hybridization was made between cultivar JL-24, susceptible to PBND and breeding line NRCG CS-85, resistant to PBND. RILs, 118, in number were developed following SSD method. These RILs were evaluated in augmented design in two blocks during 2018 *kharif* season. Each RIL was planted in single line of three meter bed. A total of two RILs were found superior than JL-24 in term of pod yield per line. Yield of these RILs will be confirmed further.

Similarly, hybridization was made between cultivar JL-24, susceptible to PBND and breeding line NRCG CS-86, resistant to PBND. RILs, 260, in number were developed following SSD method. These RILs were evaluated in augmented design in four blocks during 2018 *kharif* season. Each RIL was planted in single line of three meter bed. A total 46 RILs were found superior than JL-24 in term of pod yield per line. Yield of these RILs will be confirmed further.

#### *iii) RILs developed for tolerance of drought*

Hybridization was made between ICG 4747, susceptible to drought and TMV2NLM, tolerant to drought. RILs, 152, in number were developed following SSD method. These RILs were evaluated in augmented design in five blocks during 2018 *kharif* season. Each RIL was planted in single line of three meter bed. A total 26 RILs were found superior than check in term of pod yield per line. Yield of these RILs will be confirmed further.

### Advanced yield evaluation of promising genotype

A stem rot resistant breeding line, GG-20×CS-19-PL-4-6 and four checks (GG-20, GG-7, KDG-123 and TG-37A) were re-evaluated for yield in RBD with three replications

during 2018 *kharif* season. Each genotype was planted in five lines on five meter bed with recommended crop management practices. Pod yield per plot (15 $m^2$) was recorded at harvest and KDG-123 recorded maximum pod yield per plot (2157 g). Pod yield of GG-20×CS-19-PL-4-6 was on par with KDG-123, significantly higher than GG-20 (1723 g). Noetheless, GG-20×CS-19-PL-4-6 recorded pod yield on par with KDG-123 and significantly higher than GG-20 during 2017 *kharif* season. Hence, GG-20×CS-19-PL-4-6 could be promising one in the state of Gujarat, where farmers still prefer GG-20 over small seeded KDG-123 and KDG-128.

### Confirmation of selected pre-breeding lines for resistance to PBND

A field experiment was conducted using 42 groundnut inter-specific derivatives including check (Kadiri 6) in randomized block design (RBD) at Agricultural Research Station, Kadiri during 2018 summer season. The check genotype (Kadiri 6) was included for every 5 genotypes. The viral disease pressure and thrips population were increased by allowing parthenium weeds in and around the experimental plot.

At 90 DAS, PBND incidence was low and it ranged from 0.0 % to 5.0 % among different groundnut inter-specific derivatives. However, the genotypes *viz.*, NRCGCS 55, NRCGCS 86, NRCGCS 102, NRCGCS 262, NRCGCS 267, NRCGCS 268, NRCGCS 269, NRCGCS 275, NRCGCS 277, NRCGCS 319, NRCGCS 327, NRCGCS328 and NRCGCS 417 were free from the PBND incidence. Similarly, incidence of PSND ranged from 0.0 % to 14.8.0 % among different groundnut inter-specific derivatives. But, the genotypes *viz.*, NRCGCS 86, NRCGCS 275, NRCGCS 277, NRCGCS 282 and NRCGCS 300 were free from the PSND incidence. The inter-specific derivatives *viz.*, NRCGCS 86, NRCGCS 275 and NRCGCS 277 were free from both PBND and PSND.

However, the disease pressure of PBND was low in the season. It might be due to late sowing of the experiment (21-02-2018) as seed material received lately. It is better to screen one more season during *rabi* 2018-19 (December 1st fortnight to April). The promising genotypes will be tested by artificially sap inoculation with *Groundnut bud necrosis virus* under controlled condition.

### Screening of RILs and pre-breeding lines for resistance to stem rot

Selected 141 RILs of a cross GG-20 × CS-19 were screened for resistance to stem rot under artificially inoculated conditions during 2019 summer season. All the RILs were found susceptible to the disease with plant mortality percent ranging from 50% to 100%. The plants survived were harvested as progeny row for further screening. Similarly, 85 pre-breeding lines were screened for resistance to stem rot under artificially inoculated conditions. All the pre-breeding lines were found susceptible to the disease with plant mortality percent ranging from 85% to 100%.

### Screening of pre-breeding lines for resistance to stem rot

Pre-breeding lines were screened for resistance to stem rot under artificially inoculated condition. All 24 pre-breeding lines were found highly susceptible to the disease with 100% plant mortality.

### Seed Multiplication

Seeds, approximately, 50-60 kg each of five promising pre-breeding lines were multiplied during 2018 *kharif* season. These lines will be proposed for AICRPG testing in 2019 *kharif* season.

### Pre-breeding lines shared to the AICRP centers

Pre-breeding lines, 100 each, were supplied to UAS, Dharward; UAS, Raichur and ARS, Kadiri for screening against, major folia diseases, PBND and PSND under natural hot spot locations.

## Sub project: Enhancement of oleic acid content (~80%) in two mega groundnut varieties of Gujarat

*Bera SK, Gangadhara K and Chandramohan S*

### Backcrossing and genotyping of segregating populations for introgression of ahfad2 alleles

Probable cross pod harvested in summer 2018 (Table-1) were planted in 2018 *kharif* season. Number of probable cross pods ranged from 13 to 44 in four crosses. Plants were genotyped with ahfad2 alleles and number of plants with both the ahfad2 allele ranged from two to seven.

Individual flower tagged with thread for hybridization

In 2018 *kharif* season, eight fresh crosses were attempted to introgress *ahfad2* alleles in high and low oil, drought tolerant, short duration and high yielding background (table 2). Number of pollination ranged from 23 to 870 in different cross combinations. Similarly,

**Table-1** Detail of backcrossing and cross pod harvested

| S. No. | Name of backcross | Generation | Cross pod harvested | No. of plants with ahfad2 alleles identified |
|---|---|---|---|---|
| 1 | GG-20 × SunOleic 95R | $BC_1F_1$ | 13 | 02 |
| 2 | TG37A × SunOleic 95R | $BC_1F_1$ | 19 | 07 |
| 3 | GG-7 × SunOleic 95R | $BC_1F_1$ | 43 | 04 |
| 4 | TKG19A × SunOleic 95R | $BC_1F_1$ | 44 | 02 |

**Table-2** Detail of crossing and cross pod harvested

| S. N. | Cross | No. of pollination | No. of cross pods |
|---|---|---|---|
| 1 | HOS-30 × HOS-145 | 183 | 67 |
| 2 | NRCG 9000 × HOS 130 | 23 | 9 |
| 3 | (ICG 4747× TMV2 NLM-1-5)×NRCGCS-587 | 680 | 118 |
| 4 | NRCGCS-435 × HOS-191 | 796 | 157 |
| 5 | NRCGCS-401 × HOS-116 | 662 | 166 |
| 6 | GJG-22 × NRCGCS-587 | 812 | 143 |
| 7 | NRCGCS-268 × NRCGCS-587 | 461 | 136 |
| 8 | ICGV-15080 × NRCGCS-587 | 870 | 149 |

probable cross pod ranged from 9 to 166 in different crosses. Probable cross pods will be planted during 2019 summer for genotyping with diagnostic markers.

Probable cross pods harvested in 2017 *kharif* were planted in 2018 summer season for MAS of plants with ahfad2 alleles. Plant with both the ahfad2 alleles ranged from four to sixteen in four different crosses (Table-3)

Besides, single plant $F_2$ progeny of two different crosses were planted in 2018 summer season and genotyped for MAS of homogygous plant with *ahfad2* alleles during 2018 summer season. A total of five plants with homogygous *ahfad2* alleles were identified in TKG19A background while 23 plants with homogygous *ahfad2* alleles were identified in GG-7 background (Table-4).

Furthermore, homogygous plants with ahfad2 alleles of four different crosses were advanced to next generation for seed increase and phenotyping during 2018 *kharif* season (table-5). Phenotyping of 347 lines for fatty acid profile is in process.

**Table-3** Detail of $F_1$s and MAS of plants with *ahfad2* alleles

| S. No. | Name of cross | Generation | No of plants genotyped | No. of plants with ahfad2 alleles identified |
|---|---|---|---|---|
| 1 | GG-20 × SunOleic 95R | F1 | 118 | 16 |
| 2 | TG-37A × SunOleic 95R | F1 | 198 | 07 |
| 3 | GG-7 × SunOleic 95R | F1 | 177 | 04 |
| 4 | TKG-19A × SunOleic 95R | F1 | 98 | 16 |

**Table-4** Details of $F_2$s planted in summer 2018 and MAS of homozygous plants with *ahfad2* alleles

| S. No. | Name of cross | Generation | No of plants genotyped | No. of homogygous plants with *ahfad2* alleles identified |
|---|---|---|---|---|
| 1 | GG-7 × SunOleic 95R | F2 | 318 | 23 |
| 2 | TKG19A × SunOleic 95R | F2 | 64 | 05 |

**Table-5** Details of F2s planted in summer 2018 and MAS of homozygous plants with *ahfad2* alleles

| S. N. | Name of cross | Generation | Confirmed |
|---|---|---|---|
| 1 | GG7 X SunOleic 95R | F3 | 245 |
| 2 | TKG19A X Sunoleic 95R | F3 | 54 |
| 3 | GG20 X Sunoleic 95R | F2 | 23 |
| 4 | TG37A X Sunoleic 95R | F2 | 5 |
| 5 | GG7 X SunOleic 95R | F2 | 0 |
| 6 | TKG19A X Sunoleic 95R | F2 | 20 |
| | | **Total** | **347** |

### Yield evaluation of breeding lines with high oleic acid content

A total of 21 breeding lines containing high oleic acid were planted in RBD with three replications. Each genotype was planted in four lines of three meter bed. Observation on pod yield and related traits were recorded at harvest. Higher CV% was observed due to large variation in plant stand vis-à-vis pod yield between replications (table-6). Highest yield was observed in the check variety KDG-128 while pod yield of two breeding lines were on par of KDG-128.

### Yield evaluation of high oil content lines

Hybridization was made between high oil content and low oil content breeding lines developed by ICRISAT. Breeding lines were advanced to $F_6$ generation by SSD method. A total of 1500 lines were phenotyped for oil content and pod yield over four seasons at ICAR-DGR and selection was made based on high pod yield and high oil content separately. A total of four lines were finally selected having more than 55% oil content (table-6). These high oil content selections were evaluated for yield along with check cultivars in RBD with three replications during 2018 *kharif* season. Each genotype was sown in four lines on five meter bed. Recommended crop management practices were followed for a healthy crop. Highest pod yield (2045 g) per plot (12.0 $m^2$) was observed in the check variety, KDG-128 followed by GG-20 (1717 g). Pod yield per plot (1610 g) of single test entry (HOS-30) was on par with GG-20 and needs further confirmation.

### Yield evaluation of high yielding and oil content lines

Hybridization was made between high oil content and low oil content breeding lines developed by ICRISAT. Breeding lines were advanced to $F_6$ generation by SSD method. A total of 1500 lines were phenotyped for oil content and pod yield over four seasons at ICAR-DGR and selection was made based on high pod yield and high oil content separately. A total of 45 promising lines were selected based on yield and evaluated for yield along with check cultivars in RBD with three replications during 2018 *kharif* season. Each genotype was sown in three lines on five meter bed. Recommended crop management practices were followed for a healthy crop. Among check cultivars, KDG-128 was found with maximum pod yield (1035 g) per plot followed by GG-22 (998 g) and GG-20 (945 g). Pod yield per plot of HOS-724 was found significantly higher (1512 g) than KDG-128, while pod yield per plot of HOS-1185 was on par with KDG-128 (table-7). Moreover, these two genotypes contain higher oil content (53%) and performance of these promising lines requires further confirmation.

### Impact of high oleic acid on seed and seedling traits

Fully matured kernels harvested October 2018 were used in the experiment in third week of February 2019.

**Table-6** Groundnut breeding lines with high oil content over the environments

| Breeding Lines | Oil content % | | | | |
|---|---|---|---|---|---|
| | Kh-16 | Sum-17 | Kh-17 | Sum-18 | Kh-18 |
| HOS-22 | 55 | 55 | 55 | 54 | 55 |
| HOS-30 | 55 | 56 | 58 | 56 | 56 |
| HOS-58 | 55 | 55 | 56 | 55 | 55 |
| HOS-89 | 58 | 55 | 58 | 56 | 57 |

**Table-7** Pod yield of breeding lines containing high oleic acid

| HOS. No. | Pod wt/ha (kg) | HOS. No. | Pod wt/ha (kg) |
|---|---|---|---|
| 108 | 939 | 154 | 1385 |
| 109 | 1205 | 163 | 1669 |
| 111 | 1017 | 171 | 1716 |
| 116 | 1377 | 172 | 1994 |
| 119 | 1221 | 181 | 1209 |
| 120 | 1658 | 191 | 1951 |
| 123 | 1278 | 201 | 1139 |
| 125 | 1441 | 218 | 2116 |
| 130 | 1092 | 253 | 2831 |
| 138 | 1592 | KDG-128 | 3324 |
| 144 | 2889 | CD@5% | 713 |
| 145 | 1570 | CV% | 26.0 |

**Table-8** Details of seedling traits in normal and high oleic groundnut genotypes

| Trait | Name of genotypes | Oil % | Oleic acid % | Germi-nation% | Shoot Length | Root Length | Fresh Shoot wt. mg | Fresh Root wt. mg | Vigour index |
|---|---|---|---|---|---|---|---|---|---|
| High oleic (~80%) peanuts | **NRCGCS-587** | 55 | 80 | 80.00 | 17.78 | 7.65 | 1.97 | 0.16 | 0.3 |
| | **HOP-IL_MAS-191** | 53 | 80 | 73.33 | 21.24 | 10.89 | 2.22 | 0.13 | 0.19 |
| | **HOP-IL_MAS-14** | 55 | 580 | 76.72 | 3.00 | 9.55 | 2.56 | 0.15 | 0.25 |
| | **HOP-IL_MAS-130** | 55 | 81 | 96.7 | 17.17 | 5.80 | 1.35 | 0.06 | 0.14 |
| | **Mean** | | | 81.70 | 19.79 | 8.47 | 2.02 | 0.13 | 0.22 |
| Normal oleic (~50-55%) peanuts | **GG20** | 51 | 64 | 90 | 22.40 | 6.75 | 2.58 | 0.12 | 0.27 |
| | **ICGV6100** | 55 | 39 | 83.30 | 15.46 | 5.93 | 2.02 | 0.35 | 0.26 |
| | **ICGV05141** | 55 | 55 | 100.00 | 14.68 | 6.63 | 1.24 | 0.08 | 0.16 |
| | **ICGV06110** | 53 | 38 | 100.00 | 17.20 | 4.15 | 1.62 | 0.06 | 0.11 |
| | **Mean** | | | 93.30 | 17.44 | 5.87 | 1.86 | 0.15 | 0.20 |
| | **CD@5%** | | | 7.55 | 5.16 | 1.42 | 0.73 | 0.04 | 0.08 |
| | **CV%** | | | 4.93 | 15.84 | 11.34 | 21.4 | 14.55 | 22.04 |

**Table-10** Details of genotypes proposed for AICRP testing

| Gen. | Habit group | Pedigree | Oil content % | Oleic acid content % |
|---|---|---|---|---|
| NRCGCS 587 | VB | ICGV05141 x Sunoleic 95R | 54 | 80 |
| NRCGCS 605 | VB | ICGV06100 x Sunoleic 95R | 54 | 80 |
| NRCGCS 607 | VB | ICGV06100 x Sunoleic 95R | 53 | 76 |
| NRCGCS 610 | VB | ICGV06100 x Sunoleic 95R | 54 | 76 |
| NRCGCS 612 | VB | ICGV06100 x Sunoleic 95R | 53 | 77 |
| NRCGCS 613 | VB | ICGV06100 x Sunoleic 95R | 54 | 80 |

**Table-9** Details of high oleic lines multiplied

| S No. | Genotype | Pod wt (kg) | S No. | Genotype | Pod wt (kg) |
|---|---|---|---|---|---|
| 1 | ICGV 15080 | 182.2 | 16 | HOS-119 | 17.7 |
| 2 | ICGV 15083 | 140.4 | 17 | HOS-123 | 17.0 |
| 3 | ICGV 15090 | 120.7 | 18 | HOS-125 | 26.8 |
| 4 | ICGV 15327 | 100.9 | 19 | HOS-163 | 15.1 |
| 5 | NRCGCS-587 | 2.6 | 20 | HOS-130 | 17.9 |
| 6 | HOS-191 | 110.6 | 21 | HOS-120 | 22.1 |
| 7 | HOS-154 | 64.2 | 22 | HOS-179 | 1.9 |
| 8 | HOS-201 | 28.6 | 23 | HOS-138 | 0.1 |
| 9 | HOS-108 | 18.9 | 24 | HOS-145 | 0.9 |
| 10 | HOS-111 | 18.6 | 25 | HOS-109 | 0.2 |
| 11 | HOS-116 | 21.8 | 26 | HOS-144 | 0.5 |
| 12 | HOS-172 | 3.6 | 27 | HOS-58 | 1.1 |
| 13 | HOS-183 | 4.7 | 28 | HOS-89 | 0.4 |
| 14 | HOS-171 | 36.2 | 29 | HOS-30 | 3.6 |
| 15 | HOS-181 | 85.0 | 30 | HOS-22 | 8.7 |

Experiment was conducted in RCBD under controlled temperature (30±2), humidity (70±5%) and cooled LED lights for 24h in a laboratory BOD incubator (***). Each genotype was sown in five replications. 20 kernels were shown in each replication. Kernels were treated with Bavistin prior sowing. After sowing, polythene bags were watered up to saturation and kept in BOD for 15 days with regular watering in every alternate day. Polythene bags were removed from BOD after 15 days of sowing. Polythene bags with peanut plants were put in a plastic bucket filled with tap water. After through washing of plants in water individual plant was sampled from each genotype replication wise. Observa-tions on germination percent, shoot length, root length, shoot fresh weight, root fresh weight, plant dry weight and root dry

High oleic acid content groundnut breeding line under AICRP testing

weight, vigour index were recorded.

Seed germination in normal oleic peanut varied from 83% to 100% with a mean of 93.3%, while it varied from 73.3% to 96.7% with a mean of 81.7% in high oleic peanut. There was significant difference in mean germination between normal and high oleic peanut though gap is narrow. On the other hand we did not observe significant differences between the groups in terms of vigour index, fresh and dry plant weight, shoot and root length, fresh shoot and root weight, dry shoot and root weight, SL/RL, FSW/FRW, DSW, DRW and PFW/PDW, though genotypic difference do exists within the group. Our studies suggest no impact of high oleic acid on seedling traits except germination percent (table-8).

### Seed multiplication

In 2018 *kharif* season, 30 groundnut genotypes with high oleic acid have been multiplied (table-9). Genotypes with require quantity of seed will be proposed for AICRP testing and release.

### High oleic genotypes proposed for AICRP testing

Groundnut genotypes with76% to 80% oleic acid and 53% to 54% oil content have been proposed for AICRP testing during 2018 *kharif* season (table-10).

## Breeding for improvement of quality traits in groundnut

*Praveen Kona and Mahatma MK*

### *Hybridization Programme:*

Total eight crosses were affected during Kharif, 2018 to improve the quality traits in groundnut related to seed size, oil, protein and sugar content. Total 1399 crossed pods were harvested from eight crosses with a range of 98 (PBS 29146 x PBS 29148) to 353 (TG 37A x Mallika). The mean success rate of the hybridization programme in eight crosses was 31.01 % with a range from 18.13 to 59.32 %. The highest success rate was observed in TG 37A x Mallika (59.32 %) and lowest in GG 20 X PBS 29148 (18.13 %).

### Evaluation of 150 advanced breeding lines for yield and quality traits:

Total 150 advanced breeding lines of large seed project including both Spanish and Virginia bunch were evaluated for the yield and quality traits using four checks under augmented design during Kharif, 2018. All the traits viz., HKW, HPW, SP, KL, KW, pod yield per plant, Pod yield/ha and kernel yield/ha showed significant variation when compared to checks. Genotype, PBS 29163 was recorded highest SP as 76.51 %. Two genotypes viz., PBS 29079 B and PBS 29069 recorded >70 gm hundred kernel weight and superior over checks. Genotype, PBS 19015 recorded highest pod yield /plant as 19.19 gm followed by PBS 29082 (18.60 gm) and PBS 19013 (17.34 gm). The kernel length was varied from 1.24 cm (PBS 29206) – 1.98 cm (PBS 29079 B) whereas kernel width was in a range of 0.75 cm (PBS 29070) – 1.05 cm (PBS 29153). PBS 29079 B was recorded highest kernel length and PBS 29153 recorded highest kernel width. Total 68 genotypes recorded >34 % of protein in NIR method of estimation. PBS 29148 recorded highest protein content 36.95 % followed by PBS 29146 (36.92%), PBS

29151 (36.90%). These lines have to be confirmed further using chemical methods. The oil content varied from 40.64 % (PBS 29196) - 52.51 % (PBS 29163) using soxhlet method of oil estimation. Genotypes, PBS 19013, PBS 19015, PBS 19018, PBS 29079 B, PBS 29082, PBS 29124, PBS 29167, PBS 29196, PBS 29197, PBS 29212 and PBS 29219 had good confectionery quality traits viz., large seediness (KL: >1.5 cm and KW: >0.7 cm), good protein (>32%), good sugar (>5 %), moderate oil (42- 48% ), uniform pod size and shape, good pod yield per plant (> 10 gm) and good shelling percentage (> 60 %).

Field view of different advanced breeding lines

**Multiplication of Advanced Breeding lines:**

Total 17 advanced breeding lines (PBS 19035, PBS 19036, PBS 19037, PBS 19038, PBS 19039, PBS 29236, PBS 29237, PBS 29238, PBS 29239, PBS 29240, PBS 29241, PBS 29242, PBS 29243, PBS 29244, PBS

Emasculation and crossing program in hybridization block

29245, PBS 29246, PBS 29247) of large seed project were multiplied during *kharif*, 2018 for future program of work. These lines include both Spanish bunch and Virginia bunch genotypes.

### Germplasm multiplication for high protein content

Total 21 germplasm lines were multiplied during *kharif*, 2018 for further use in breeding program for high protein content and large seeded characters. NRCG 7128 (35.6) and NRCG 11981 (35.4%) recorded highest protein content through NIR analysis.

### Evaluation and advancement of large seeded $F_4$, $F_5$ and $F_6$ segregating material for quality traits

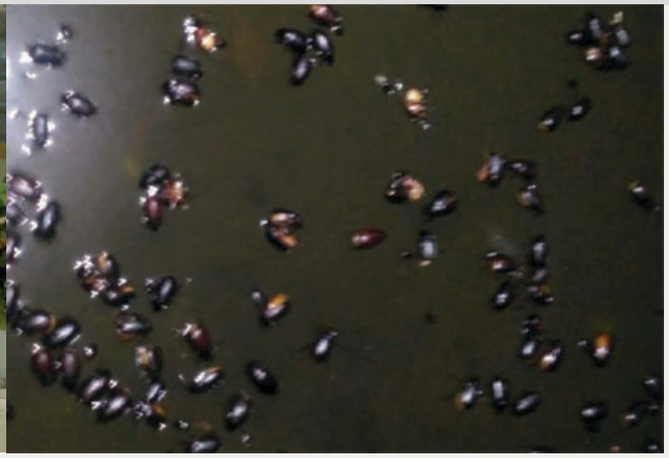
Total 60 single plant progeny (SPP) of $F_4$, $F_5$ and $F_6$ segregating material were raised and advancement of generations was done based on uniform pod, seed size and pods per plant during kharif, 2018. Total 190 single plants in $F_4$ from seven crosses, 114 single plants in $F_5$ from five crosses and 177 single plants in $F_6$ from six crosses were selected and advanced for next filial generation.

### Screening of mutant population ($M_5$) for yield traits

A total of 129 mutant genotypes along with their parent TPG 41 as control were evaluated for various yield related traits in $M_5$ generation during *kharif*, 2018. The population was generated by EMS mutagen treatment with 0.2% to 0.6% range of concentrations. Shelling percentage, PW/plant and HKW showed significant variation in all lines when compared to control. Twelve lines recorded >12gm of PW/plant of which SPP 4 of 0.6% EMS treatment was the highest (15.58 gm). SPP 3 and SPP 4 of EMS 0.6% recorded highest shelling percentage of 76.69 and 76.50 %, respectively.

Field view of $F_4$, $F_5$ and $F_6$ segregating material

# 02 Groundnut pest and diseases-emerging problems and their management



## Refinement and validation of management module for Soil borne diseases of groundnut

*Dutta R, Mahatma MK, Thirumalaisamy PP and Kumar N*

### Assessment of varieties for resistance to stem rot and collar rot:

The assessment was carried out with three replications in the sick plot developed at field and concrete blocks. 24 cultivated varieties in field and 20 varieties in concrete block were screened for resistance to stem and/ or collar rot disease. During summer 2018, the assessment was done in concrete blocks, while during *kharif* 2018 it was both in concrete blocks and field sick plots.

### Stem and collar rot in Concrete block sick plot during summer-2018:

The minimum (26%) stem rot was recorded with variety ICGV-86590 followed by DH-86 (28%). The collar rot was also minimum (16%) with ICGV-86590, which was at par with Girnar-2 (16%). The maximum stem rot (61%) and collar rot (41%) was recorded with variety ICGS-76 and DH-86, respectively.

### Stem rot in field sick plot (*kharif* 2018):

The minimum (14%) disease was recorded with variety JSP-19 being at par with checks followed by Kadiri-3 (16%). The maxi-mum (33%) disease was with variety GG-20. While, maxi-mum pod (1756 kg/ha) and fodder yield (5778 kg/ha) was supported by Kadiri-3.

### Stem and collar rot in Concrete block sick plot (*Kharif* 2018):

The minimum (26%) stem rot was recorded with variety LGN-2 followed by GG-8 (32%) being at par with Tirupati-3. While, minimum (5%) collar rot was recorded with variety SG-99 followed by JSP-19 (9%) being at par with HNG-10. However, the maximum stem rot (55%) and collar rot (39%) disease was recorded with variety Girnar-2.

### Variation in stem rot from field to concrete block sick plots:

The minimum (4%) variation was noticed with the variety LGN 2, followed by GG-5 (5%). The maximum (26%) variation in the incidence was noticed with variety Girnar-2. The genotypes having maximum stability for tolerance (i.e. minimum variation in incidence from low disease pressure to high disease pressure) to stem rot could be chosen for cultivation, so that grower remains safe even during untoward situation of high disease pressure in particular season/year.

### Evaluation of organic formulations for growth promotion of groundnut and management of stem rot disease:

The experiment was conducted with four organic formulations namely DGROF1, DGROF2, DGROF3 and DGROF4 with different spraying and soil application schedule.

### Summer 2018:

The maximum inhibition (44%) of stem rot was recorded in DGROF2 followed by DGROF1 (33%) with spraying

at 30 and 60 DAS (Days after sowing), and soil application at 45 and 75 DAS over farmers' practice. DGROF2 also supported maximum pod yield (1677 kg/ha) and fodder yield (6292 kg/ha) being followed by DGROF3 having pod yield and fodder yield of 1554 and 5583 kg/ha, respectively, which was 19 and 20 per cent higher than the farmers' practice achieving an ICBR of 1:6.86.

### Again during *kharif* 2018:

The maximum inhibition (50%) of stem rot was recorded in DGROF2 followed by DGROF4 (42%) with spraying at 30 and 60 DAS (Days after sowing), and soil application at 45 and 75 DAS over farmers' practice. During this season, maximum pod yield (2099 kg/ha) and fodder yield (6042 Kg/ha) was supported by 'DGROF4' followed by DGROF2 with pod yield of 1985 kg/ha and fodder yield of 5708 kg/ha.

### Refinement of different modules for stem rot and collar rot disease:

The experiment was conducted during summer and *kharif* 2018. Altogether, 7 promising modules identified from previous project were used with farmers' practice and absolute control. There were two sets of experiment, one for stem rot and another for collar rot.

### Effect of modules on stem rot and yield (Summer 2018):

The maximum (60%) inhibition of stem rot was achieved by Module-M17Ai.e. Deep summer ploughing with mould board plough+seed of variety TG 37A+ seed treatment with tebuconazole @ 1.5 g/ kg of seed + soil application of *Trichoderma harzianum S1* @ 4 kg/ ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS, over farmers' practice. The module also supported maximum pod (1986 kg/ha) and fodder yield (6278 kg/ha), which was 22 and 15 per cent, respectively, higher than the farmers' practice.

### Effect of modules on stem rot and yield (*kharif* 2018):

Again during *kharif* also, maximum (32%) inhibition of stem rot was achieved by Module M-17A followed by Module-M10A (31%)i.e. Deep summer ploughing with mould board plough+ seed of variety GG-20+seed treatment with *T. harzianum*S1 @ 10 g/ kg of seed + soil application of *T. harzianum S1* @ 4 kg/ ha enriched in FYM first at the time of sowing, second at 35 DAS over farmers' practice. However, Module-M2 received maximum stem rot (-29% inhibition) over farmers' practice. The maximum pod (1899 kg/ha) yield was supported by Module M-17A followed by Module-M15A (1681 kg/ha) being increase of 43% and 27% respectively, over farmers practice. Similarly, maximum fodder (6083 kg/ha) yield was also supported by Module M-17A followed by Module-M15A (5667 kg/ha) over farmers' practice being increase of 36% and 27% respectively over farmers practice.

### Effect of modules against collar rot and yield (*Kharif* 2018):

The maximum (17%) inhibition of collar rot was also achieved by Module M-17A being statistically at par with Module-M11A (16%) and Module M5A (14%). However, Module-M2 received maximum stem rot (-41% inhibition) over farmers' practice. The maximum pod (2150 kg/ha) and fodder (6222 kg/ha) yield was supported by Module M-17A followed by Module-M15A with pod (2000 kg/ha) and fodder (5833 kg/ha) yield over farmers' practice. The pod and fodder yield increase with Module 17A was 25% and 32% respectively, while with Module 15A it was 16% and 24% respectively, over farmers practice.

### Validation of management modules for soil borne diseases at AICRP-G centres:

The validation was carried out at Aliyarnagar, Dharwad, Kadiri, Jalgaon, Vridhachalam, Raichur, Ludhiana and Bikaner centres.

### Stem rot:

Maximum (67%) inhibition was achieved by Module-M10V at Aliyarnagar. Whereas, Module-M4V was effective at Vridhachalam, Jalgaon and Kadiri with 40%, 39% and 30% inhibition. While, Module-M17V was effective at Ludhiana, Raichur and Dharwad achieving inhibi

tion of 63%, 56% and 42%, respectively over local farmers' practice.

**Collar rot:**

Module-M4V was effective at Ludhiana, Vridhachalam, Bikaner, and Jalgaon having inhibition of 71%, 56%, 50% and 44%, respectively. M17V was effective at Raichur and Dharwad with 71% and 60% Inhibition, while M10V was effective at Kadiri giving 44% inhibition, over local farmer's practice.

**Dry root rot:**

Module-M4V was effective at Vridhachalam and Kadiri with inhibition of 52%, and 50%, respectively. While, M17V was effective at Raichur (52% inhibition) and Ludhiana (50% inhibition), over local farmers' practice.

**Screening of *Trichoderma* spp. / isolates for chitinolytic activity:**

Altogether, 70 isolates/ species of *Trichoderma* collected/ maintained were utilized for screening of chitinolytic activity. Of them, 17 isolates/species exhibited chitinolytic activity with different initiation and completion time (hours). The earliest initiation of activity was recorded just after 24 hours of inoculation.

## Biology, epidemiology and management of Alternaria leaf blight in groundnut

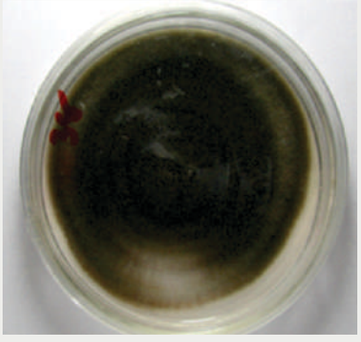
*Thirumalaisamy PP and Dutta R*

### 1. Morphological characterization of isolates of *Alternaria* sp. associated with leaf blight disease of groundnut

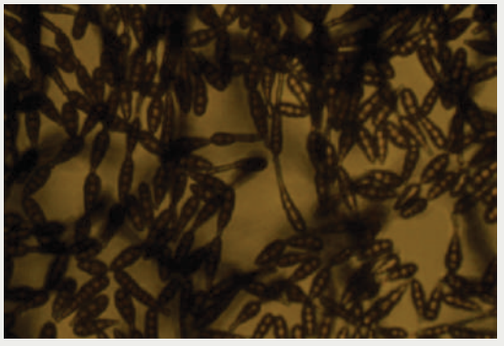
*Alternaria* sp. associated with the leaf blight disease of groundnut were isolated and maintained on PAD slants at 4°C. Presently 45 isolates were collected from groundnut grown in different agro-climatic regions of India. Majority of the isolates were belong to *Alternaria alternate*. All the isolates were morphologically similar and mycelia in dark green to ash colour. Black colour concentric ring from centre to periphery containing spores with short or long beak 4-6 horizontal septa and 2-4 longitudinal septa were recorded. Spores were observed in chain.

### 2. Epidemiological factors responsible for disease development

Weather factors (temperature, relative humidity & rainfall) were analyzed with the disease severity. In the crop age of 70-110 days, at RH below 60% and temperature above 37 degree C, *Alternaria* leaf blight occurred upto 7 rating scale (max. 60% severity) of 1-9 scale. It was found that water stress was a predisposing factor for the *Alternaria* leaf blight. Withholding irrigation water after 33 days after germination to 66 days, predisposed the groundnut crop to *Alternaria* leaf blight to the severity of 7 in 1-9 scale.



Growth of *Alternaria alternate* on PDA



Microphotograph of conidia of *Alternaria alternate*

### 3. Identification and evaluation of cultural, biological and chemicals for management of *Alternaria* leaf blight

Among 12 treatments comprising fungicides and bio-agents, pyraclostrobin + metriam spray reduced the

severity of leaf blight (3) compared to control (7) in TG 37A. In GJG 31, pyraclostrobin + metriam and tebuconazole has reduced the severity of leaf blight (4) compared to control (7).

### 4. Management of leaf blight and wilt disease of groundnut occurring in western part of Rajasthan

A special programme was suggested for the management of leaf blight and wilt disease of groundnut occurring in western part of Rajasthan in the *kharif* 2018 IRC. The experiment was conducted at DGR-regional station, Bikaner. Treatments *viz.,* Tebuconazole 50%+ Trifloxystrobin 25% w/w WG (75 WG) (Nativo), Pyraclostrobin 5% + Metiram 55% (Cabrip Top), Tebuconazole 430 SC (Folicure 430SC), Carbendazim 12% + Mancozeb 63% WP (Saaf 75% WP), Propiconazole 25% EC (Tilt 25% EC), Copper oxychloride 50 WP (Blitox 50% WP) and Carbendazim 50% WP (Bavistin 50% WP) were used for foliar spray at 30 and 60 DAS. Carbendazim 50% WP (Bavistin 50 % WP) and neem cake @ 200 kg/ha (appox. 500g/25 sq. M) were applied through soil application as basal. However, the disease was not developed sufficiently to evaluate the treatments.

## Studies on white grub and bruchid beetle and their management ingroundnut

*Harish G and Dutta R*

### 1. Survey for collection and identification of white grub

Survey was conducted in Villages namely, Navagam, Mitapur, Kadpipadi, Semasi, Mendarda etc. of Junagadh district and white grubs were collected and sent for identification, species were identified as *Phyllognathus dionysius, Holotrichia serrate, Holotrichia* sp. and *Holotrichia reynaudi.*

### 2. Pesticide usage pattern in groundnut

Survey results showed that around 20 insecticides were available in market for pest management Imidicloprid was the popular sold product followed by thiamethoxam and Coragen. Fipronil, Cypermethrin, Diafenthiuron, Novaluron, Buprofezin, Spinosad, profenocyper, phosphomidon and lambda cyhalothrin were other chemicals available in market.

### 3. Efficacy of Sweet flag rhizome in managing bruchid beetles

Sweet flag rhizome powder at one, two, five, ten, fifteen and twenty per cent concentration was tested for its efficacy in managing bruchid beetle along with untreated control. Observations were taken on egg laying and pod damage. Observations recorded showed that there was a significant difference among the treatments in egg laid on pods. Pods treated with twenty per cent sweet flag rhizome powder recorded lowest number of eggs (7 per

10 pods). In case of pod damage sweet flag rhizome powder of ten percent and above concentration found significantly superior and recorded 18 per cent damage as compared to 64.2 per cent damage in untreated control.

### 4. Seasonal incidence of insect pests of groundnut

Seasonal incidence of insect pests of groundnut was studied by sowing groundnut every month under unprotected condition. Sucking pests were estimated using sweep net catches. Thrips and leafhoppers were found throughout the season. Highest thrips population was recorded 40 per five sweeps during 36$^{th}$ Standard week and leaf hopper population 88 per five sweeps was recorded during 7$^{th}$ standard week. Natural enemies like coccinellids and spiders were recorded during last year. Highest number of coccinellids (6) was recorded during 30$^{th}$ and 48$^{th}$ Standard week and spiders (7) were recorded during 38$^{th}$ Standard week.

# 03 Enhancing the productivity, sustainabilaty and resilience of groundnut based production system

## Development of Climate Resilient Groundnut-based Production Systems through Precision Management Practices

*Jat RA and Reddy KK*

### Experiment: 1. Précising row ratio and time of sowing of relay crop of pigeonpea in groundnut crop

A field experiment was conducted during *kharif* 2018 to validate suitable row ratio and timing of relay sowing of pigeonpea in bunch and semi-spreading varieties of groundnut. The objectives of study were to maximize system productivity and profitability per unit of land and water resources, decrease cost of cultivation, enhance resource use efficiency, and sustainable intensification of groundnut based cropping systems. Two row ratios *viz.* 2:1 (R1) and 3:1 (R2) of groundnut + pigeonpea relaycropping system were allotted in main plots and three relay sowings of pigeonpea i.e. 30 (S1), 40 (S2), and 50 (S3) days after sowing of groundnut were applied in subplots. The experiment was conducted in split plot design with three replications. Two separate experiments with same set of treatments were conducted with Spanish bunch (TG 37A) and Virginia bunch (GJG 22) varieties. Groundnut varieties TG 37A and GJG 22 were sown on 21st June, 2018 at 30 x 10 cm and 45 x 10 cm spacing and harvested on 5th October and 9th October, 2018, respe

**Fig. :** Pigeon Pea relay sown after 30 DAS of groundnut in 2:1 (left) and 3:1 (right) ratio.

ctively. Pigeonpea variety GJP1 was relay sown after every 2 or 3 rows of groundnut as per the treatments on 23rd July, 1st August, and 10th August, 2018 which coincided 30, 40, and 50 days after sowing of groundnut. 100 percent of RDF was applied to both groundnut (25:50:30 $kgha^{-1}$ NPK) and pigeonpea (25:50:00 $kgha^{-1}$ NPK) through urea, SSP and MOP. Two inter-culturing operations were done at 25 and 45 DAS with mini tractor in GJG 22 and manually in TG 37A.

In Spanish bunch variety, plant height, dry matter and number of branches per plant at 75 DAS and harvest, green area index at 75 DAS, number of pegs at 75 DAS, number of immature pods per plant and their dry weight per plant at 75 DAS was recorded higher with 2:1 ratio. However, pod yield, haulm yield, hundred kernel weight, and shelling percent (p=0.0013) was found higher under 3:1 ratio of groundnut + pigeonpea relaycropping system. Groundnut pod equivalent yield (GPEY) was also found higher with 3:1 ratio. In case of Virginia bunch variety, plant height at 75 DAS and harvest, dry matter per plant at harvest, pegs per plant at 75 DAS, number of mature pods were found higher under 2:1 ratio. While, weight of mature pods per plant, pod yield, haulm yield, hundred kernel weight, and shelling percent remained higher with 3:1 ratio. Groundnut pod equivalent yield (GPEY) was found higher with 3:1 ratio in both the varieties but differences were not significant.

In Spanish bunch variety, plant height at 75 DAS and harvest, dry matter per plant at 75 DAS, green area index at 75 DAS, number of immature pods and their dry weight at 75 DAS, number of mature pods and their dry weight (p=0.008), hundred kernel weight, shelling percent, and pod yield (p=0.008) was found higher with S3. However, haulm yield was recorded higher with S2 with differences being non-significant. In case of Virginia bunch variety, plant height at 75 DAS, and harvest, branches at 75 DAS and harvesting, dry matter per plant at 75 DAS, green area index at 75 DAS, pegs per plant at 75 DAS, pod yield, hundred kernel weight, and shelling percent was found higher with S1, while haulm yield was found higher with S2 with differences being non-significant. GPEY was found significantly higher with S1 in both the varieties. Pigeonpea grain yield was recorded higher under 3:1 ratio relay sown in both Spanish and Virginia bunch varieties but differences were not significant however, stover yield was found higher under 2:1 ratio. S1 being at par with S2 was found to give significantly higher pod yield and stover yield over S3.

### Experiment 2. Identifying optimum time of application of paclobutrazol in kharif groundnut

A field experiment was conducted during kharif 2018 to find out optimum time of spray of paclobutrazol in *kharif* groundnut. The treatments were: control (water spray), paclobutrazol 100 ppm at 15 DAS, paclobutrazol 100 ppm at 20 DAS, paclobutrazol 100 ppm at 25 DAS, paclobutrazol 100 ppm at 30 DAS, paclobutrazol 100 ppm at 35 DAS, paclobutrazol 100 ppm at 40 DAS. The experiment was conducted in randomized block design with three replications. Groundnut variety GJG 22 was sown on 20th June, 2018 at 45 x 10 cm spacing and harvested on 15th October, 2018.

Spray of paclobutrazol was found to significantly affect plant height at 45, 75 DAS and at harvest, branches at harvest, shelling percent and

**Fig. 1:** Groundnut at 75 DAS stage with control (left) and paclobutrazol @100ppm spray at 25 days after sowing.

100 kernel weight. Plant height at 45 DAS was highest with control and paclobutrazol spray at 40 DAS and lowest was with paclobutrazol spray at 20 and 25 DAS. At 75 DAS and harvest plant height was highest with control and paclobutrazol spray at 15 DAS and 35 DAS while lowest was with paclobutrazol spray at 25, 30, and 40 DAS. Branches per plant were significantly lowest with paclobutrazol spray at 15 and 20 DAS. Shelling percent and 100 kernel weight was significantly reduced when paclobutrazol was sprayed at 30, 35, 40 DAS as compared to control and spray at 15, 20, 25 DAS. Pod yield and haulm yield was produced significantly highest with paclobutrazol spray at 25 DAS and 30 DAS, respec-tively. While lowest pod yield and haulm yield was produced with control.

### Experiment 3. Evaluating Conservation Agriculture in groundnut+pigeonpea and groundnut+cotton cropping systems

A field experiment was conducted for consecutive fourth sseason during *kharif* 2018 to validate the impact of Conservation Agriculture in groundnut+pigeonpea and groundnut+cotton cropping systems in light black soils. The treatments were: four tillage practices viz. normal tillage (NT), minimum tillage (MT), zero tillage(ZT), and rota-till (RT) in main plots; two residue management practices viz. no residue (NR), and residue application (RR) in sub-plot; and two cropping systems viz. groundnut+pigeonpea (GP) and groundnut+cotton (GC) relay/intercropping systems in sub-sub-plots. The experiment was laid out in split-split plot design with three replications. In plots having residue application treatments, pigeonpea and cotton residues were used. Groundnut and cotton was sown on 19$^{th}$ June, 2018 while pigeonpea was relay sown on 23$^{rd}$ July, 2018. Groundnut was sown with pigeonpea and cotton in 3:1ratio. 100 percent of RDF was applied to groundnut (25:50:30 kgha$^{-1}$ NPK), pigeonpea (25:50:00 kgha$^{-1}$ NPK) and cotton (240:50:150 kgha$^{-1}$ NPK) through urea, SSP and MOP. Groundnut and pigeonpea were harvested on 8$^{th}$ October and, 2018 and 18$^{th}$ January, 2019 respectively while in cotton last picking was done on 21$^{st}$ December, 2018.

Groundnut pod and haulm yield was found highest with

**Fig. 1:** Groundnut+pigeonpea (left) and groundnut+cotton (right) cropping systems under minimum tillage.

normal tillage (NT), while lowest pod yield and haulm yield was produced with rota tillage (RT) and zero tillage (ZT), respectively with differences being non-significant. Pigeonpea grain yield and stover yield was highest under NT and lowest was under RT with differences being non-significant. While seed cotton yield and stalk yield was higher under minimum tillage (MT) and lowest with RT. Groundnut pod equivalent yield (GPEY) was significantly higher with NT, being at par with MT, over both ZT and RT. Groundnut pod and haulm yield was higher when residues were removed while pigeonpea grain and stover yield, seed cotton yield and GPEY was produced higher with residue application but differences were not significant. Groundnut+ pigeonpea cropping system was found to give significantly higher groundnut pod yield, haulm yield and GPEY over groundnut+ cotton intercropping system.


**Fig. 1: Experimental field view**

## Experiment 4. Re-optimization of nitrogen doses in kharif groundnut

An experiment was conducted in kharif-2018 in randomized complete block design (RCBD) having nine treatments (T1-0kg N/ha; T2-15 kg N/ha; T3-20 kg N/ha; T4-25 kg N/ha; T5-30 kg N/ha; T6- 35 kg N/ha; T7 - 40 kg N/ha; T8-45 kg N/ha;

T9-50 kg N/ha) and three replications to know the effect of different levels of nitrogen doses on two different groundnut varieties viz. TG37A (Spanish bunch) and GG22 (Virginia bunch) (Fig.). Pod yield increased with increasing level of N doses and highest significant yield was found at 35 kg N/ha (2013 kg/ha)and 30 kg/ha (2271 kg/ha) in GG 22 and TG37A, respectively. Haulm yield of GG-22 was not significantly affected by different treatments, while in TG 37A haulm yield was significantly high at 45 kg N/ha.Total biomass production was significantly high at 45 kg N/ha and 35 kg N/ha in TG37A (5092 kg/ha) and GG22 (4902 kg/ha) respectively. Total N uptake (kg/ha) in TG37 A (451 kg/ha) and GG 22(308 kg/ha) was found to be significantly high at 50 kg N/ha. Nodule count and fresh nodule wt. per plant in TG37A and GG 22 was found to be significantly high at 30 kg N/ha and 50 kg N/ha, respectively.

## Project: 11 Management of soil and irrigation water salinity through agronomic practices in groundnut

*(Meena HN and Reddy KK)*
Till date: 23/6/2018

### Effect of different mulching on groundnut yield under different salinity stress

The experiment was conducted during summer 2018 to ameliorate the effect of salinity with application of different mulches under different salinity levels. The treatment consisted of four levels of salinity (0.5, 2, 4 and 6 dS $m^{-1}$) in main plot, three levels of mulching [without mulch (control), polythene mulch and straw mulch] in sub plot. The results revealed that significantly higher pod yield was recorded with the application of 2 dS/m saline irrigation water but significant reduction was recorded at 6 dS/m as compare to other treatments. The 60% higher pod yield was recorded at 2 dS/m as compared to 6 dS/m saline irrigation water but haulm yield of groundnut was significantly reduced at 2 dS/m and also in higher salinity levels. Further, significant differences were also recorded between types of mulching. Similar incremental effect in pod (38%) and haulm yield (14%) was observed under both type of mulching over control. Although, interaction effect of salinity x mulching revealed that as the level of saline irrigation water increases pod and haulm yield of groundnut significantly increase under polythene mulching and straw mulching as compare to without mulching. In 6 $dSm^{-1}$ of irrigation water, pod yield under polythene mulch and straw mulch was 49% & 55% higher as compared to control.

## Project 12: Efficient utilization of soil phosphorus in groundnut production system

*Reddy KK, Jat RA and Meena HN**

*Associated till 23rd June 2018

### Field experiment on application of best PSB culture using different P doses for mobilizing native soil phosphorus

The experiment was conducted in *Kharif*-2018 at DGR experimental farm (L-6) using TG37 A variety and using DAP as P Source (Plot size 5*3.6 m, spacing 30*10 cm). A total of 6 PSB (phosphate solubilizing bacteria) cultures (BHU-1, BM-1, BM, ACC-10, S-16 and BM8) were qualitatively (Pikovskaya Agar) and quantitatively (Pikovskaya Broth) estimated *in-vitro* for P solubilization (**Fig. 1**). BM8 culture was found to have maximum P solubilization (35.8 ppm) and it was used in field trial. The experiment consisted of 9 treatments (No P, 25% RDP, 50% RDP, 75% RDP, 100% RDP, PSB+25%RDP, PSB+ 50%RDP, PSB+75%RDP and PSB alone) in randomized block design with four


**Fig 1:** Zone of P solubilization as shown by different PSB cultures on Pikovskaya Agar

replications (**Fig. 2&3**). Application of PSB + 75% RDP has significantly improved groundnut dry pod yield (2258 kg/ha) by 136% compared to No P control (955 kg/ha), which was at par with 100% RDP (2185 kg/ha). Total Biomass was found to be significantly high in PSB+75% RDP (4831 kg/ha), which was at par with 100% RDP (4833 kg/ha). Effect of different treatments on haulm yield and nodule dry weight were found to be non-significant.

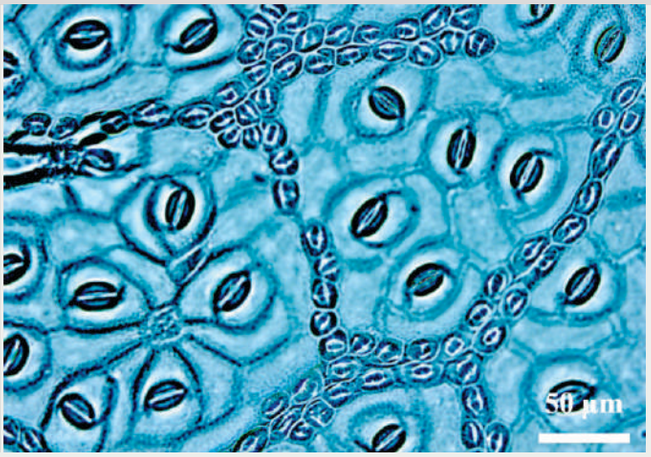
Application of PSB+75% RDP has also significantly improved pod yield by 12.3 % compared to 75% RDP only. PSB+75% RDP also significantly improved various growth parameters like nodule count, shoot length, root length, shoot dry weight,

**Fig 2:** Experimental field view

root dry weight, total biomass, shelling %, harvest index, hundred kernel weight, hundred pod weight and total plant P uptake %. It also improved various yield parameters like Hundred kernel weight, shelling &, harvest index. PSB alone treatment has significantly increased pod yield by 16% when compared to No P control. Plant P uptake (%) was significantly high in PSB+25% RDP treatment (0.78%) compared to No P (0.40%), 100% RDP treatment (0.46%) and PSB+75% RDP treatment (0.55%). Total P uptake (kg/ha) was significantly high in PSB + 25% RDP, which is 2.18-fold more than No-P treatment. This clearly demonstrates that the PSB improves P-uptake by plant when DAP or soluble forms of phosphorus is applied in low amounts. This suggests that PSB has effectively helped in solubilization and mobilization of native unavailable phosphorus to available forms by producing acid phosphatases, alkaline phosphatases and also by reducing the rhizosphere soil pH. Soil available P at harvest improved in treatments with PSB. Application of PSB+75% RDP has significantly improved native available P (11.9 kg P/ha) compared to no P control (10.6 kg P/ha).


**Fig 3:** Experimental Field view

# 04 Biochemistry, Microbiology and physiology of groundnut in relation to plant health and nutrition, photosynthetic efficiency, nutritional quality, biotic and abiotic stress tolerance




## Iron and zinc bio-fortification in groundnut

*Sushmita, Singh AL, Bishi SK* and Gangadhara K*

* Associated till June 2018

### *Zinc biofortification through Zn solubilizing microbes*

Four Zn-solubilizing microbes (FP 82, FP 93, BHU-1 and BM-6) when compared with zinc sulphate (2 kg Zn /ha) in field experiment using 10 groundnut cultivars all these increased growth and pod yield of groundnut and also Fe and Zn content in the seeds. Among the Zn-solubilizers, FP 82 and FP 93 showed better response to yield and were similar to that of zinc sulphate, however all these increased the Fe and Zn contents in seed and haulm of groundnut.

### *Screening groundnut cultivars for high Zn and low phytic acid-contents in seed*

A study on Fe and Zn biofortification was undertaken in 100 groundnut cultivars by treating these with various combinations ($T_1$–control, $T_2$-Three foliar spray of 0.5% $FeSO_{4+}$ Samriddhi + Fantac, $T_3$- Soil application of 50% Zn as Monzin (1kg $ha^{-1}$ Zn) + Three foliar spray of 0.2% $ZnSO_{4+}$ Samriddhi + Fantac) during rainy season where application of Zn increased pod yield and other parameters by controlling the over growth. The seed samples of these produce are to be analyzed for Fe and Zinc enrichments.

Seeds of groundnut cultivars, from the previous year experiments, when analyzed for Zn along with many other nutrients a wide range in the Zn and Fe concentration were observed and a few cultivars with high Zn in seed were identified (GG7, CO2 and Tirupati 3). The soil and foliar application of zinc sulphate in field caused Zn enrichment in seed both under rainfed and protected conditions.

The morphological and pod characters for high Fe and Zn cultivars and phytic acid contents in seeds of high Zn containing cultivars are in progress. Seeds of 12 groundnut cultivars were undertaken for phytic acid analysis through Megazyme kit (K-PHYT) where phytic acid contents ranged from 0.98 to 2.65 g 100 $g^{-1}$. Interestingly, the cultivars having high phytic acid showed lower Zn content in their seed.

### Genetics of Zn and Fe in groundnut

During *kharif* 2018, single cross was made for studying genetics of Zn and Fe in groundnut involving two parents, SG 99 and ICGV 06099. A total of 153 pods were harvested from cross between SG 99 and ICGV 06099 with success rate of 24.5 %.

### Zinc biofortification in groundnut using various sources of Zn

The nutrient analysis of seed of a number of groundnut

cultivars, previously grown under influence of zinc sulphate and Zn-EDTA application (soil and foliar), indicated that both of these increased the Zn content in the groundnut seed from 45-50 ppm under control to 52-64 ppm with zinc sulphate and 50-60 ppm with Zn-EDTA. There was a wide variation among the cultivars. Thus application of Zn fertilizer is must to increase Zn of groundnut seed.

### Zinc and Fe biofortification through various Zn-sources

Five commercial Zn sources ie Techno Zn (15 % Zn), Monzin (33 % Zn), Tag nano zinc granules, Tag nano zinc liquid (6% chelated Zn) and Zn-Param 35 (33% Zn) were tested in a field experiment using 10 groundnut cultivars during rainy season where all these increased yield with varied responses. The seed samples of these are being analyzed for the enrichment of Zn as a result of application of different sources.

### Zn and Fe biofortification in various seed-size groundnut and influence of B, Zn and Ca

The influence of B, Zn and Ca and hormone was studied on the mineral nutrition and Fe and Zn biofortification in various seed size groundnut in field taking 50 genotypes varying in their pod structure and sizes and grown at various combination with fertilizers ($T_1$-control, $T_2$-Mixture of B (1 kg $ha^{-1}$) Ca (100 kg $ha^{-1}$) and Zn (4 kg Zn as $ZnSO_4$), $T_3$-$T_2$ + Foliar Spray of hormone Mepiquate chloride (Chamatkar @ 2.5 ml/L) and GA (Progib @ 0.20 mg/L) where a large variation in the response depending upon the seed size was observed. The organic fertilizer and Zn through Monzin was beneficial and enhanced yield.Seeds of these produce are being analysed for Fe and Zn contents.

The seeds of the produce analysed for Fe and Zn contents from the previous years experiments reveals that the seed Zn content was high in small seeded genotypes (28-60 mg $kg^{-1}$ mean 42 mg $kg^{-1}$) and application of P decreased Zn in leaf, seed and shell irrespective of seed size, but Ca application increased the Zn content in all these tissues with more pronounced effects in large-size seeds. The large-size seeds require more nutrients for attaining full seed growth and high Zn in their seed. Calcium, which is essential for seed filling, increased uptake of Zn from the soil to the seeds and hence is crucial for Zn-biofortification. The cultivars with high Zn in their seed were also responsive to Ca fertilizers. The study reveals that cultivation of high Zn-density peanut with Ca fertilizer has the potential to improve the Zn in seed.

### *Screening groundnut genotypes for iron-deficiency chlorosis*

The screening for lime-induced iron-chlorosis (LIIC) and identification of tolerant genotypes is the regular feature of this centre in the ear-marked screening blocks where114 advanced breeding lines (110 of Plant breeding and 4 from Cytogenetics sections) were screened for their reaction to LIIC, categorized under various classes of their tolerance and finally from these 15 were identified as tolerant to iron chlorosis during *kharif* season. Also 100 cultivars grown for Zn- biofortification were screened for LIIC,and 16 tolerant and5 sensitive were identified.

### Physiological studies in groundnut under water-deficit and salinity stresses

*Singh AL, Sushmita and Bishi SK**

* Associated till June 2018

### Physiological efficiencies among Indian groundnut cultivars

The 100 groundnut cultivars during *Kharif* season and 40 groundnut cultivars during *Summer* season were studied for, photosynthesis ($P_N$), transpiration ($E$), stomatal conductance ($g_s$), chlorophyll fluorescence, SCMR and

yields under various treatments where large variability was observed. The study identified several cultivars as high and lowin $P_N$, $E$ and $g_s$ and their positive correlation with various parameters and finally pod yield.

## Elasticity of tolerance to various drought situations

The screening for drought and identification of tolerant genotypes for various situations is the regular feature of this centre for the last one decade. During *kharif* season 40 recent groundnut cultivars were grown under protected (P), rainfed (RF), RF+ hydrogel as well as exposed to mid season (MSD, 50-70 DAS) and late season drought (LSD,70-90 DAS) under ROS and their elasticity of drought tolerance were studied. Though during 2018 there was about 800 mm rainfall this was very unusual season with about 650 mm rainfall during July, 90 mm during August and only 52 mm during Sept and rest of the time crop faced drought. There was excess moisture during July, proper moisture during August, but from 15th Sept onwards the crop faced drought. The rainfed crop faced about more than 40 days of mid to end season droughts where pod and haulm yields were affected. The yield data revealed that there was severe reduction in pod yield due to drought. However several cultivars performed well with lesser reduction in yield accordingly identified suitable for rainfed, MSD and LSD. Among the 40 a few cultivars performed well under both MSD and LSD and also a few cultivars showed most elasticity and performed well under all the 5 situations.

## Pod zone moisture contents influences yield, yield attributes and aflatoxin

In a microplot study 24 groundnut cultivars, grown under normal conditions were exposed to various moisture content (on dry wt basis), from 50 DAE in their pod zone (>19.6, 17.2-19.6, 15.0-17.1, 12.4-14.8, and < 12.4% moisture content) through drip. The data reveals that various groundnut cultivars, based on their phenophases, behaved differently to exposure of moisture contents in their pod zone and the moisture content below 15 % was very critical, below which drastic reduction in yield was observed. Among these seven cultivars were very sensitive showing severe yield reduction. However, 6 cultivars were most tolerant showing appreciable yield even at <15.0 % moisture content. Exposure of drought caused a few days early maturity in the cultivars with

determinate nature with more immature pods in the highly stressed crop. There was aflatoxin development in the seed of the groundnut when grown below 12.4 % soil moisture pod zone.

### Water requirement of groundnut cultivars for their cultivation under drought

The 40 groundnut cultivars grown in micro-plot at only 400, 500 and 600 mm of total water distributed as per requirement of crop growth stages during cropping season behaved differently depending on their water requirement (WR) during summer season. It was observed that at 500 mm 18 cultivars, at 400 mm 16 cultivars and only 13 cultivars at 600 mm showed >2500 kg/ha pod yield and hence ideal for growing crops. Interestingly four cultivars showed maximum elasticity by performing well under all the three situations hence should be preferred for assured cultivation. There was clear cut demarcation in the Chlorophyll fluorescence and LAI (Leaf area index) recorded in these three different levels of irrigation treatments. In general the Chlorophyll fluorescence was high in the cultivars having higher photo-synthetic rate and stomatal conductance while the water sensitive cultivars showed low chlorophyll fluorescence. The cultivars with dense canopy showed 6-7 LAI, while it was 3-5 in other cultivars.

### Amelioration of drought through integrated approaches under rainfed

The drought management approaches (application of SOP (60 kg K/ha, Hydrogel at 2.5 kg $ha^{-1}$, and spray of succinic acid (150 ppm) and Abscisic acid (50 µM)) were evaluated by growing 10 groundnut cultivars under rainfed conditions in a field and compared with the one grown under protected conditions to minimise the yield losses. The crop faced droughts from $10^{th}$ Sept onward causing sufficient reduction in pod yield under rainfed.The study reveals only a mild effect of these ameliorant on increasing pod yield and none of these treatment could increased pod yield in groundnut under rainfed conditions. However effect of these treatments varied with cultivars and SOP increase pod yield of Kadiri 9 and Hydrogel increased pod yield of GJG 13 and GPBD 4 under rainfed.

### Influence of growth regulators on seed size

The commercial growth regulators Lihocine (Chlormequate chloride), Planofix (Alpha Nepthyl Acetic acid), Chamatkar (Mepiquate chloride), Progibb (GA) and Herbo-zymes applied as foliar spray (thrice at 40, 60 and 75 DAS) arrested growth and incr-eased pod yields, seed size and germination of two groundnut GG 7 and TG 37 cultivars and hence recommended.

### Studied on soil salinity tolerance mechanism

In a salt treated screening block, 57 groundnut cultivars were grown at two (2 dS $m^{-1}$ and 4 dS $m^{-1}$) salinity levels and based on germination, plant survival, and yield attributes five cultivars showing comparatively high tolerance with reasonable pod yield at 4 dS $m^{-1}$ were recommended for their cultivation. The higher salinity decreased most of the physiological parameters (photosynthesis, transpiration and stomatal conductance) resulting in low yield.

### Physiological studies in groundnut under water-deficit and salinity stresses

The effect of water deficit and salinity stress was studied in various groundnut cultivars by recording Chlorophyll fluorescence, RWC, SLA, membrane stability index and lipid peroxidation. In general, Chlorophyll Fluorescence, RWC and SLA of leaves declined during water deficit as well as salinity

stress. The water stressed plants showed lower membrane stability index (65-76) indicating leaky membrane which ultimately increased lipid peroxidation (MDA content of the mem-brane).

### Impact of heat stress on groundnut metabolism and quality

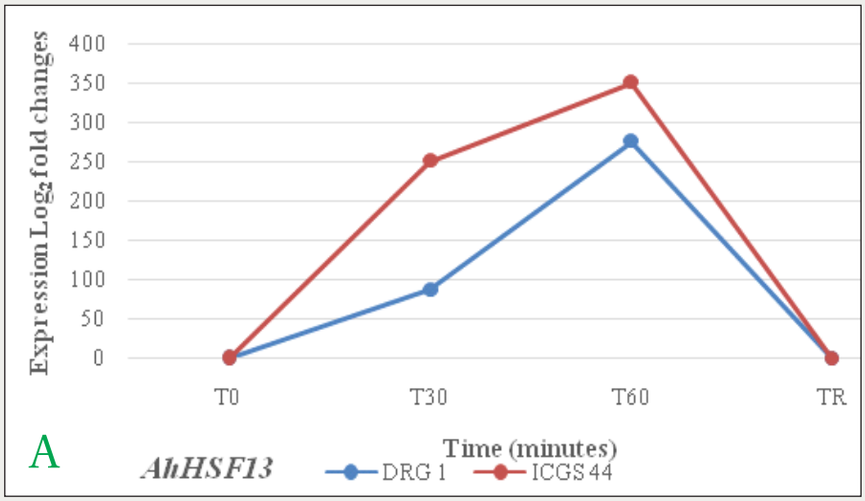
*Bishi SK, Mahatma MK, Singh AL and Sushmita*

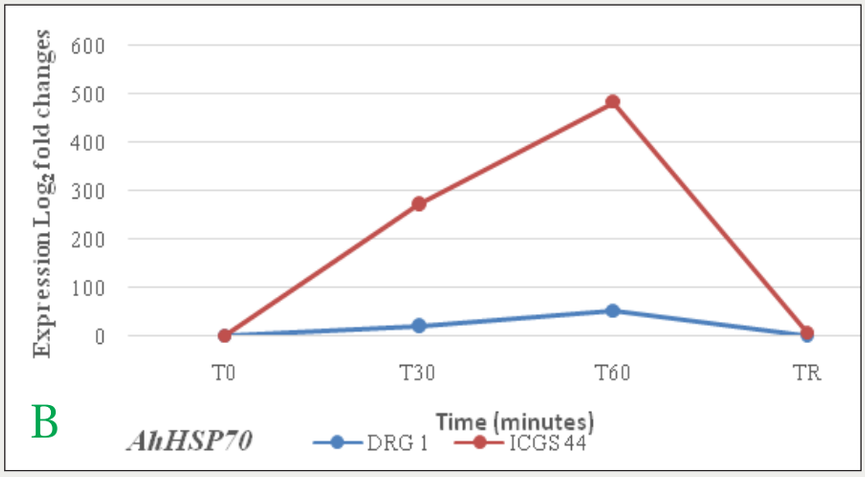
Forty groundnut cultivars (19 spanish and 21 virginia) were undertaken for a field experiment wherein stagge-red date of sowing was done with 20 days interval between each date of sowing (D1: 21$^{st}$ Jan; D2: 10$^{th}$ Feb; D3: 2$^{nd}$ March). This was done to expose the cultivars to different temperature conditions at their flowering time and characterize them for thermo-tolerance. The second date of sowing coincides with the normal date of sowing for groundnut crop.

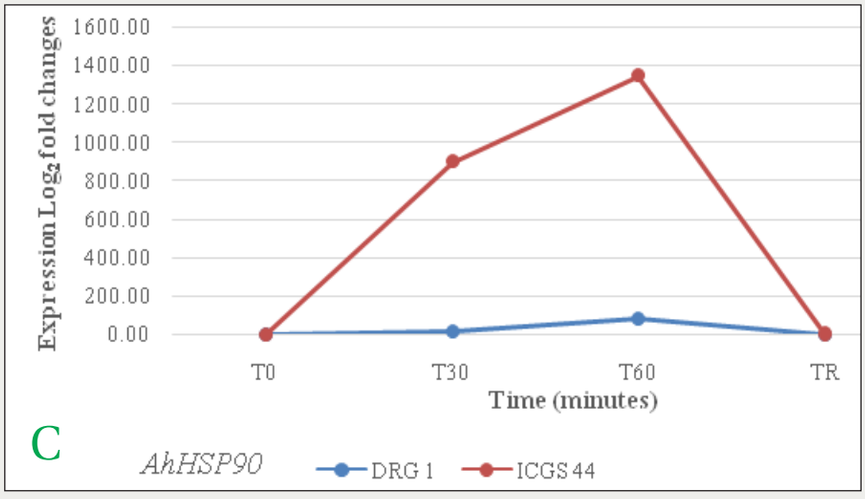
**Salient Findings:**

1. The Physiological observations for different temperature regimes varied considerably with a marked reduction in photosynthetic rate, relative water content, membrane stability index (MSI) and chlorophyll fluorescence values. The treatment D3 was found to have more severe impact on all these parameters with membrane stability values showing 40-52% and chlorophyll fluorescence (quantum efficiency, Fv/Fm) values 0.57-0.65. Among the cultivars, ICGS 44 was found to be relatively tolerant and was recorded to have higher values for chlorophyll fluorescence (Fv/Fm: 0.65) and MSI (52%)whereas susceptible cultivars like DRG 1 showed minimum values for MSI (41%) and chlorophyll fluorescence (0.56). These physiological aspects can therefore be crucial to impart thermo-tolerance attributes to the cultivars. The crop phenology was found to be shortened for all the cultivars displayed shortened with earliness in flowering as well as reduction in number of days to attain physiological maturity under late sown condition (D3).
2. Heat shock transcription factors (HSFs) play a crucial role in plants response to several abiotic stresses especially heat stress (HS) by regulating the expression of stress-responsive genes, such as heat shock proteins (HSPs). The role of plant HSFs in heat stress (HS), has been recently brought to light. In a recent study, Wang et al (2017) identified 16 and 17 *HSF* genes from *Arachis-duranensis* and *A. ipaensis*, respectively and studied their temporal and spatial expression under HS (42$^{0}$C). From the study, it was observed that *AhHSF4*, *5*, *6*, *10*, *11*, and *13* could response rapidly to high temperature, and up-regulated after 1 h treatment. In the present study, we carried out the expression analysis of few of the above HSFs and HSPs (*AhHSP70* and *AhHSP90*) using two genotypes (identified in our earlier experiments), ICGS 44 (tolerant) and DRG 1 (susceptible). The seeds were grown in controlled condi-tions in P-II glass house with mean day-night temperature 35/25 $^{0}$C and mean relative humidity 40/60 %. The 7 days old plants were exposed to HS i.e. 42 $^{0}$C in a seed germi-nator with light and humidity control. The leaf tissues were collected after different time intervals (0, 30 and 60 min) for RNA isolation to study the kinetics of *AhHSF13, AhHSP 70* and *AhHSP90* gene. Sample harvested from unstressed plant was used as control (C). Further, to study the recovery after HS, tissues were collected from plants exposed to 1 hr HS and kept at 25 $^{0}$C overnight.

   The gene expression analysis showed that *AhHSF13* induced within 1 min after HS treatment. To check the exprression status of *AhHSF13, AhHSP70* and *AhHSP90*,it was revealed that all these genes showed similar expression pattern only differing in their magnitude. The




**Gene expression pattern of *AhHSF13*,*AhHSP70* and *AhHSP90* in contrasting groundnut genotypes in response to heat stress.**

The time-course induction pattern of A. *AhHSF13*,B. *AhHSP70* and C. *AhHSP90*by exposing seven days old seedlings to 42°C in the groundnut genotypes DRG 1 (susceptible)and ICGS 44 (tolerant) using qRT PCR.

tolerant genotype, ICGS44 mainta-ined a higher induction of all these genes at any point of time than that of the susceptible genotype, DRG1. The gene expression pattern in the HS recovered plants also showed similar pattern of expression as that of control plants suggesting their roles only on exposure to HS.

In future, further characterization of *AhHSF13* and detailed expression analysis of HSPs and other downstream genes need to be carried out to confirm its role in HS tolerance in groundnut.

## Evaluation of nutritional and bioactive compounds of groundnut

*Mahatma MK, Bishi SK*, Rathnakumar AL, Singh AL*
* Associated till 23rd June 2018

### Experiment-1: Estimation of phenolics and mineral content in groundnut cultivars

Total 16 phenolics viz., caffeic acid, catechol, chlorogenic acid, cinnamic acid, coumaric acid, ferulic acid, gallic acid, syringic acid, salicylic acid, vanillic acid, catechin, epicatechin, epigallocatechin, kaempferol, resveratrol and quercetin were identified in groundnut kernel using LC-MS/MS. These phenolics were identified based on retention time and mass value of standard phenolics. Cinnamic acid, syringic acid, catechol, kaempferol and catachin are predominant phenolics in groundnut kernels. Highest cinnamic acid was observed in ICGV-91114 (24.91 $\mu g^{-1}g$) followed by Kadiri 6 (21.33 $\mu g^{-1}g$) and TAG 24 (20.24 $\mu g^{-1}g$) while minimum in GG5 (1.45 $\mu g^{-1}g$). Less genotypic variation was observed for kaempferol, catechol, salicylic acid and quercetin. Resveratrol is a naturally occurring stilbene that is present in red wine grapes varieties (19 to 508 $\mu g^{-1}g$ skin); red wine (0.6-8.0-1 $\mu g^{-1}mL$ ) blueberries (32 $ng^{-1}g$ ) is also found in groundnut at different levels. AK159 had lowest resveratrol content (0.47 $\mu g^{-1}g$) while highest in GG7 (7.13 $\mu g^{-1}g$) followed by TAG 24 (4.54 $\mu g^{-1}g$) and GG20 (2.93 $\mu g^{-1}g$). Resveratrol content was observed more than 2 $\mu g^{-1}g$ in GG5, TAG39, Kadiri 6 and GG18. Mineral content in kernels of 31 groundnut cultivars were analysed. Iron content was observed in the range of 3.6-8.9 $g^{-1}$ 100g in Kadiri 9 and TG 51. TG 51, Kadiri 7 and GJG 22 have more than 8.0 $g^{-1}$ 100g Fe content. Average Zn content in groundnuts cultivars was 3.1 $g^{-1}$ 100g with a range from 24-47 g/100g. Highest Zn content was observed in JL 776 (4.7 $g^{-1}$ 100g) followed by GG7 (4.3 g/100g) and TG26 (4.0 $g^{-1}$ 100g). Wide variation for Ca content was observed in groundnut cultivars, which ranged from 12.8 g/100g (TKG 19A) to 63.3 $g^{-1}$ 100g (GJG 22). Groundnut is a good source of K which ranged from 422 $g^{-1}$ 100g (BAU13) to 602 $g^{-1}$ 100g (Kadiri 7).

### Experiment-2: Effect of roasting on nutritional quality traits of groundnut genotypes

Groundnut kernels of 31 cultivars were roasted in oven at 140° C. Nutritional quality traits of roasted kernels was analysed. Though, moisture content was decreased in all the analysed cultivars from 0.8% (GJG 22) to 4.5% (BAU 13). Oil content was increased in 17 cultivars while decreased in 14 cultivars after roasting. An inverse relationship was observed for protein content, which was decreased in 17 cultivars where oil content was increased and decreased in 14 cultivars where oil content was decreased. Total phenol content was decreased in all genotypes after roasting from 13.7% (GJG18) to 50.9% (TLG45) with an average decrease of 35.3%. Free amino acid content of groundnut kernel increased in all cultivars after roasting in the range of 10 (TG26) to 155% (AK159) compared to their raw kernels. Results of sugar profiles revealed that total sugar content was

**Table:** MRM of mixture of 15 polyphenol standards in ESI positive mode
*MRM of Resveratrol in ESI negative mode
Multiple reaction monitoring (**MRM**)

| Name of the std | MRM transition | | MRM retention time (min) |
|---|---|---|---|
| | Parent ion | Daughter ion | |
| Gallic acid | 168.91 | 124.82 | 1.180 |
| Epigallocatechin | 305.06 | 124.82 | 1.990 |
| Catechin | 289.07 | 108.84 | 2.080 |
| Catechol | 108.89 | 107.80 | 2.110 |
| Chlorogenic acid | 353.12 | 190.11 | 2.300 |
| Caffeic acid | 178.95 | 134.83 | 2.665 |
| Vanillic acid | 166.95 | 107.81 | 2.705 |
| Epicatechin | 289.08 | 122.82 | 2.730 |
| Syringic acid | 197.00 | 122.80 | 2.885 |
| Coumaric acid | 162.94 | 118.84 | 3.440 |
| Ferulic acid | 192.97 | 133.85 | 3.710 |
| Salicylic acid | 137.92 | 93.82 | 4.470 |
| Quercetin | 301.03 | 150.81 | 5.710 |
| Cinnamic acid | 146.93 | 76.79 | 5.800 |
| Kaempfero | l285.03 | 92.81 | 6.295 |
| Resveratrol* | 229.18 | 106.89 | 4.470 |

increased after roasting in most of cultivars it was increased except Girnar 2 and GG 20 in which it was decreased 4.8% and 14.11. Sucrose content was also increased after roasting except Girnar 2 and GG 20. While, raffinose a flatus sugar was decreased in 18 cultivars. Fatty acids also altered after roasting of groundnut kernels. Palmitic acid increased from 0.20 to 2.3% with an average of 0.44% in all cultivars. While oleic and linoleic acid decreased in about 20 cultivars. Phenolic acid profiles of twenty cultivars was carried out using LC-MS/MS. Results showed that gallic acid, ferulic acid, chlorogenic acid, catechin, epicatechin and resveratrol content were increased in JL501, BAU13 and OG52-1. Coumaric acid was increased only in Girnar 2 and JL501. Cultivars which possess low content of resveratrol in raw kernels, it was increased after roasting while cultivars possess higher content, it was decreased after roasting. Resveratrol content was found higher in raw kernels of GG7 (7.5 $\mu g^{-1}g$), TAG 24 (4.6 $\mu g^{-1}g$), GG20 (2.9 $\mu g^{-1}g$), GG5 (2.6 $\mu g^{-1}g$), TG 39 (2.4 $\mu g^{-1}g$). While, after roasting resveratrol content was found

higher in GJG18 (4.3 $\mu g^{-1}g$), JL 501, BAU13 (2.5 $\mu g^{-1}g$), Girnar 3 and GG20 (2.3 $\mu g^{-1}g$). Antioxidant activity was decreased in all most all cultivars after roasting, Mineral contents were also altered after roasting, but a distinct trend was not observed. Overall, these results showed that roasting alters the quality traits of groundnut kernels but increase or decrease after roasting is cultivar dependent.

**SERVICES:**

Oil, protein and moisture content of 4600 groundnut samples from different section of DGR and AICRP-G centers were measured by NIR spectroscopy.

## Studies on microorganisms in relation to plant health and nutrition in groundnut

*Dey R, Pal KK and Thirumalaisamy PP*

### A. Development of liquid formulation of DAPG-producing fluorescent pseudomonads

Formulations of DAPG-producing *Pseudomonas putida* DAPG4, which has been recommended for enhancing growth, yield and nutrient uptake in groundnut due to development of suppressive soils for management of stem and collar rot diseases of groundnut, were developed in different combinations. The formulations were inoculated with the concentrated culture suspension of $1.5 X 10^{12}$ cfu/ml and population built- up and shelf-life was monitored at 0h, 3d, 5d, 15d, 30d, 45d, 60d, 90d, 120d, 150d, 180d, 210d, 240d, 270d, 300d, 330d and 360 days after inoculation in eight different combinations. The population of DAPG4 in the eight different liquid formulations stored in room temperature was monitored upto 1 year. The bacterial popu-lation dropped at 15 days after inoculation, and after 6 months the population declined sharply. After 9 months of inoculation and storage at room temperature, the culture was viable in formulation 4 and 8 only. The population count in formulation 4 and 8 was $1.76 x 10^8$ and $4.2 x 10^8$ cfu, respectively after storage in room temperature for 1 year. Thus, these two liquid formulations of DAPG 4 can be

**Table 1.** Evaluation of competitive strains of groundnut rhizobia for enhancing BNF and yield of groundnut (cv TG37A) during Summer 2018

| Treatment | PY (kg/ha) | NN/p |
|---|---|---|
| Control | 2065 | 17.1 |
| TAL1000 | 1952 | 20.5 |
| Rhi23 | 2073 | 19.8 |
| Rhi24 | 2396 | 31.2 |
| Rhi25 | 2340 | 28.0 |
| Rhi11 | 2237 | 25.5 |
| Rhi19 | 2226 | 25.4 |
| Rhi35 | 2423 | 29.1 |
| Rhi26 | 2114 | 21.8 |
| Rhi10 | 2487 | 33.1 |
| Rhi17 | 2224 | 21.3 |
| Rhi18 | 2084 | 24.4 |
| Rhi20 | 2343 | 30.8 |
| CD (0.05) | 225 | 6.3 |

used for preparing, storage and application of DAPG 4 bioinoculant.

### B. Evaluation of competitive strains of groundnut rhizobia for enhancing BNF and yield in groundnut

Eleven efficient and competitive strains of groundnut rhizobia, including a standard culture TAL1000, were evaluated in a field trial with cultivar TG37A during the summer season, to assess the effects of their inoculation on the growth and yield of groundnut. Seed inocula-tion with 5 of the isolates resulted in significant enhancement of yield (13 – 20%). These isolates also resulted in increase in haulm yield, shelling out-turn and nodulation (Table 1).

### C. Studying the diversity of groundnut rhizobia in the Saurashtra region of Gujarat

A total of 61 rhizobial isolates were obtained from nodule samples collected from different groundnut germplasm and cultivars. The isolates will be characterized and identified by 16S rRNA sequencing before further evaluation.

### D. Characterisation of epiphytic bacteria and their selection

Phyllosphere or epiphytic bacteria can be used as potential biological control agents for air-borne fungal pathogens. Forty-eight morphologically different isolates of epiphytic bacteria were selected for studying their antifungal activities against two major foliar pathogens of groundnut, i.e *Alternaria* and LLS pathogen. Though 19 cultures showed antifungal activities against *Alternaria* (3-18 mm inhibition zone after 96 h of incubation), six isolates were promising in showing high degree of antifungal activity against *Alternaria* (>10 mm inhibition zone). Nine epiphytes showed antifungal activities against LLS pathogen, the inhibition zones ranging from 6 to 12 mm.

### B. Characterization of Zn, K, and Mn solubilising microorganisms and quantitative estimations Zn solubilisation:

The PGPR cultures BHU-1, FP82, BM6, FP93 and *Bacillus megaterium* have been identified as efficient Zn solubilizers. The quantitative estimation of Zn solubilised by these cultures was carried out under in vitro conditions, using three insoluble sources of Zn, i.e., zinc oxide, zinc phosphate, and zinc carbonate. All the 5 cultures were able to solubilise insoluble zinc compounds as evident from the amount of soluble zinc available in the broth and drop in pH. Among the three insoluble sources of zinc,

**Table 2. Solubilization of different forms of zinc by different isolates of PGPR**

| Isolate | ZnO | | $Zn_3(PO_4)_2$ | | $ZnCO_3$ | |
|---|---|---|---|---|---|---|
| | Zn (ppm) | pH | Zn (ppm) | pH | Zn (ppm) | pH |
| FP82 | 2.26(±0.14) | 6.33(±0.07) | 7.92(±0.70) | 4.87(±0.12) | 1.10(±0.12) | 5.54(±0.09) |
| BHU1 | 1.96(±0.37) | 5.92(±0.03) | 7.40(±0.91) | 6.69(±0.01) | 1.09(±0.06) | 4.75 (±0.13) |
| BM6 | 1.81(±0.26) | 6.58(±0.09) | 6.96(±0.98) | 6.46(±0.12) | 1.78(±0.32) | 4.66 (±0.13) |
| FP93 | 1.96(±0.06) | 6.60(±0.05) | 8.22(±0.96) | 5.01(±0.20) | 2.30(±0.34) | 6.63 (±0.01) |
| B. megaterium | ND | ND | 7.05(±0.69) | 4.94(±0.27) | 0.28(±0.08) | 6.55(±0.01) |

ND= not detected; data in the parenthesis represent standard deviation from mean

**Table 3.** In vitro solubilization of potassium aluminosilicate by different PGPR and DAPG-producing fluorescent pseudomonads

| Treatments | K (ppm) | pH |
|---|---|---|
| Control | 2.40 (±0.20) | 7.49 (±0.04) |
| DAPG1 | 21.20 (±0.61) | 6.39(±0.02) |
| DAPG2 | 24.10 (±1.04) | 6.10(±0.22) |
| DAPG3 | 21.93 (±1.86) | 6.16(±0.33) |
| DAPG4 | 19.13 (±140 | 6.48(±0.18) |
| DAPG5 | 21.93 (±1.32) | 6.34(±0.32) |
| DAPG6 | 23.57 (±1.91) | 6.31(±0.09) |
| DAPG7 | 23.83 (±1.29) | 6.11(±0.13) |
| FP 46 | 28.30 (±0.70) | 6.27(±0.13) |
| FP 82 | 26.43 (±1.16) | 6.21(±0.26) |
| FP 86 | 26.37 (±0.78) | 6.39(±0.19) |
| FP 93 | 14.30 (±1.90) | 5.44(±0.18) |
| FP 121 | 14.50 (±1.39) | 4.96(±0.16) |
| FP 133 | 12.63 (±1.07) | 5.18(±0.26) |
| BHU 1 | 12.57 (±0.72) | 5.00(±0.21) |
| S 16 | 16.10 (±0.79) | 5.39(±0.21) |
| BM 6 | 17.70 (±0.53) | 4.83(±0.10) |
| NC 92 | 14.07 (±2.08) | 5.39(±0.34) |
| ACC 3 | 19.63 (±0.91) | 5.16(±0.08) |
| C 185 | 8.60 (±0.60 | 5.27(±0.09) |
| B mega | 12.70 (±1.11) | 5.44(±0.07) |
| ACC 10 | 9.23 (±1.08 | 4.98(±0.06) |
| SEN 15 | 17.73 (±1.93) | 6.38(±0.09) |
| J 22 | 18.30 (±2.00) | 5.51(±0.31) |
| SEN 29 | 14.07 (±1.50) | 5.60(±0.05) |
| J 20 | 6.00 (±0.26) | 6.75(±0.08) |

Data in the parenthesis represent standard deviation from mean

zinc phosphate was solubilised the maximum (Table 2). The cultures FP82 and FP93 were more efficient Zn solubilizers.

The solubilisation of insoluble zinc into soluble forms was due to the production of organic acids. The profile of organic acids secreted by different organisms during solubilisation of different forms of zinc was studied by HPLC. Different organic acids like malic, citric, succinic, propionic, oxalic, malonic acid, etc. were secreted by the zinc solubilising microorganisms. Malic acid was found to be a major organic acid secreted during the process.

### K solubilization:

Twenty-five PGPR cultures showed clear zones of K solubilization in petridishes, using potassium aluminosilicate as insoluble source of K. These K-solubilizing bacterial cultures were tested under in vitro conditions for quantification of K-solubilization using potassium aluminosilicate as insoluble source of potassium. All the isolates solubilised K (6–28 ppm) with decrease in pH (4.8–6.75). All the DAPG-producing fluorescent pseudo*-monads were efficient K-solubilizers. The profile of organic acids secreted by K-solubilizing bacteria during K-solubi-lization in vitro was studied by HPLC. The organic acids like oxalic, malic, malonic, citric, succinic and propionic could be detected in the culture filtrate, oxalic and succinic being the major organic acids.

### Mn solubilisation:

Around 30 tentative Mn solubilising isolates have been obtained and the qualitative method for solubilisation studies are underway.

## Application of microorganisms for management of biotic and abiotic stresses in groundnut

*Pal KK, Dey R, Meena HN*, Mahatma MK, Harish G, Ajay BC, Narayanan G and Reddy KK***

*Upto June 2018 ; ** from January 2019

### A. Evaluation of role of different endophytes for alleviation of drought stress and saving of irrigation water and mechanisms of alleviation (Summer 2018)

To ascertain whether substantial irrigation water can be saved by application of endophytic bacteria in summer groundnut, it was found that application of endophytes and 5 irrigations can provide as much pod yield (average 2604 kg/ha) that can be obtained with 10 supplementary irrigations after emergence (2494 kg/ha) without endophytes. Inoculation of endophytes improved the pod and haulm yield of groundnut at all level of irrigations (Table 1). Maximum benefit was provided by *Bacillus firmus* J22, followed by *Acinetobacter junii* J20.

Thus, it would be feasible to reduce quantity (30-50%) and frequency of irrigations (4-5 irrigations) substantially for raising summer groundnut with endophytes and there is possibility of horizontal spread in areas with the application of endophytes with the available quantity of irrigation water.

A separate experiment was also conducted to ascertain the role of endophytes in alleviation of drought stress with two supplementary irrigations after emergence (50 DAE and 75 DAE) with cultivar TG37A. It was found that there was improvement in yield of groundnut by 16-26% due to inoculation of endophytes (Table 2). Maximum benefit was accrued due to inoculation of *Bacillus firmus* J22.

The modulation of C3-CAM transition was also studied and it was found that there was enhanced level of production of key enzymes of carboxylation and de-carboxylation modules of C3-CAM pathways due to inoculation

**Table 1.** Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut (Summer 2018; TG37A)

| Treatments | No of supplementary irrigations | | | | Mean |
|---|---|---|---|---|---|
| | 3 | 4 | 5 | 10 | |
| Control | 1602 | 2173 | 2321 | 2494 | 2147 |
| REN47 | 1739 | 2296 | 2604 | 2586 | 2306 |
| SEN29 | 1957 | 2305 | 2549 | 2535 | 2337 |
| J20 | 1738 | 2270 | 2664 | 2497 | 2292 |
| R51 | 1782 | 2390 | 2663 | 2660 | 2374 |
| J22 | 1777 | 2273 | 2543 | 2591 | 2296 |
| **Mean** | **1766** | **2285** | **2557** | **2561** | **2292** |
| | LSD (0.05) | | | | |
| Treatment | **90** | | | | |
| Irrigation | **63** | | | | |
| Treatment X Irrigation | **153** | | | | |

**Table 2.** Application of endophytes for alleviation of drought stress in groundnut (cv TG37A), Summer 2018 (2 irrigations after emergence)

| Treatments | PY (kg/ha) | HY (kg/ha) | % increase over control |
|---|---|---|---|
| Control | 1668 | 3203 | - |
| J20 | 1997 | 3433 | 19.7 |
| J22 | 2103 | 3877 | 26.1 |
| R47 | 1908 | 3743 | 14.4 |
| R51 | 1941 | 3787 | 16.4 |
| SEN29 | 1958 | 3707 | 17.4 |
| **CD (0.05)** | **213** | **396** | - |

of endophytes in groundnut during the period of drought stress in different treatments.

### B. Evaluation of endophytes for alleviation of salinity stress in groundnut and mechanisms of alleviation

Five endophytes (*Bacillus firmus* J22, *Bacillus subtilis* REN51, *Pseudomonas pseudoalcaligenes* SEN29, *Acinetobacter junii* J20 and *Pseudoxanthomonas mexicana* REN47) were evaluated during summer 2018 with cultivar TG37A for alleviation of salinity stress, if any and with salinity level of around 4.8 at harvest. Results indicated that there was drastic reduction in yield of groundnut with the application of saline water, and at around 4.87 EC of soil salinity at harvest. However, application of endophytes like *Bacillus firmus* J22, *Pseudoxanthomonas mexicana* REN47 and *Bacillus subtilis* REN 51 prevented the reduction in yield losses by improving the yield by 10%, 14%, and 11%, respectively (1566 kg/ha in control and 1724-1793 kg/ha with these endophytes) at soil EC of around 4.87 at harvest (Table 3). Attempt was made to understand whether there was modula-tion in the C3-CAM transition in salinity stress alleviation by these endophytes also, besides enhanced produc-tion of ROS scavenging enzymes for detoxification of reactive oxygen species. To do so, it was required first to understand whether C3-CAM transition occurs in cultivated groundnut under salinity stress.

However, as C3-CAM transition in salinity stress in cultivated agricultural crop has not been reported yet, a separate experiment was undertaken with TG37A and two of its C3-CAM transited and drought tolerant variants with soil salinity level of around 4.87 at harvest to understand the phenomenon further. Salinity was developed by application of $NaCl:Na_2SO_4:MgSO_4:CaCl_2$ @ 6:4:2:1 ratio. It was found that while development of salinity at 4.87 of soil EC at harvest reduced the biomass production in the cultivar TG37A by almost 48% (7300 kg/ha in normal soil condition to 3786 kg/ha in around 4.2 soil EC in TG37A), the over-expressive C3-CAM transited variants of TG37A (which are otherwise drought tolerant) like DGRMB5 minimized the biomass reduction (5736 kg/ha) and maintained at 25% level of reduction (Table 4). Studying the expression of key enzymes of modules of C3-CAM transition indicated the over-expression of CA, PEPC, MDH, NAD(P)-ME, PPDK, VATPase, etc. many fold in carboxylation and decarboxylation modules in leaf with inverse stomatal behaviour which began at around 4.0 EC of soil salinity. Night-time carboxylation and day-time decarboxylation were observed.

### C. Evaluation of endophytes for alleviation of salinity stress in groundnut at Madvi, Bhuj (Collaborator, Dr. S. Acharya, CSSI, Mandvi)

Three endophytes *Bacillus firmus* J22, *Bacillus subtilis*

**Table 3.** Effect of endophytes in alleviation of salinity stress in groundnut (cv TG37A) during summer 2018 (Soil EC at harvest: 4.87)

| Treatments | PY (kg/ha) | HY (kg/ha) | % reduction in yield | % reduction in biomass |
|---|---|---|---|---|
| Control | 1566 | 3420 | | |
| J20 | 1706 | 3700 | 8.94 | 8.42 |
| J22 | 1724 | 3570 | 10.11 | 6.18 |
| R47 | 1793 | 3793 | 14.50 | 12.04 |
| R51 | 1737 | 3900 | 10.92 | 13.06 |
| SEN29 | 1518 | 3677 | -3.09 | 4.18 |
| **CD (0.05)** | **137** | **242** | | |

**Table 4.**Biomass production under salinity stress (average soil EC at harvest: 4.87 in salinity treatment)

| | Pod yield (kg/ha) | | | Haulm yield (kg/ha) | | | % reduction in yield | % reduction in biomass |
|---|---|---|---|---|---|---|---|---|
| **Treatments** | **1** | **2** | **Grand Total** | **1** | **2** | **Grand Total** | | |
| DGRMB19 | 3457 | 1814 | 2635 | 4037 | 3200 | 3618 | 47.53 | 20.73 |
| DGRMB5 | 3399 | 2173 | 2786 | 3860 | 3563 | 3712 | 36.07 | 7.68 |
| TG37A | 2590 | 1489 | 2040 | 4710 | 3630 | 4170 | 42.50 | 22.93 |
| **Grand Total** | **3149** | **1825** | **2487** | **4202** | **3464** | **3833** | | |
| LSD (0.05) | | | | | | | | |
| Treatments | 171 | | | 218 | | | | |
| Salinity | 113 | | | 217 | | | | |
| T X S | 195 | | | 376 | | | | |

R51 and *Pseudomonas pseudoalcaligenes* SEN29 were evaluated in two separate experiments, one with cultivar GG2 with flat bed and broad bed whereas in 2nd experiments, these endophytes were evaluated with four Spanish bunch varieties GG2, GG5, GG7, and TG37A. The treatments differences for pod yield were significant mainly due to significant differences among microbes and Land Configurations x Microbes x FYM. Among microbes, J22 was the best giving significantly and 80 and 23 per cent higher pod yield (846 kg/ha) than the mean pod yield with no microbes (471 kg/ha) and SEN 29 and R 51 (691 kg/ha each), respectively. Land configurations evinced no difference; though flat bed with FYM gave the highest yield (724 kg/ha). The Land Configurations X Microbes x FYM interaction term was significant. Therefore, it would be worthwhile to select their specific combinations for higher pod yield. J 22 in combination with FYM gave significantly and 128 and 81 per cent higher pod yield under flat bed (1073 kg/ha) and raised bed (853

**Table 5.** Impact of application of endophytes on yield of different genotypes under irrigated condition (saline water, Mandvi, Bhuj, kharif 2018)

| Treatments | Endophytes | | | | |
|---|---|---|---|---|---|
| | J22 | SEN29 | R51 | Control | Mean |
| GG2 | 1833 | 1503 | 2479 | 2000 | **1954** |
| GG5 | 2176 | 2409 | 2118 | 1920 | **2156** |
| GG7 | 2433 | 1908 | 2021 | 1460 | **1955** |
| TG37A | 1572 | 2027 | 1397 | 1270 | **1567** |
| **Mean** | **2003** | **1962** | **2004** | **1663** | **1908** |
| $SE_m$ ± (Genotypes) | | 135.2 | CD 5% ± (Genotypes) | | 390.5 |
| $SE_m$ ± (Endophytes) | | 135.2 | CD 5% ± (Endophytes) | | NS |
| $SE_m$ ± (Genotypes x Endophytes) | | 270.4 | CD 5% ± (Geno x Endophytes) | | NS |

kg/ha) than mean pod yield with no microbes' application (471 kg/ha), respectively. All the microbes' combinations, irrespective of FYM application or land configurations (except SEN 29 with no FYM application) gave significantly higher yield than the mean performance under no microbes' application (471 kg/ha). J 22 in combination with FYM was the best both under flatbed (1073 kg/ha) and raised bed (853 kg/ha) evincing 128 and 81 per cent higher pod yield than mean pod yield with no microbes' application (471 kg/ha).

In the 2nd experiment, there were significant differences among the genotypes for pod yield. GG 5 gave significantly and 38 per cent higher pod yield (2156 kg/ha) than TG37A (1567 kg/ha) but was at par with GG2 (1954 kg/ha) and GG7 (1955 kg/ha) (**Table 5**). Further, GG2 and GG7 were at par with TG37A. The endophytic strains did not differ significantly, though numerically J22, R51 and SEN29 out yielded control (1663 kg/ha) by 20, 20 and 18 per cent, respectively.

### D. Evaluation of C3-CAM transited variants of TG37A

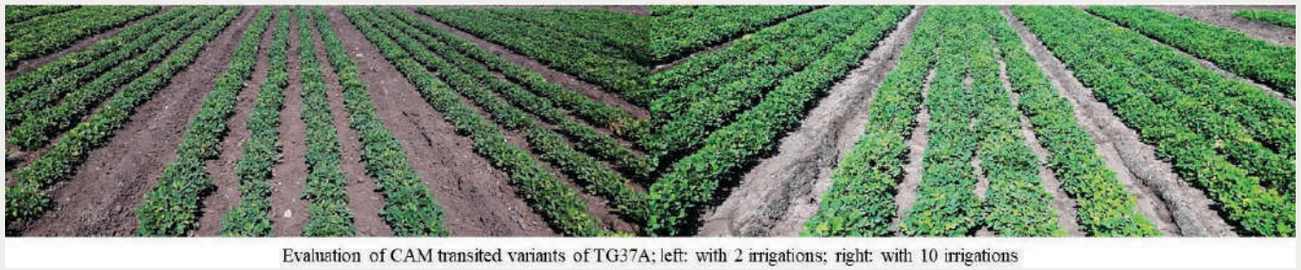
A total of seven drought tolerant variants of TG37A (DGRMB3, DGRMB5, DGRMB13, DGRMB17, DGRMB19, DGRMB29 and DGRMB31) were evaluated alongside TG37A with two levels of irrigations, two and full (10), after emergence. It was found that whereas reduction of biomass was around 42% in TG37A with two supplementary irrigations, C3-CAM transited variants showed biomass reduction from 25-32% in similar conditions. Least reduction in biomass was obtained with DGRMB5. In case of pod yield, reduction was around 49% in TG37A with two irrigations whereas it varied from 32% to 40% in different CAM variants (Table 6).

During kharif 2019, twelve CAM variants of TG37A were evaluated for yield under rainfed condition keeping TG37A as control. The pod yield of variants ranged from 2590 kg/ha to 4110 kg/ha against 3177 kg/ha for TG 37A. Yield of DGRMB5, DGRMB19, DGRMB24 and DGRMB32 were significantly higher than TG37A (**Table 7**).

### E. Evaluation of the role of endophytes (J22 and SEN29) in alleviating the moisture-deficit stress in groundnut through OFT (farmers field at Anantapur and Kalyandurga through KVK at Reddypalli and Kalyandurg)

**Table 6.** Evaluation of CAM transited variants of TG37A for yield (summer 2018)

| | Pod yield (kg/ha) | | | Haulm yield (kg/ha) | | | | |
|---|---|---|---|---|---|---|---|---|
| **Treatment** | **2 irrig-ations** | **10 irrig-ations** | **Mean** | **2 irrig-ations** | **10 irrig-ations** | **Mean** | **% pod yield reduction** | **% reduction in biomass** |
| DGRMB13 | 1899 | 2960 | 2379 | 3420 | 4583 | 4002 | 35.84 | 29.5 |
| DGRMB17 | 2003 | 3000 | 2451 | 3553 | 4950 | 4252 | 33.23 | 30.1 |
| DGRMB19 | 1967 | 3150 | 2508 | 3607 | 4853 | 4230 | 37.56 | 30.4 |
| DGRMB29 | 1725 | 3063 | 2344 | 3673 | 4830 | 4252 | 43.69 | 31.7 |
| DGRMB3 | 1805 | 3050 | 2478 | 3790 | 4763 | 4277 | 40.82 | 28.4 |
| DGRMB31 | 1859 | 3012 | 2436 | 3467 | 4827 | 4147 | 38.28 | 32.1 |
| DGRMB5 | 1922 | 2828 | 2325 | 3783 | 4647 | 4215 | 32.04 | 23.7 |
| TG37A | 1323 | 2578 | 2101 | 2967 | 4877 | 3922 | 48.68 | 42.5 |
| **Total** | **1725** | **2955** | **2378** | **3533** | **4791** | **4162** | | |
| **LSD (0.05)** | | | | | | | | |
| Treatment | 118 | | | 150 | | | | |
| Irrigation Level | 104 | | | 64 | | | | |
| TXL | 294 | | | 182 | | | | |



Evaluation of CAM transited variants of TG37A; left: with 2 irrigations; right: with 10 irrigations

During kharif 2018 a total of 18 OFTs on role of endophytes in alleviation of drought stress in groundnut were conducted with the help of KVKs located at Kalyandurga and Reddypalli in Andhra Pradesh. *Bacillus firmus* J22 was used as seed treatment. At Kalyandurga, 12 OFTs were conducted strictly under rainfed condition with 50% deficient rain of about 240 mm during the crop season. There was enhancement in pod and haulm yield of groundnut by 24.3% (435 kg/ha in endophytes treatment against 350 kg/ha in farmers practice). Haulm yield was enhanced by 31% in treated one. In Anantapur taluka, two OFTs were conducted under rainfed condition (about 50% deficient rain) and there was improvement in yield by 38.4% (494 kg/ha in OFT against 357 kg/ha in control). However, one supplemen

**Table 7.** Yield evaluation of C3-CAM variants of TG37A strictly under rainfed conditions during kharif 2018

| Treatments | PY (kg/ha) | HY (kg/ha) | SP (%) | HKM (g) |
|---|---|---|---|---|
| TG37A | 3177 | 3520 | 70.47 | 48.23 |
| DGRMB1 | 2833 | 3433 | 72.00 | 50.77 |
| DGRMB3 | 2813 | 3760 | 71.67 | 47.57 |
| DGRMB5 | 3920 | 4710 | 72.17 | 50.33 |
| DGRMB13 | 2933 | 3790 | 73.17 | 46.67 |
| DGRMB17 | 2830 | 3523 | 73.67 | 49.90 |
| DGRMB19 | 4110 | 4920 | 73.67 | 53.70 |
| DGRMB20 | 2860 | 3517 | 72.17 | 48.03 |
| DGRMB24 | 4040 | 5210 | 70.83 | 50.37 |
| DGRMB29 | 2590 | 3843 | 71.83 | 49.17 |
| DGRMB31 | 2930 | 3830 | 73.33 | 47.00 |
| DGRMB32 | 4000 | 4727 | 72.67 | 50.10 |
| DGRMB41 | 2893 | 3883 | 73.17 | 49.83 |
| **CD (0.05)** | **212** | **314** | **2.22** | **2.02** |

tary irrigation was provided, yield improvement was 40% with the treatment of endophyte. Further addition of one more irrigation could not improve the yield further indicating that endophytes can have pronounced impact during drought stress.

### F. Evaluation of endophytes for enhancing growth and yield of groundnut (5 endophytes; rainfed, field by plant growth promoting attributes (kharif 2018)

Five endophytes (*Bacillus firmus* J22, *Bacillus subtilis* R51, *Pseudomonas pseudoalcaligenes* SEN29, *Acinetobacterjunii* J20 and *Pseudoxanthomonasmaxicana* R47) were evaluated during *kharif* 2018 with cultivar TG37A to assess the plant growth promoting abilities of the cultures. Seed inoculation with the endophytes, in general, resulted in increase in plant biomass production, shelling percentage and hundred kernel mass. Significant enhancement in pod yield was obtained in treatments receiving R51 (20.11%) and REN47 (27.82%) cultures (**Table 8**). Treatments with other endophytes resulted in yields at par with control.

**Table 8.** Evaluation of endophytes for plant growth promotion and yield enhancement of groundnut strictly under rainfed conditions (cultivar TG37A)

| Treatments | PY (kg/ha) | HY (kg/ha) | SP (%) | HKM (g) |
|---|---|---|---|---|
| Control | 2531 | 3638 | 69.40 | 47.55 |
| *Acinetobacterjunii* J20 | 2674 | 4028 | 71.00 | 48.13 |
| *Bacillus firmus* J22 | 2695 | 4080 | 71.38 | 48.95 |
| *Pseudoxanthomonas mexicana* REN47 | 3235 | 4385 | 71.25 | 49.28 |
| *Bacillus subtilis* R51 | 3040 | 3948 | 70.75 | 49.05 |
| *Pseudomonas pseudoalcaligenes* SEN29 | 2821 | 4108 | 71.25 | 47.63 |
| **CD (0.05)** | **388** | **327** | **1.27** | **1.34** |

# 05 Socio-economic Research and Extension for Groundnut in Developments

## Assessment of Farm-Managerial Abilities and Resource Use Efficiency of Small and Marginal Groundnut Farmers of High and Low Productivity Areas: Suggesting Suitable Policy Measures to Double the Farm Income

*Narayanan G and Jat RA*

### Study on resource use efficiency: cost and returns from groundnut cultivation of small and marginal farmers

Groundnut is usually grown as one of the primary cash crops in Karnataka. There is wider yield gap exists in groundnut. To improve the productivity better resource use is essential. This will lead to attainment of desirable behavior for higher production among small and marginal farmers for high output per unit input.

For collecting primary data, survey was undertaken among 120 farmers of *Chitradurga* district with structured interview schedule in the end of *Kharif* 2018. Farmers were chosen by following multistage random sampling method. In this study, those farmers having up to 1.5 ha were considered as marginal farmers and 1.5 to 3.0 ha as small farmers and interviewed directly among 30 farmers each from four randomly chosen villages. Apart from frequency, percentage for assessing farm-managerial abilities, Frontier Production Function Model was used to analyze their economic and technical efficiency.

Of much production limiting factors, low technical literacy, inadequate infrastructure, unscientific farming of groundnut growers fails them to exploit fully the potential of technology. Hence, resource use efficiency in value terms was analysed. Farmers invest about 25% of cost in seed and post harvesting practices. The total cost of cultivation was Rs. 23668/ha. Allocative efficiency is concerned; the allocation for seed seems to be same and constant. The change may have to be effected in seed use, fertilizers, plant protection chemicals. The BC ratio, range is very narrow i.e. 1:1.3 to 1:1.8. Majority of marginal farmers (61.0 per cent) operating with 67.50 per cent of technical efficiency. About 39 per cent farmers operating with 73.0 per cent of technical efficiency. This reveals that among small and marginal farmers, with the same investment, about 32.5 per cent yield improvement can be achieved. This speaks about the reasons for having wider yield gap exists in groundnut and need to build the capacity of small and marginal farmers on better allocative efficiency there by achieveing greater resource use efficiency

**Table.1:** Technical efficiency of small and marginal farmers (Frontier production function model)

| TE range | Farmers (%) | Average TE | % of output lose due to inefficiency |
|---|---|---|---|
| < 70% | 73.2 | 67.50 | 32.50 |
| 70-80% | 26.8 | 73.0 | 27.0 |

**Table.2.** Assessing the extent of farm-managerial abilities of groundnut growers

| Extent of farm-managerial abilities | Marginal Farmers (60) | | Small Farmers (60) | |
|---|---|---|---|---|
| | No. of Farmers | Percentage | No. of Farmers | Percentage |
| High >77 | 14 | 23.3 | 12 | 20.0 |
| Medium ≤ 77 | 46 | 76.6 | 48 | 80.0 |

| Sl.No. | OFTs Pod yield (Kg/ha) | FP Pod yield (Kg /ha) | Per cent Increase | OFTs Haulm yield (Kg /ha) | FP Haulm yield(Kg /ha) | Per cent Increase |
|---|---|---|---|---|---|---|
| OFTs on rain fed, without irrigation KVK, Kalyandurg | | | | | | |
| Mean | 435.0 | 350.8 | 24.1 | 643.8 | 497.9 | 31.1 |
| OFTs on rain fed, without irrigation KVK Reddipalli | | | | | | |
| Mean | 494.4 | 357.3 | 40.0 | 1106 | 844.5 | 31.1 |
| OFTs with one irrigation at 30 DAS | | | | | | |
| Mean | 732.9 | 627.3 | 16.9 | 1831.0 | 1300.0 | 41.14 |
| OFTs in KVK with Two irrigation at 55&75 DAS | | | | | | |
| | | | | | | |

### Assessing the extent of farm-managerial abilities of groundnut growers:

The study was carried out for assessing the extent of farm managerial abilities of small and marginal farmers. It was found that majority of the small (60%) and marginal farmers (76%) found to have medium farm managerial abilities. Among small farmers, only about 20% of farmers found to have high farm managerial abilities.

A detailed examination of components of farm managerial abilities performance among small and marginal farmers was carried out. The study revealed that high farm managerial ability has been found among marginal farmers in the components of supervision in cultivation of groundnut, budgeting, co-ordinating the activities than small farmers. As far as knowledge of scientific practices was concerned almost all farmers respondents were in medium range. Hence capacity building of farmers is necessary in this component.

### Evaluation of Endophytes for alleviation of drought through OFT

During *Kharif*-2018 in total 18 OFTs were undertaken with help of KVK Kalyandurg and KVK Reddipalli. In

Kalyandurg taluka 12 OFTs were conducted under rainfed condition. The seed treatment culture given was *B.firmus and J22*. The average pod yield recorded with OFTs was 435kg/ha in comparison with FP 350 kg/ha. The Haulm yield difference was 31 % higher in OFTs in comparison with farmers practice. In Anantpur taluka two OFTs were undertaken under rainfed condition that reported 494kg/ha and 357kg/ha among OFT & FP respectively. Other 4 OFTs with irrigation also cond-ucted. Amongst them the pod yield was significantly higher in two OFTs with1 supplementary irrigation (40 %) yield difference and at the same time with two irriga-tions the yield difference was only (4%). Hence, it may be concluded that the culture may helps the crop to be drought tolerant and not makes crop fail even in scanty rain fall (50% less rainfall situations). Further, treatment with one supplement irrigation help crop not only with stand drought but also boost yield in comparison with check.

| Group name | Yield (Kg/ha) | | | | | |
|---|---|---|---|---|---|---|
| | Pod | | % of pod yield | Haulm yield | | % of Haulm yield |
| | IP | FP | | IP | FP | |
| Group -1 | 1608 | 1449 | 11 | 2185 | 1970 | 11 |
| Group -2 | 1411 | 1289 | 10 | 1892 | 1729 | 10 |
| Group -3 | 1133 | 1021 | 12 | 1506 | 1366 | 11 |
| Group -4 | 1546 | 1373 | 13 | 2000 | 1767 | 14 |
| Group -5 | 1390 | 1247 | 11 | 1834 | 1631 | 12 |
| **Average** | **1417** | **1275** | **11** | **1883** | **1692** | **11** |

## FLDs conducted through MGMG villages

### Improved variety: GJG 20 Farmers Practice: GG20

The data revealed from 125 FLDs with improved practice GJG 20 recorded an average pod yield of 1417 kg/ha compared to 1275 kg/ha with farmers practice. The pod yield increased by 11.5 per cent with improved practice over farmers practice. The average haulm yield was 1883 kg/ha with improved practice compared to 1692 kg/ha with farmers practice. The haulm yield with improved practice was 11.7 per cent increased over farmers practice. The economics display in average cost of cultivation and average gross marginal return with improved practice was Rs. 49048 /ha and Rs.67840/ha respectively whereas, in farmers practice it was Rs. 55254/ha and Rs. 61114/ha respectively. The gross return increased by11 per cent. The average net return with improved practice Rs. 66297 / ha compared to Rs. 60250/ha with farmers practice and increased by 10.8 per cent. The Benefit Cost (B:C) ratio was 2.1 with improved practice compared to 1.9 in farmers practice.

## Visit of farmers

This year (2018-19), altogether 564 visitors from various states viz. Gujarat, Maharashtra, Uttarkhand and Rajasthan visited this Directorate. It includes a total of 564 farmers from 4 different states, 33 students from four universities and 35 women farmers. These visits were sponsored by State Depart

ment of Agriculture or State Agricultural univer-sities concerned. All visiting groups were taken to the demonstration fields, provided with Hindi, Gujarati and English literatures; shown field experiments, Technology Park, laboratories, museum, library etc. and interaction meetings with the scientists were also arranged.

## Development activities for tribal and hill regions: Reaching the unreached

Groundnut is an important oilseed crop in tribal areas not only to enrich the soil but also the life of tribal farmers in terms of income and nutritional security. Tribal mostly cultivate the poor yielding groundnut varieties along with minor cereals. Among them, groundnut cultivation as sub-system in their primitive farming is a non-profitable one with their poor knowledge on improved adoption practices and less efficient resource use management behaviour. Thus, training of tribal farmers on improved technologies and supply inputs was need of the hour to establish remunerative groundnut farming system.

With this rational in mind, the ICAR-DGR through Tribal Sub Plan (TSP) had collaboration with SAUs and KVKs where tribal farmers are more in number and able to cultivate groundnut if they trained. Generally the seed given to these farmers will be brought back and distributed to other beneficiaries in the next season. Thus this process will be continued till having to establish groundnut as suitable livelihood crop among tribal farmers. There by economic growth of area will be improved. At the time of implementation, the specific objectives kept were:

I. Empowering the tribal population through advanced management practices in groundnut like., deep ploughing, seed treatment, pre-emergence weedicide application, soil test based fertilizers applications, farm mechanization, inter cropping system etc.,

II. Improving productivity levels by supplying the high yielding multiple resistant groundnut varieties which can withstand drought and diseases at the same time yielding high while compared with old varieties.

III. Enhancing the economic status of tribal populations by increased productivity there by leading to sustainable lively hood.

IV. Developing community seed banks among tribal farmers.

V. Introducing the farm mechanization technologies there by reducing the labor cost.

During 2018-19 to conduct the On-Farm Demonstration on groundnut with latest varieties and technologies about Rs.21.46 lakhs was sanctioned to BCKV agricultural university, Kalyani, West Bengal, Agricultural Research Station, Vizianagaram, and covered about 170 tribal farm families.

# 06 Highlights of AICRP on Groundnut: 2018-19

## I. Crop Improvement

### 1. Maintenance, multiplication and characterization of groundnut germplasm

- 60 wild Arachis accessions representing six sections of the genus Arachis: section *Arachis* (40 accessions); *Erectoides* (12 accessions); *Caulorhizae* (2 accessions); *Rhizomatosae* (2 accessions); Extranervosae (2 accessions); and *Heteranthae* (2 accessions) are being maintained in the field gene bank at Vridhachalam.
- In the same centre, a field gene bank comprising four allotriploids {(*A. hypogaea* cv. VRI 4 x (*A. correntina* X *A. helodes*); *A. hypogaea* cv. VRI 2 x *A. correntina*; *A. hypogaea* cv. VRI 2 x *A. kempffmercadoi* and *A. hypogaea* cv. VRI 2 x *A. cardenasii*}; three autotetraploids developed from two diploid species of the section *Arachis* (*A. villosa* and *A. stenosperma* and one species from the section *Erectoides* viz. *A. rigonii*); 11 amphidiploids (2n=4x=40) obtained through direct hybridisation between diploid wild species and tetraploid cultivated species were also being field maintai-ned were being field main-tained.
- From fourteen interspecific crosses effected in kharif 2017, 64 true $F_1$ hybrids were identified; to recover the genome of recurrent parents, 272 $BC_1F_1$ plants were recovered from nine interspecific cross-combinations in rabi-summer 2017-18. In *kharif* 2018, 18 interspecific crosses have been made introgressing the alien genes through triploid and tetraploid pathways.
- Four thousand one hundred and forty-six (4146) germplasm accessions are being maintained at 11 centres. This included 60 wild accessions; 19 interspecific derivatives; exotic collection; 2834 Spanish bunch accessions; 53 Valencia accessions; 810 Virginia Bunch accessions; 374 Virginia Runner accessions; and four other germplasm accessions.
- Few promising genotypes, soil borne (stem rot and collar rot) diseases (K 1812, JL 1176, CS-319, JL-977, JL-977, HNG-10, HNG-10, ICGV-86325, CS-19, GG-16) and earliness with fresh seed dormancy (TCGS 1157, TCGS 1694, VG 13127, VG 13149, VRI 8).

### 2. Hybridization programme

- For developing high-yielding groundnut cultivars possessing resistance to various biotic and biotic stresses which limit yield in season, 98 single-crosses during rabi-summer and 189 in crosses in *kharif* 2018 were made different AICRP-G centers
- During *rabi*-summer progenies of 362 crosses were advanced to their respective next filial generation from which a very large number (10646) of selections were made
- During *rabi*-summer, proge

nies of 312 crosses were advanced to their respective next filial generation and in *kharif* season; progenies of 1513 crosses were advanced to their respective next filial generation from which very large number of objective specific selections was made. Of the total crosses, which were advanced to different filial generations, in *rabi*-summer, 136 crosses were in early generations ($F_1$- $F_3$) and in *kharif* progenies of 1154 crosses were in early generations ($F_1$- $F_4$) and the rest were in advanced generations ($F_5$ onwards).

### 3. Varietal evaluation at multi-location

- A three tier system of evaluation of groundnut entries under the nomenclature of Initial Varietal Trial, Stage I (**IVT I**); Initial Varietal Trial, Stage II (**IVT II**) and Advanced Varietal Trial (**AVT**) was adopted and the trials were allotted to 25 centers located in five agro-ecological zones of groundnut both in kharif and rabi-summer
- During *kharif*, 16 entries of Spanish Bunch; 10 entries of Virginia in IVT-I; 19 SB entries, 12 genotypes of Virginia and 6 large seeded genotypes in IVT-II were tested across the five zones with appropriate checks. Entries of IVT-I will be evaluated for one more year in IVT-II.
- In IVT-II, during *kharif*, the genotype Dh 257 (Proposed by UAS, Dharwad) promoted to AVT in Zone II (Gujarat and southern Rajasthan) with a high pod (3161 kg/ha) and kernel (2304 kg/ha) yield (10% higher over the best check, GG 7) and K 1812 with high pod (3385 kg/ha) and kernel (2346 kg/ha) yield (13% higher kernel yield) over the best check, R 2001-2 was promoted to AVT in Zone V (Tamil Nadu, Andhra Pradesh, Karnataka).
- At LSVT (Large Seeded Varietal Trial) out of seven test genotypes, two geno-types viz. **K 1574** (2825 kg/ha of pod and 1994 kg/ha of kernel yield) followed by **ICGV 06189** (2768kg/ha of pod and 1960 kg/ha of kernel yield) respectively. Both these genotypes recorded 10% higher kernel yield over the best check BAU 13 and hence promoted to ALSVT.
- In kharif 2018, at AVT, the genotype **Dh 256** was found superior over the best check R 2001-2 in Zone V (Tamil Nadu, Andhra Pradesh, Karnataka). Across different stages of testing from 2016 to 2018, the genotype, **Dh 256** (Proposed by UAS Dharwad), recorded a high pod (3258 kg/ha) and kernel yield (2183 kg/ha) against the best zonal check variety, R 2001-2 with 2837 kg/ha of pod 1882 kg/ha of kernel yield. Over different check varieties, the increase in pod yield of **Dh 256** was 61.2% over GPBD 4; 29.9% over GJG 32; and 20.1% over R 2001-3 and 14.8% over the best check of this zone R 2001-2 respectively. Increase in kernel yield of **Dh 256** over these check varieties was 59.3% over GPBD 4; 36.6% over GJG 32; 20.2% over GJG 32 and 16.0% over the best check of this zone R 2001-2 respectively. Oil content of Dh 256 is 50%. Hence proposed for identification.

### 4. High oleic Acid Varietal Trial (AVT-I; HOVT SB &VG)

- A special trial on High oleic Acid Varietal Trial (HOVT) was constituted in kharif 2018 (first year) with eight elite Spanish Bunch and six elite Virginia genotypes developed by ICAR-DGR Junagadh (6 VG entries), JAU Junagadh (5 SB entries) and UAS Raichur (3 SB entries). The check varieties used were TG 37A, GPBD 4 and GJG 32 (ICGV 03043) in Spanish Bunch trial and GG 20, KDG 128 (Phule Warna) and KDG 123 (Phule Morna) in Virginia trial. The trial was conducted at six locations, Tindivanam (Tamil Nadu), Palem (Telengana), Tirupati (Andhra Pradesh), Dharwad (Karnataka), Junagadh (Gujarat), and Durgapura (Rajasthan). The mean yield levels of the Spanish Bunch test materials including those of check varieties were 2746 kg of pod and 1806 kg per ha of kernel.

### 5. High oleic Acid Varietal Trial (AVT-I; HOVT SB &VG)

- A special trial on High oleic Acid Varietal Trial (HOVT) has been constituted during *kharif* 2017 with 18 genotypes. The check varieties used were TG 37A, GPBD 4 and GJG 32 (ICGV 03043). There were six locations Tindivanam (Tamil Nadu), Palem (Telengana), Tirupati (Andhra Pradesh), Dharwad (Karnataka), Junagadh (Gujarat), and Durgapura (Rajasthan).
- Across different locations and over two years, the check variety ICGV 00343 recorded 52.58% oleic acid. Whereas two genotypes **ICGV 15083 and ICGV 15090** 78.2% oleic acid which fulfills the bench mark (78%±2) set for high Oleate lines.
- Over different check varieties, the increase in pod yield of **ICGV 15083** was 57.3% over GPBD 4; and 41.4% over TG 37A, but fell short by just by 2.9% over ICGV 00343 (GJG 32). Whereas increase in kernel yield of this genotype **ICGV 15083** over these check varieties was 56.4% over GPBD 4; and 36.0% over TG 37A, but was less by 3.8% over ICGV 00343 (GJG 32) respectively. The genotype **ICGV 15083** matured in 112d with 67% of shelling; 43 g as Hundred Seed Mass, which was comparatively higher over all the check varieties and with high oil, content (53%) which is 1-2% higher over all the checks. Protein content of this genotype was 27% and comparable with that of other check varieties.
- Over different check varieties, the increase in pod yield of the other entry **ICGV 15090** was 52.7% over GPBD 4; and 37.3% over TG 37A, but fell short by 5.7% over ICGV 00343 (GJG 32) respectively. Whereas increase in kernel yield of this genotype over these check varieties was 54.0% over GPBD 4; and 33.9% over TG 37A, but was less by 5.3% over ICGV 00343 (GJG 32) respectively. The genotype **ICGV 15090** matured in 113d with 67% of shelling; 41 g as Hundred Seed Mass, which was comparatively higher over all the check varieties and with a high oil content (53%) over all the checks. Protein content of this genotype was 26% and comparable with that of other check varieties. Hence these two high Oleate lines are proposed for identification.
- **In *rabi*-summer 2017-18**, one genotype, **J 95** (with 4558 kg/ha of pod and 3367 kg/ha kernel yields **in Zone I (Punjab and UP)**; two genotypes, **Dh 257** (with 3854 and 2788 kg/ha of pod and kernel yield) and **K 1812** (with 3854 and 2788 kg/ha of pod and kernel yield) **in zone IIIa** (Maharashtra, Karnataka); and **J 94** (with 3293 kg/ha of pod and 2283 kg/ha kernel yield in **Zone IIIb** (Tamil Nadu, Telengana, Andhra Pradesh) and **KGL 1322** (with 3047 kg/ha of pod and 2182 kg/ha of kernel yield) for Zone IIIb and Zone IV (Odisha, West Bengal, Manipur) were promoted to AVT based on their superiority over the best check of their respective zone and are currently in verge of their evaluation.

### 6. Breeder Seed Production

- During *kharif* 2018, DAC indents to the tune of 10458.91q of breeder seeds were received for 48 groundnut varieties. Based on the availability of nucleus / breeder seed stage I, a production target of 10167.23q was assigned for 46 groundnut varieties to 21 centres. During *kharif* 2018, a total quantity of 2940.55q breeder seed could be produced. To mitigate the short fall, a compensatory programme was undertaken during *rabi*-summer 2018-19 and the anticipated production is about 6382.50q. Thus, the total expected production of groundnut breeder seeds during 2018-19 would be 9323.05q.

## II. Crop Production

### *Kharif* 2018

### 1. Effect of paclobutrazol on growth and productivity on rain fed groundnut

The experiment was conducted at Bhubaneswar and Shirgaon during kharif, 2018. At Bhubaneswar single spraying at 30DAE of Paclobutrazol @100ppm gave significantly higher dry pod yield. While at Shirgaon double spray of paclobutrazol @ 100 ppm at 30 and 50 DAE gave significantly higher pod yields (2619 kg/ha)

2. **Evaluation of DAPG-producing fluorescent pseudomonads for enhancing nutrient use efficiency, biocontrol of soil-borne diseases and yield of groundnut**

The experiment was conducted at Raigarh during kharif, 2018. Application of DAPG 1 gave the highest dry pod yield but was found to be non-significant.

3. **Studies on tank mix application of post-emergence herbicides for efficient weed control in groundnut**

The experiment was conducted at Mohanpur during kharif, 2018. Significantly highest pod yield was found with weed free check followed by farmers practice (Hand weeding at 15 and 30 DAS), which was at par with the application of pendimethalin as pre-emergence along with tank mix of imazethapyr and quizalfop ethyl either 50: 50 or 60:40. Weed control efficiency was found maximum with tank mix application of Imazethpyr (60%) + Quizalofop ethyl (40%)

4. **Identification of rainfed groundnut+millet intercropping system for red soils of Karnataka**

The trial was conducted at Dharwad and Hiryur during kharif, 2018. At Dharwad significantly higher ground nut pod equivalent yield was obtained with groundnut + little millet (4:2) while at Hiriyur sole groundnut gave significantly higher groundnut pod equivalent yield.

5. **Response of *kharif* groundnut to plant geometry and fertility levels**

The trial was allotted at Bawal, Gwalior, Raigarh and Jodhpur during *kharif*, 2018. Bawal centre did not report any result. At Gwalior 75% RDF gave the significantly higher pod yield with plant population @ 3.33 lakh $ha^{-1}$ (30 x 10 cm) but plant population treatment did not have any significant effect on pod yield. At Raigarh 125 % RDF and Plant population @ 3.33 lakh $ha^{-1}$ recorded the highest pod yield but found to be non-significant. At Jodhpur significantly higher pod yield was observed with 125 % RDF while plant population @ 4 lakh $ha^{-1}$ gave highest pod yield without having significant effect on pod yield.

6. **Alleviation of moisture deficit stress in groundnut by application of endophytic bacteria**

The experiment was conducyh6ted at Akola, Durgapura, Hiryur, Kadiri and Tirupati during *kharif*, 2018. At Akola significantly higher dry pod yield was recorded with any DGREB Culture with normal inter-culturing while at Durgapura DGREB-1 with suggested inter-culture operations gave the highest dry pod yield but did not have any significant effect. At Hiriyur, DGREB-3 (i/c 15 days interval) obtained significantly higher pod yield. At Kadiri significantly higher yield was gained with DGREB-2 and at Tirupati DGR Endophytic Bacteria 1 (DGREB 1) with normal inter cultural operations provided highest pod yield without having significant effect.

7. **Standardization of sowing depth of groundnut crop in light soils of hyper arid regions**

The trial was conducted at Bikaner during kharif, 2018. Significantly higher pod yield was obtained with 7 cm depth of sowing.

8. **Identification of remunerative groundnut-based cropping systems**

The experiment was conducted at Dharwad, Jalgaon, Junagadh and Vridhachalam. At Dharwad significantly higher groundnut pod equivalent yield was obtained with

Ground-nut+Cotton (4:2) cropping system. At Jalgaon signifi-cantly higher groundnut pod equivalent yield was found with Groundnut +Pigeonpea (4:2) cropping system. At Junagadh significantly higher groundnut pod equivalent yield was found in Groundnut-coriander cropping sequence. At Vridhachalam significantly higher groundnut pod equivalent yield was obtained with groundnut-groundnut cropping sequence.

### 9. Application of bio-formulations in *kharif* groundnut production

The experiment was conducted at Dharwad, Durgapura, Gwalior, Jalgaon, Junagadh, Kadiri, Jhargram, Shirgaon and Tirupati. At Dharwad, Durgapura and Jalgaon, Junagadh, Kadiri, Jhargram, Shirgaon and Tirupati significantly high dry pod weight was found with application of 100 % RDF and at Gwalior highest pod yield was found with 75% RDF but was non-significant. At Durgapura, Jalgaon, Kadiri and Tirupati significantly high dry pod weight was obtained with Bio-Grow bio-formulation. At Dharwad, Gwalior, Junagadh, Jhargram and Shirgaon significantly high dry pod weight was found with application of NPK liquid formulation+Zn solubilizing bacterial bio-formulation.

### 10. Integrated water management in rainfed groundnut

The experiment was conducted at Bhubaneswar, Gwalior, Jalgaon, Kadiri and Palem. At Bhubaneswar and Gwalior application of hydrogel @ 2.5 kg/ha along with mulching of agrowaste / weed biomass @ 5 t/ha recorded significantly higher pod yield. At Jalgaon, Kadiri and Palem application of hydrogel 2.5kg/ha + mulching 5 t/ha + use of endophytic bacteria recorded higher dry pod yield which was at par with application of hydrogel @ 2.5 kg/ha along with mulching of agrowaste/weed biomass @ 5 t/ha.

### 11. Identifying suitable crop geometries for mechanical interculturing in Spanish bunch type groundnut

The trial was conducted at Jalgaon, Junagadh and Bikaner. At Jalgaon, intercropping of groundnut + pigeon pea (3:1 row proportion) (60/30/30 cm) recorded significantly higher groundnut pod equivalent yield which was at par with intercropping of groundnut pigeon pea (2:1 row proportion) (60/30 cm). At Junagadh, groundnut-pigeonpea intercropping-2:1 (60/30 cm) recorded significantly higher groundnut pod equivalent yield. At Bikaner different crop geometries did not have any significant effect on groundnut pod yield. Bhubaneswar and Hiriyur did not report any data.

### 12. Developing Conservation Agriculture practices in groundnut-wheat cropping system

The trial is in progress at Bikaner, Durgapura, Jalgaon and Ludhiana

### 13. Improving phosphorus use efficiency in kharif groundnut with microbial cultures

The trial was conducted at Bikaner, Hiriyur, Junagadh, Ludhiana, Jhargram, Puducherry, Tindivanam and Vridhachalam. At Bikaner significantly highest pod yield was recorded with application of 60 kg $P_2O_5$ with or without DGRC culture. At Hiriyur, application of 40 kg/ha of P + DGRC culture recorded significantly higher dry pod. At Junagadh, different phosphorus doses alone and in combination with DGRC culture did not have any significant effect on pod yield. At Ludhiana, applica*-tion of FYM @ 2.5 t/ha+ DGRC culture recorded significantly higher pod yield. At Jhargram, Puducherry and Vridhachalam, application of 60 kg $P_2O_5$/ha+ DGRC recorded significantly higher pod. At Tindivanam significantly higher pod yield was recorded with application of application of 60 kg/ha of P, which was at par with application of 40 kg/ha

of P + DGRC culture. Jalgaon centre did not report any data

### 14. Identification of most profitable groundnut based intercropping systems under rain fed situation

The experiment was conducted at Tindivanam Centre. Groundnut + cotton intercropping system reported significantly higher groundnut pod equivalent yield and BCR of 3.2.

### 15. Integrated weed management in *kharif* groundnut

The experiment was conducted at Dharwad, Durgapura, Gwalior, Hiriyur, Jodhpur, Puducherry, Raigarh, Tindivanam, Tirupati and Vridhachalam. At Dharwad, Hiriyur, Raigarhand Vridhachalam, significantly higher dry pod yield obtained with treatment pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + manual weeding at 25-30 DAS. At Durgapura, Jodhpur and Tirupati, two manual weedings at 25 and 40 DAS recorded significantly higher dry pod yield. At Gwalior and Puducherry application of pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + quizafop – p- ethyl @ 50 g/ha at 15-20 DAS recorded significantly highest pod yield. At Tindivanam, significantly higher dry pod yield was recorded with application of Pendimethalin@ 0.75 or 1.0 kg/ha PE* + Imazethapyr@ 75 or 100* g/ha at 15-20 DAS.

### 16. Optimization of seed rate for groundnut cultivars having differential seed sizes

The experiment was conducted at Bikaner, Bhubaneswar, Jalgaon and Junagadh. At Bikaner significantly higher pod yield was obtained with HNG-10 @ 210 kg $ha^{-1}$ and Mallika @ 240 kg $ha^{-1}$. At Bhubaneswar, significantly higher pod yield was obtained with Dharani (seed rate as calculated by considering HKW and recommended plant population) followed by ICGV 00351. At Jalgaon, significantly higher pod yield was recorded by Phule Morna (2538kg/ ha) which was remain at par with Phule Warna and JL-776 (seed rate as calculated by considering HKW and recommended plant population). At Junagadh significantly higher pod yield was recorded by GJG 32 (Bunch type, 45cm x 10cm) (seed rate as calculated by considering HKW and recommended plant population).

### 17. Agronomic management of AVT

The experiment was conducted at Bhubaneswar and Tirupati. At Bhubaneswar Variety GNH 804 recorded significantly higher pod yield with RDF (25-50-50) N, $P_2O_5$, $K_2O$/ha (N in 2 splits, 80% basal, 20% TD) at 25DAS.

At Tirupati, among the entries, Dh-256 has recorded significantly higher per hectare pod (2872 kg), kernel (1703 kg), haulm (5087 kg) over local check Dharani which recorded 1493 kg, 1035 kg and 4968 kg pod, kernel and haulm yield per hectare respectively.

## *Rabi*-Summer 2017-18

### 1. Evaluation of DAPG-producing fluorescent pseudomonads for enhancing nutrient use efficiency, bio-control of soil-borne diseases and yield of groundnut.

The experiment was conducted at Puducherry, Rahuri, Tindivanam, and Tirupati during *rabi*-summer, 2017-18. At Pudducherry and Rahuri DAPG-producing fluorescent pseudomonads FP 86 and at Tindivanam and Tirupati DAPG 4 was found to give significantly higher pod yield.

### 2. Standardization of potash levels and apportioning time in summer groundnut under drip irrigation.

The experiment was conducted at Rahuri and Junagadh during *rabi*-summer, 2017-18. At Rahuri application of 30 kg/ha K2O in 10 equal splits while at Junagadh application of 50 kg/ha K2O in 8 equal splits produced significantly highest pod yield.

### 3. Economizing phosphorus use in groundnut production by exploiting phosphorus build up in soil.

The experiment was conducted at Bhubaneswar, Dharwad, Jagtial, Jalgaon, Junagadh, Kadiri, Mohanpur, Puducherry, Rahuri, Raigarh, Shirgaon, Tindivanam, Tirupati, Vridhachalam during *rabi*-summer, 2017-18. Application of FYM @ 5t/ha +100 % RDP+DGRC 2 was found to give significantly higher pod yield at Jalgaon, Kadiri, Mohanpur, Puducherry, Shirgaon, Tindivanam, Tirupati, and Vridhachalam while application of FYM @ 5t/ha +100 % RDP+DGRC 2 gave significantly higher pod yield at Dharwad. At Bhubane-shwar application of FYM @ 5t/ha +50 or 100 % RDP + DGRC 2; at Junagadh FYM @ 5t/ha +50 % RDP+DGRC 2; and at Rahuri FYM @ 5t/ha +100 % was found at par with FYM @ 5t/ha +50 % RDP+DGRC 2.

### 4. Fertilizer recommendation based on targeted yield concept for groundnut under alluvial zone of West Bengal

The trial was allotted at Mohanpur center for *rabi*/ summer 2017-18 but the centre has not reported results.

### 5. Studies on tank mix application of early post emergence herbicide for efficient weed control in groundnut

At Pudducherry the highest pod yield (4735 Kg/ha) was observed with application of Pendimethalin @1.5 kg ai/ha (PE) + tank mix of Imazethpyr (50%)+Quizalofop ethyl (50%) at 20- 30 DAS which was followed by Pendime-thalin @ 1.5 kg ai/ha (PE)+ tank mix of Imazethpyr (60%)+ Quizalofop ethyl (40%) at 20- 30 DAS (4496 Kg/ha). While Tindivanam, pre-emergence application of Pendimethalin @ 1.5 kg a.i/ha (PE) followed by 50 % tank mix application of each of Imazethapyr @ 37.5 g a.i/ha + Quizalopfop ethyl @ 25 g a.i/ha at 20-30 DAS as early post-emergence was found effective for weed management and higher yield (2244 kg/ha) of groundnut.

### 6. Evaluation of suitable varieties with nutrient levels for potato- groundnut system.

The trial was allotted at Deesa, Mohanpur and Mainpuri centers for *rabi* / summer 2017-18 but only centre has reported the results.

### 7. Irrigation Management in Potato- Groundnut Systems in light soils.

The trial was allotted at Deesa, Mohanpur and Mainpuri centers for *rabi* / summer 2017-18 but none of the centres have reported results.

### 8. Efficacy of herbicide application on groundnut under rice-fallow.

The trial was allotted at Akola, Bhubanswar, Dharwad (Kumta), Kadiri (Vijayanagaram), Mohanpur, Raigarh, Tindivanam, Vridhachalam for *rabi*-summer 2017-18 and all the centres except Kadiri (Vijayanagaram) and Raigarh have reported the results. At Akola significantly highest dry pod yield (2084 kg ha-1) was gained from weed free check and followed by two hand weeding treatment. Whereas among the herbicidal treatments application of Pendimethalin 30 % E.C @ 1.5 kg a.i. ha-1 (Pre E) + Imazethapyr 10 % S.L @ 75 g a.i. ha-1 (Post E) at 20-30 DAS recorded superior dry pod yield (1724 kg ha-1) than the application of Pendimethalin 30 % E.C @ 1.5 kg a.i. ha-1 + Quizalofop-p-ethyl 5 % E.C @ 50 g a.i. ha-1 at 20-30 DAS. At Bhubaneswar best herbicidal response to weed density and weed dry matter was observed from application of Pendimethalin 30% EC@1.5 kg/ha+ 1 HW(25 DAS) as well as with 2 HW(20 and 40 DAS). At Dharwad Significantly higher dry pod yield obtained with weed free treatment(2603 kg ha-1) which was at par with pendimethalin 30% E.C. @ 1.5 kg a.i./ha + One hand weeding at 25 DAS (2457 kg ha-1). Further, pendimethalin 30% E.C. @ 1.5 kg a.i./ha + One hand weeding at 25 DAS(2457 kg

ha-1) was at par with pendimethalin 30% E.C. @ 1.5 kg a.i./ha + quizalfop-p-ethyl 5% E.C.@ 50 g a.i./ha at 20-30 DAS(At 2-5 leaf stage weeds) (2345 kg $ha^{-1}$) and pendimethalin 30% E.C. @ 1.5 kg a.i./ha + imazethapyr 10% S.L. @ 75 g a.i./ha at 20-30 DAS(At 2-5 leaf stage weeds) (2334 kg $ha^{-1}$). At Mohanpur The highest pod yield (2963 kg ha-1) was obtained with the treatment Weed free which was significantly superior to rest of the treatments. But chemical weed controls increased the pod yield a tune of average 26 % and maximum was 36 % over un-weeded control. At Tindivanam application of Pendimethalin @ 1.5 kg a.i / ha (PE) + Tank mix Imazethpyr (50%) + Quizalopfop ethyl 50 (50%) at 20-30 DAS resulted in higher groundnut pod yield. At Vridhachalam Application of Pendimethalin 30% EC @ 1.50 kg a.i/ha + one hand weeding at 25 DAS recorded higher pod yield (2785 kg/ha) and it was statistically superior to the rest of the herbicide combination treatments.

### 9. Agronomic practices for Rice-fallow groundnut.

The trial was conducted at Dharwad (Kumta), Kadiri (Vizianagaram), Mohanpur, Puducherry, Raigarh, Shirgaon, Tindivanam, Vridhachalam during and all the centres except Kadiri (Vizianagram) and Raigarh have reported the results. At Dharwad groundnut variety Dh-101 recorded higher dry pod yield(2592 kg $ha^{-1}$) and haulm(2638 kg $ha^{-1}$) yield than Dh-86(2412 kg $ha^{-1}$ and 2563 kg $ha^{-1}$), respectively. At Mohanpur, TAG24 and TG51remained at par with respect to pod yield. The groundnut variety TKG Bold recorded significantly higher pod, kernel and haulm yield (2599, 1897 and 2714 kg $ha^{-1}$, respectively) over groundnut variety Konkan Gaurav (2269, 1674 and 2401 kg $ha^{-1}$, respectively). At Tindivanam, higher growth and yield parameters were observed in TMV 13 under rice fallow groundnut system over TMV 7. At Vriddhchalam, VRI 8 produced higher pod yield over VRI 7. At Dharwad (Kumta), Mohanpur, Shirgaon, and Vridhachalam application of 125 % RDF + Rhizobium gave significantly higher pod yield while at Tindivanam application of 100 % RDF + Rhizobium gave significantly higher pod yield.

### 10. Application of bio-formulations in *rabi*-summer groundnut production.

The trial was conducted was at Akola, Dharwad, Jalgaon, Junagadh, Kadiri, Mohanpur, Rahuri, Tirupati for *rabi*-summer 2017-18 and all the centres except Akola have reported the results. Application of 100 percent RDF was found to produce significantly higher yield over rest of the treatments at all the centres. At Tirupati, yield levels were comparable with the application of 100 percent and 75 percent RDF. At Dharwad and Mohanpur, application of NPK liquid formulation + Zn solubilizing bacteria produced significantly higher pod yield over biogrow and control. At Jalgaon and Rahuri, significantly higher pod yield was obtained with the application of biogrow. While at Junagadh, the yield levels were at par with the application of NPK liquid formulation + Zn solubilizing bacteria and biogrow. However, at Tirupati no significant effect of application of bioformulations was observed on pod yield of groundnut.

### 11. Effect of foliar application of water soluble fertilizer on growth, yield and nutrient uptake of summer groundnut.

The trial was conducted at Jalgaon, Junagadh, Puddducherry and Rahuri centres during *rabi*/summer 2017-18. At Jalgaon and Rahuri, application of 75% RDF+2% WSF at 45,60,75 DAS while at Junagadh and Pudducherry application of 75% RDF+

1.5% WSF at 45,60,75 DAS produced significantly higher pod yield over control.

### 12. Agronomic management of AVT

No AVTs were conducted by any center during *rabi*/ summer 2017-18.

## III. CROP PROTECTION

Altogether 21 trials, 9 during *rabi*-summer 2017-18, 12 during *kharif* 2018 from entomology and pathology were conducted. The highlights with five recommendations from the research of selected centres are presented:

### ENTOMOLOGY (*Kharif*)

❖ **Insect-pests' situation:**

Incidence of sucking pest and defoliators was recorded throughout the centres. *Spilarctia ablique* was observed during the entire cropping season with defoliation per cent of 2.5 to 5.5. at Dharwad. The maximum damage by *Spodoptera litura* Fab. and leaf miner was noticed during 45-75 days of crop growth wherein, *Spodoptera* damage ranged from 15-35 percent at Raichur. Latur recorded highest population of leaf hopper ranging from 5 to 25 leaf hoppers/3 leaves with damage of 25 per cent. Whereas, the population of thrips ranged from 5 to 22 leaf hoppers/3 leaves damage 16.8 thrips/3 leaves. *Helicoverpa* and leaf miner ranged between 20 and 15 per cent in farmers field respectively.

- **Occurrence of natural enemies:**

Natural enemies observed during *kharif* season were predatory Coccinellids, spiders and green lace wings from Latur, Pavagada, Raichur, Vridhachalam and being maximum at Dharwad. *Nomuraea rileyi* was recorded at Dharwad causing mortality of *Spodoptera* larvae being peak during September (6.5-17%). The birds observed were mina, black dungro and cattle egret, and the major parasitoids recorded were *Apanteles sp.and Campoletis chlorideae.*

- **Monitoring of *Spodoptera*, *Helicoverpa*, leaf miner and sucking pest of groundnut:**

Peak *Spodoptera* moths of 182 during 32$^{nd}$ standard week at Dharwad while in Latur it was 38$^{th}$ standard week, in Raichur 45$^{th}$ standard week (84.2 moths/ trap), and Vridhachalam observed three peak catches on 27 SMW, 28 SMW and 32 SMW. The highest (26 adults) numbers of *Helicoverpa* were caught during 39$^{th}$ SMW at Latur and Raichur. However, leaf miners noticed were more (4.8/trap) during 38$^{th}$ standard week at Raichur. Leafhoppers, in yellow sticky trap were maximum on 33 and 34 SMW (16.4 and 15.4 hoppers/trap/day/acre) and there after declined to 8.6 hoppers/trap/day/acre on 39 SMW at Vridhachalam.

- **Screening for resistance to insect pests:**

ISK-I-2018-18 and ISK-I-2018-29 was found promising against defoliators and sucking pests at Dharwad; leaf hopper, *Spodoptera* and leaf miner in Latur, and for leaf miner at Vridhachalam. ISK-I-2017-09 was effective against thrips at Dharwad, leaf hopper, *Spodoptera* at Latur. ISK-I-2017-20 had recorded lower damage score against Thrips at Dharwad, leaf hopper and *Spodoptera* at Latur.

- **Management of root-feeders in groundnut:**

➢ Seed treatment with Chlorpyriphos @12ml/kg or Imidacloprid 600FS @2ml/kg were found effective in managing white grub species from 63-72% at Junagadh (Gujarat) with ICBR of 1:48 and 83-92% at Dharwad (Karnataka) with ICBR of 1:34.9

### PATHOLOGY (*Kharif*)

- **Diseases situation:**

Monitoring of major diseases at farmers' field and research stations was reported. Maximum Late leaf spot (LLS) was reported from Aliyarnagar (7 scale) followed by Dharwad (7-9 scale), Junagadh (4-6) Ludhiana and Vridhachalam

(5-7). Early leaf spot (ELS) was moderate at Dharwad (2-5 scale) and low in other research stations. Rust was maximum at Aliyarnagar (7 scale) followed by Dharwad and Vridhachalam (5-7). Maximum Alternaria leaf blight (ALB) was reported from Vridhachalam (5 scale), Junagadh and Pavagada (3-4 scale). Collar rot from Vridhachalam (15-20%), Bikaner and Junagadh (10-14%). Dharwad and Vridachalam reported stem rot incidence of 30%. PBND was reported from Raichur (32-82%) and Pavagada (13%). Dry root rot was recorded high at Raichur (12-29%) and Kadiri (24-36%). PSND was reported from Kadiri (16-36%). Collar rot was maximum at Vridhachalam (21%).

- **Screening of IVT-I & AVT and other coordinated trial material for resistance / tolerance to major diseases:**

Among genotypes screened, ISK-I-2018-18 was promising to rust and LLS at Aliyarnagar, Jalgaon and LLS at Junagadh and Vridhachalam. ISK-I-2018-29 showed resistance to rust and LLS at Aliyarnagar; LLS, stem rot and dry rot in Junagadh. IVK-I-2018-9 showed resistance to rust and LLS at Aliyarnagar and collar rot incidence in Bikaner. ISK-I-2018-10 (rust and LLS) Aliyarnagar and LLS at Vridhachalam. ASK-2018-7 showed resistance to rust and LLS at Aliyarnagar and stem rot (Junagadh) and collar rot (Kadiri). LSVT-II-2017-9 showed resistance to rust and LLS at Aliyarnagar and to collar rot and stem rot at Jalgaon. IVK-I-2018-6 was resistant against LLS at Dharwad; collar rot, stem rot, LLS and rust at Junagadh and LLS at Kadiri, and ELS, LLS, soil borne and PBND at Raichur. ISK-I-2017-30 was resistant to LLS at Dharwad; dry root rot (DRR) at Kadiri. IVK-I-2017-3 had resistance to LLS at Dharwad and DRR at Kadiri. IVK-I-2017-27 showed resistance to LLS at Dharwad and was free from collar rot at Junagadh and Kadiri. ISK-I-2018-3 was found to be resistant against collar rot, stem rot, leaf spots and rust at Jalgaon, and collar rot at Kadiri. ISK-I-2018-4 was found resistant to collar and stem rot at Jalgaon and ELS, LLS and PBND at Raichur. ISK-I-2018-18 was resistant to LLS and rust at Jalgaon and stem rot at Vridhachalam. IVK-I-2018-13 exhibited resistance to collar rot, stem rot, LLS and rust at Jalgaon, collar rot and stem rot at Junagadh and ELS, LLS, soil borne diseases and PBND in Raichur. ISK-2018-1 was resistant to collar rot and LLS at Junagadh. ASK-2018-9 was free from stem rot in Vridhachalam and ELS, ALB and soil borne diseases in Raichur.

- **Validation of Management Modules for soil borne diseases:**

The module $T_4$ was used as check and next best performing module was $T_6$ at Kadiri, Dharwad, Raichur, and Vridhachalam. {T6: Deep summer ploughing with mould board plough + Soil application of *Trichoderma* @ 4 kg/ ha enriched in 250 kg FYM/ha+Seed treatment with Tebuconazole 2DS @ 1.5 g/ kg of seeds + Soil application of *Trichoderma* @ 4 kg/ ha enriched in 250 kg FYM/ha at 35 and 70 DAS}. At Aliyarnagar, T2 {Deep summer ploughing with mold board plough+ Soil application of *Trichoderma* @ 4 kg/ ha enriched in FYM+ Seed treatment with *Trichoderma* @ 10g/ kg of seed+ Soil application of *Trichoderma* @ 4 kg/ ha enriched in FYM at 35 days after sowing (DAS)}.

- **Management of major foliar diseases:**

➢ (T4) Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seeds followed by Tebuconazole 50% + Trifloxystobin 25% WG @ 1.32 g/L (0.035%) at 40 and 65 DAS in managing LLS (75%), Rust (65%) at Dharwad (Karnataka) with ICBR of 1:10; ELS (68%), LLS (70%), Rust (67%) at Pavagada (Karnataka) with ICBR of 1:8; and ELS (68%), LLS (60%) at Raichur (Karnataka) with ICBR of

1:1.9. LLS (61%), Rust (52%), ALB (46%) at Vridhachalam (Tamilnadu) with ICBR of 1:3.97

- **Management of different insect pests and diseases through integration of different IPM modules:**

➢ Module 1: Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg seed + Border crop with bajra (3 or 4 rows) + Need based spray of Thiodicarb 75 WP @ 1 g/L for defoliator 50-70 DAS + Need based spray of Hexaconazole 5 EC @ 1 mL/L 50-70 DAS was effective at Dharwad (Karnataka) in managing diseases like Stem rot (60%), LLS (63%), Rust (64%) with ICBR of 1:8.3. At Raichur (Karnataka) it was effective in managing diseases viz. collar rot (56%), Stem rot (35%), Dry root rot (46%), ELS (9%), LLS (28%) with ICBR of 1:9.2

## ENTOMOLOGY (*Rabi*-Summer)

- **Insect – pests' situation:**

Sucking pests were observed in all the centres while leaf miner, *Spodoptera* were observed at Kadiri. Moderate to high incidence of thrips was recorded at Dharwad, Junagadh, Kadiri (1-7 scale), Raichur (4.6/terminal bud) and Vridhachalam (6/leaflet). *Spodoptera litura* damage was severe (6-8) in farmers' field of Vridhacha-lam Leafhopper and leaf miner infestation was recorded at Kadiri (1-8). *Helicoverpa armigera* incidence was high at Vridhachalam and moderate at Dharwad and Kadiri.

- **Occurrence of natural enemies:**

The predatory insects such as Coccinellids and spiders were observed at Dharwad, Vridhachalam (1/plant) and Kadiri @ 1-4/4 sqm area. *Apanteles* and *Compoletis chlorideae* (2-10%) was observed at Kadiri parasitizing on Spodoptera, *Helicoverpa* and leafminer. In Raichur *Chelonus* sp. was noticed in the 9th standard week parasitizing leaf miner.

- **Monitoring of *Spodoptera*, *Helicoverpa*, Leaf miner and sucking pests of groundnut using traps (pheromone or sticky traps):**

The highest *Spodoptera* was recorded (103/ trap) at 51st standard week in Raichur, and (6.6/day) trap at 3rd standard week in Junagadh. The peak incidence of leaf hopper was recorded (80.2/trap/week) at 52th week at Kadiri, which also recorded Leaf miner (15.6/trap) at 12th standard week.

- **Screening for resistance to insect pests:**

INS-I-2016-07 and INS-I-2016-08 recorded lower damage of thrips and leaf hopper at Dharwad, Leafhopper and *Spodoptera* at Kadiri. INS-I-2016-01 was found effective for *Spodoptera* at Dharwad, for thrips at Junagadh and for Leafhopper at Kadiri. RSWUE- 2016-2 was efficient against leaf hopper (Dharwad) and Leafhopper & *Spodoptera* (Kadiri). INS-I-2016-6 and INS –I-2016-26 had lowest thrips damage at Junagadh and Leafhopper and *Spodoptera* damage at Kadiri. INS-I-2016-5 was resistant to thrips in Junagadh, Leafhopper and leaf miner at Kadiri. INS-I-2016-11 was resistant to thrips in Junagadh and leaf miner at Kadiri. INS-I-15 and INS-I-2016-23 was resistant to thrips ad Leafhopper at Junagadh and Kadiri. INS-I-2016-8, 23, 27, 28, 29 were resistant to Leafhopper and *Spodoptera* at Kadiri. INS-I-2016-2, 6, 9, 10. 21, 23, 26, 27, 28, 29 were resistant to Leafhopper and leaf miner at Kadiri.

- **Management of groundnut defoliator pests using botanicals:**

➢ Pongamia oil @ 3 ml/l or Azadirachtin 3% @ 3 ml/lit or Neem oil @ 3.0 ml/lit or Pongemia oil 50% plus Neem oil 50% @ 3 ml/l were found effective in managing defoliators viz. 31-41% (Spodoptera), 38-44% (Leaf Miner), 30-33% (*Helicoverpa armigera*) at Kadiri (Andhra Pradesh) with ICBR of 1:2.37. At Vridhachalam (Tamil-nadu) it reduced 68-79%

*Spodoptera* with ICBR of 1:3.60, and 50-60% of Leaf Miner at Raichur (Karnataka) with ICBR of 1:6.73.

## PATHOLOGY (*Rabi-Summer*)

- **Monitoring of major diseases of groundnut:**

  The experiment was conducted at Aliyarnagar, Dharwad, Jalgaon, Junagadh, Kadiri, Raichur, Pavagada and Vridhachalam. ELS, LLS and ALB had moderate infection and ranged between 2 -7 across all the centres. Stem rot and root rot ranged between 10-22% at Aliyarnagar (22%). PBND was highest at Raichur (16-32%).

- **Screening of IVT-I & II, AVT and other coordinated trial material for resistance/ tolerance to major diseases:**

  INS-I-2017-11 showed resistance to both rust and LLS at Aliyarnagar, stem rot at Dharwad, DRR at Kadiri. INS-I-2017-27 showed resistance to rust and LLS at Aliyarnagar, collar rot at Jalgaon. INS-I-2016-12 showed resistance to rust and LLS at Aliyarnagar, stem rot at Dharwad and Kadiri. INS-I-2016-13 showed resistant to rust and LLS at Aliyarnagar, collar rot at Junagadh. INS-I-2016-18 was resistant to rust and LLS at Aliyarnagar, stem rot at Dharwad. INS-I-2016-20 was resistant to rust and LLS at Aliyarnagar and stem rot at Junagadh. INS-I-2016-23 was resistant to rust and LLS at Aliyarnagar, stem rot at Juangadh. AVT-II-2016-6 was resistant to rust and LLS at Aliyarnagar and collar rot at Jalgaon. INS-I-2017-3 recorded less incidence of stem rot in Dharwad and ALB at Kadiri. INS-I-2017-7 showed resistance to stem rot at Jalgaon, DRR and ALB at Kadiri. RSWUE-II-2016-6 and RSWUE-2016-7 were found promising against collar rot (Jalgaon) and stem rot (Kadiri). RSWUE-2016-8 was free from stem rot at Jalgaon and PBND at Kadiri. INS-I-2017-10 was found free from collar rot at Jalgaon and ALB at Kadiri. INS-I-2017-21 was free from stem rot at Junagadh and ALB at Kadiri. INS-I-2017-6, 16, 21 shown resistances to ALB at Kadiri and collar rot at Raichur. INS-I-2017-26 had low incidence of ALB and DRR at Kadiri. INS-I-2017-12 was free from stem rot and PBND at Kadiri. INS-I-2016-16 was free from stem rot and DRR at Kadiri. INS-I-2016-26 and RSWUE 2016-7 were free from DRR and PBND at Kadiri.

- **Management of PBND through integration of different modules:**

  ➢ (Module II) Border crop with bajra (4 rows) + Seed treatment with Imidacloprid 600 FS @1 mL/Kg seeds + Foliar sprays using Thiocloprid 480 SC @ 0.3 mL/L at 20-25 DAS followed by Fipronil 5SC @ 1mL/L @ 40DAS and Acetamaprid 20 SP @ 0.2 g/L at 60 DAS) in managing thrips and PBND with thrips damage of 52% and PBND incidence of 62% at Kadiri (Andhra Pradesh) with ICBR of 1:2.7. At pavagada (Karnataka) it reduced thrips damage of 63% and PBND incidence of 66% with ICBR of 1:8.95. At Raichur (Karnataka) it reduced thrips damage of 36% and PBND incidence of 53% with ICBR of 1:8.65.

## IV. AICRP-G FLDs:

### FLD Results for *Kharif* 2018

- During *Kharif*- 2018 FLDs were allotted in 8 states having 13 groundnut research FLD centers. The states in which FLDs conducted were Gujarat, Karnataka, Maharashtra, Rajasthan, Manipur and West Bengal. The FLDs were allotted on Whole Package (WP). Among the 550 FLDs allotted, results were received for 342 FLDs from 8 centers, which indicated 62 per cent of implementation.
- There were 10 new varieties' production potential and profitability were compared with 8 old ruling varieties which are cultivated with farmers' traditional cultivation practices.
- The average pod yield achieved was 2032 kg/ha under improved whole package of practices, in which mainly,

new varieties were demonstrated. The old varieties performance observed was 1667 kg/ha with farmer's traditional practices. The yield increase observed was 23.9 per cent. The minimum yield difference observed was 11.9 percent and the maximum was 37.0 per cent.

- The average cost of cultivation with improved practice was Rs.58897kg/ha in comparison with Rs.54198 kg/ha with farmer's practice. The maximum observed was 129922 kg/ha in improved practice and 104082 kg/ha with farmer's traditional practice.
- The average Gross Marginal Returns with improved practice was Rs.98036/ha and Rs.78461/ha with respect to traditional practices. Net returns observed was Rs.59985/ha and Rs. 44177/ha for improved practice and farmer's practices respectively.
- The average B: C was 2.1 and 1.7 for improved practice and farmer's practices respectively.

### FLD Results for *rabi*-summer 2017-18

- The *rabi*-summer 2017-18 FLDs were allotted in 9 states having 18 groundnut research FLD centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Pradesh and West Bengal. The FLDs were allotted on Whole Package (WP) component. Among 300 FLDs allotted, from 13 centers results were received for 215 FLDs, which indicated 71 per cent of implementation.
- There were 11 new varieties' production potential and profitability were compared with 12 old ruling varieties which are cultivated with farmers' traditional cultivation practices.
- The average pod yield achieved was 2749kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 2219kg/ha with farmer's traditional practices. The yield increase observed was 25 per cent. The minimum yield difference observed was 12.4 percent and the maximum was 44.0 per cent.
- The average cost of cultivation with improved practice was Rs.45682/ha in comparison with Rs. 43197 / ha with farmer's practice. The maximum observed was Rs.86581/ha in improved practice and Rs.99228/ha with farmer's traditional practice.

  The average Gross Marginal Returns with improved practice was Rs. 116948/ha and Rs.931138/ha with respect to traditional practices. Net returns observed was Rs.63612/ha and Rs.45585/ha for improved practice and farmer's practices respectively. The average B: C was 2.5 and 2.1 for improved practice and farmer's practices respectively.

# 07 Externally funded projects

## 1. ICAR Seed Project on Seed Production in Agricultural Crops

***Nodal Officer & PI:***

*Dr. Narendra Kumar*

**Co- PI :**

*Mr. Ghous Ali, Scientist, Agronomy, Arid Regional Campus (ARC)-ICAR-CSWRI, Bichhwal Industrial Area, Bikaner*

***Funding Agency:***

*ICAR-Indian Institute of Seed Science, Mau-275103, Uttar Pradesh*

***Duration:*** *2017-2020*

***Fund outlay:*** *Rupees 8.40 Lakhs during 2018-2019*

### Summary

- Breeder seed production of Girnar-2 and Girnar-3 variety was taken in 5.0 ha and 14.5 at Bikaner and DGR, Junagadh respectively during 2018-19.
- Nucleus seed production of Girnar-2 and Girnar-3 variety was taken in 0.85 ha and 0.6ha. at Bikaner and DGR, Junagadh respectively during 2018-19.
- Produced a total 134.10q breeder seed of Girnar-2 (44.1q) and Girnar-3 (90.0q) variety during 2018-19.
- Produced a total 19.0q nucleus seed of Girnar-2 (10.5q) and Girnar-3 (8.5q) variety during 2018-19.
- Supplied a total 64.65q breeder seed of Girnar-2 (45.3q), Girnar-3 (19.35q) varieties to eight different indentors during 2018-19.
- Generated a revenue of rupees 10,11,618.00 from selling of the groundnut breeder seed and other produce.
- Groundnut fodder of 6.0 ha. area of Girnar-2 was handed over to ICAR-CSWRI-ARC, Bikaner.
- Organized one Groundnut farmers fair of 250 farmers of Junagadh district on 24th February 2019 at DGR Junagadh.

### Breeder Seed Production Achievement:

***Kharif* 2018:**

The DAC indent of breeder seed of Girnar-2 and Girnar-3 varieties was 4.0q and 117.7q respectively for *kharif*-2019, accordingly which was undertaken in *kharif*-18. Against the BSP-I/DAC indent, breeder seed production of Girnar-2 variety was taken up in 5.0 ha. at DGR-RRS, Bikaner and Girnar-3 in 14.5 ha. (Seeds unit: 9.7ha. and Farm section: 4.8ha.) area at DGR, Junagadh. Besides that nucleus seed production programme of Girnar-2 was also undertaken in 0.85ha at DGR-RRS, Bikaner and Girnar-3 in 0.6ha area at DGR, Junagadh. Under this project, seed unit produced 44.1q and 90.0q (Seeds unit: 51q and Farm section: 39q) breeder seed and 10.5q and 8.5.q nucleus seed of Girnar 2 and Girnar-3 variety respectively. Now there is enough

**Table-1: Variety-wise seed of different classes produced under ISP during *kharif*- 2018**

| Variety | Indent (q) | | Plot no. | Area sown (ha.) | | Total production (q) | Seed Production (q) | | |
|---|---|---|---|---|---|---|---|---|---|
| | DAC | BSP-I | | BS | NS | | Breeder Seed (BS) | Nucleus Seed (NS) | TFL Seed |
| Girnar-2 | 4.0 | 4.0 | RRS, BKN | 5.0 | 0.85 | 54.6 | 44.10 | 10.5 | -- |
| Girnar-3 | 117.7 | 50.0 | DGR, JND | 14.5 | 0.6 | 98.5 | 90.00 | 8.5 | -- |
| Total | **121.7** | **54.0** | | **19.5** | **1.45** | **153.10** | **134.10** | **19.0** | -- |

## HRD programmes and field visits

Groundnut farmers fair organized on 24th February at ICAR-DGR, Junagadh


Seed production field at DGR, Junagadh

Seed production field at DGR-RRS, Bikaner

BSP monitoring team from IISS, Mau

**Table 2:** Details of seed materials supplied during 2018-19.

| SN | Variety | No. of indentor | Breeder seed (q) | quality seed (q) | Resource generation (Rs) |
|---|---|---|---|---|---|
| 1 | Girnar-2 | 04 | 45.30 | 0.0 | 10,11,618.00 |
| 2 | Girnar-3 | 04 | 19.35 | 0.0 | |
| 3 | Girnar-3 | -- | 43.25* | 0.0 | |

*Disposed-off as general produce due to non lifting

**Table 3:** Details of HRD programme organized during 2018-19

| SN | Programme name | Date | No of farmers | Place of farmers |
|---|---|---|---|---|
| 1. | Groundnut farmers fair | 24th February 2019 | 250 | 15 village of Junagadh district |

nucleus seed of Girnar-2 and Girnar-3 to meet out demand of breeder/quality seed of Girnar-2 and Girnar-3 for the *kharif*-2020, which will be produce in *kharif*-2019.

### Distribution of seed/planting material

During 2018-19, seed unit has supplied a total 64.65q breeder seed of Girnar-2 (45.3q), Girnar-3 (19.35q) varieties to eight different indentors. Due to non-lifting of breeder seed of Girnar-3 variety (43.25q) was dispo-sed-off as general produce in the local market with the approval of the Director (Table-2).

### Resource generation

During 2018-19, seed unit has generated revenue of Rs. 10,11,618/- through supplied of a total 107.9q breeder seed of Girnar-2 and Girnar-3 varieties to the different indentors. Annual budget of Rs. 8.40 lakhs received under this project from the ICAR-Indian Institute of Seed Science, Mau during the period under report (01.04.2018 to 31.3.2019).

### Capacity building and technology dissemination

During the 2018-19, under HRD component of ICAR seed project organized a groundnut farmer fair on 24th February, 2019 at ICAR-DGR, Junagadh. About 250 farmers from 15 villages from Junagadh district participated in this mela. The aim this mela was to provide information on improved technology of groundnut cultivation.

## 2. Mapping of QTLs conferring resistance to peanut bud necrosis disease in groundnut

***PI:*** *Ms. Mital D. Jasani*
***Mentor:*** *Bera SK*
***Funding Agency:***
*DST under WOS-A scheme*
***Duration:***
*3 years (April 2018- March 2021)*
***Fund outlay:*** *Rs.21,55,200.00*

### Brief progress report of the project

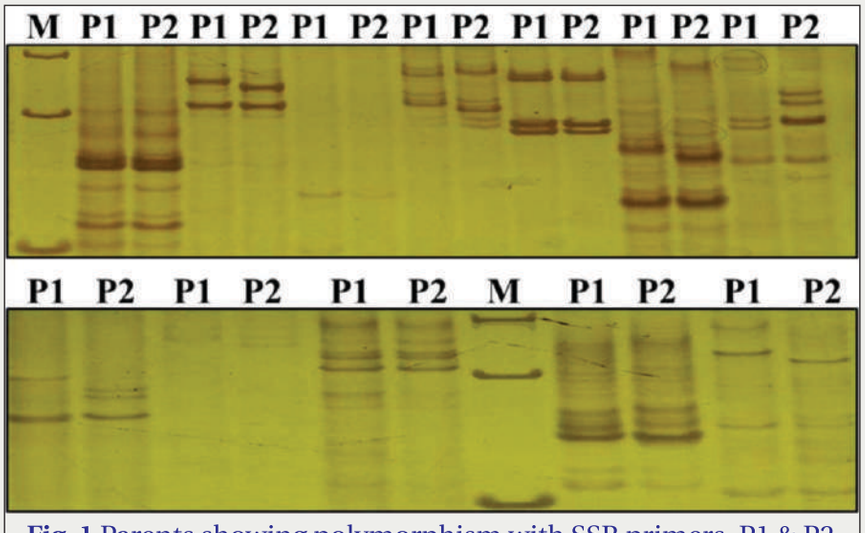



**Fig. 1** Parents showing polymorphism with SSR primers, P1 & P2 indicate JL-24 & NRCGCS-86 and M indicates 100bp DNA marker

- In *kharif* 2018, 260 RILs of JL-24 and NRCGCS 86 (F6) were multiplied for further use in phenotyping and genotyping
- Phenotyping of 260 RILs along with parents has been done under UAS, Raichir, a natural hot spot for PBND in Rabi 2019.
- A total 500 SSRs have been screened between the parents so far and 70 (14%) SSRs were found polymorphic between parents.

  Study of parental polymorphism with 1dditional 1500 SSRs is in progress.

### 3. Modelling insect pests and diseases under climate change and development of digital tools for pest management

***Centre-PI (DGR, Junagadh):***

*Thirumalaisamy PP*

***Centre Co-PI (DGR, Junagadh):*** *Harish G*

***Thematic Area:*** *Pest dynamics in relation to climate change in the national innovation on climate resilient agriculture (NICRA)*

***Funding Agency:*** *Ministry of Agriculture and Farmers' welfare, GoI through NICRA project*

***Duration:*** *2017-2020*

***Fund outlay:*** *Rs.18 lakh for three years*

#### Objectives

- Pest and disease dynamics, changes in crop-pest/ pathogen relationships, changed profile of insect pests and emergence of new biotypes due to climate change, and development of forewarning system

#### Summary – *kharif* 2018

- About 790 mm rain-fall was received from 24$^{th}$ to 38$^{th}$ metrological week falling in the second week of June to third week of September. Rain-fed sowing was taken in the first week of July. Outbreak of *Helicoverpa* and thrips was recorded in the *kharif* groundnut. Defoliation of groundnut by *Helicoverpa* sp. was severe and less damage by Spodoptera were recorded at the crop age of 45 to 55 days as temperature 32±2°C (max.) and 25±2°C (min.) and rain-fall (about 140mm evenly distributed from 30$^{th}$ to 38$^{th}$ std. week) which favored these pest. An average of 3-5 larvas per plant was recorded in unprotected farmers' fields. Thrips damage was recorded from 32$^{nd}$ std. week to 42$^{nd}$ std. week. At the time of subside of defoliators damage, severe damage by thrips was recorded due to increased temperature from 32±2°C (max.) to 37±2°C (max.) and zero precipitation from 39$^{th}$ std. weeks. Besides, jassids and aphids were recorded in few fields with low infestation.
- Foliar diseases (ELS and LLS) were not developed beyond 3 and 6 grade of 1-9 scale, respectively, during the crop period, due to increased temperature from 32±2°C (max.) to 37±2°C (max.) and zero precipitation from 39$^{th}$ std. week coinciding the crop age of 60 days to till harvest. Maximum disease severity of LLS was recorded at the crop age of 70-80 days, coinciding the std. week of 42-43.
- Farmers taken groundnut in pre-monsoon sowing was suffered with collar rot. The incidence of collar rot and stem rot was ranged from 0 to maximum of 4 plants out of 10 plants in few fields in the month of August (34$^{th}$ std. week).
- Special efforts were taken to manage the white grub damage in groundnut by ICAR-DGR. White grub damage in groundnut was well tackled by adopting prophylactic control measures (spray of insecticide on host trees and seed treatment with insecticides) by the famers.

### 4. All India network project on soil biodiversity-biofertilizers

***PI:*** *Pal KK*
***CO-PI:*** *Dey R*
***Funding agency: ICAR***
*Duration: 01.04.2017-31.03.2020*
***Fund outlay:*** *Rs. 11.00 lakh*

#### Objectives:

- Identification of drought- and salinity- tolerant rhizobia for enhancing BNF and yield of groundnut

**Table 1.** Evaluation of rhizobia under moisture-deficit stress (five alternate irrigations at 15 d interval from date of germination), cultivar TG37A (summer 2018)

| Treatment | PY (kg/ha) | HY (kg/ha) | NN/p |
|---|---|---|---|
| Control | 1961 | 4400 | 16.3 |
| NC92 | 2009 | 4753 | 23.2 |
| DGR-Rhi11 | 2099 | 4820 | 24.3 |
| DGR-Rhi19 | 2126 | 4580 | 20.3 |
| DGR-Rhi10 | 2036 | 4730 | 23.9 |
| DGR-Rhi17 | 2520 | 5050 | 32.6 |
| CD (0.05) | 208 | 332 | 5.1 |

- Microbial diversity in groundnut based cropping systems
- Development of formulation of bioinoculants

**Achievements:**

- Four groundnut rhizobia viz. DGR-Rhi10, DGR-Rhi11, DGR-Rhi17, DGR-Rhi19 along with standard isolate NC92 were evaluated with application of irrigation at 15 days interval after emergence. These rhizobia were capable of tolerating matric potential of -2.5 MPa to -3.5 MPa. Application of DGR17 significantly enhanced the pod yield, haulm yield, nodulation and shelling outturn (Table 1) of groundnut (cvTG37A).
- Seventy-seven rhizobia, tolerant to moisture-deficit stress, have been isolated and identified by 16S rRNA sequencing. Majority of them belonged to *Rhizobium* sp., *Rhizobium tropici* and *Ochrobactrum* sp.

## 5. Exploring the diversity of extreme halophiles by functional and comparative genomics for isolating novel genes and alleles for affording salinity tolerance to crop plants

***PI:*** *Pal KK*
***CO-PI:*** *Dey R*
***Funding agency:*** *ICAR through AMAAS project*
***Duration:*** *01.04.2017-31.03.2020*
***Fund outlay:*** *Rs. 31.64 lakh*

**Objectives:**

- To understand the biochemical and molecular bases of osmoadaptation and osmoregulatory mechani-sms of selected extreme halophilic bacilli, archaea and fungi on evolutionary perspective
- To identify candidate gene(s) having relevance to salinity tolerance for future exploitation in development of crops tolerant to salinity

**Significant Achievements:**

- Besides validation of expression of genes/enzymes linked to alternate carbon (survival and multiplication) in extreme haloarchaeon 3A1-DGR via the action of biocarbonate transporter (Bic), phophoenolpyruvate orthophosphate dikinase (PPDK), phosphoenolpyruvate carboxylase (PEPC) and

**Table 1.** Over-expression of genes of the enzymes linked to over-expression of serine-glyoxylate cycle

| Treatment | Genes/enzymes | | | | |
|---|---|---|---|---|---|
| | Serine-hydroxy-methyl transferase | Phospho-serine phosph-atase | Serine glyoxylate aminotra-nsferase | Methyl malonyl CoA mutase | Malate synthase |
| 3A1-DGR (10% NaCl) | 1.00$^{c}$ | 1.00$^{c}$ | 1.00$^{c}$ | 1.00$^{c}$ | 1.00$^{C}$ |
| TG37A 3A1-DGR (20% NaCl) | 4.79$^{b}$ | 9.23$^{b}$ | 12.05$^{b}$ | 10.18$^{b}$ | 11.12$^{b}$ |
| 3A1-DGR (30% NaCl) | 16.47$^{a}$ | 13.56$^{a}$ | 18.09$^{a}$ | 21.54$^{a}$ | 17.07$^{a}$ |

malate dehydrogenase (MDH) utilizing dissolved CO2 i.e. biocarbonate as carbon source and its subsequent modifications into malate when 3A1-DGR was grown at 30% of NaCl concentration as compared to when it was grown at 10% NaCl, the concpmmitant overexpression of Serine hydroxymethyl transferase, phosphoserine phosphatase, and serine-glyoxylate aminotransferase which will lead to production of glycine as osmoprotectant. Simultaneously, methylmalonyl CoA-mutase, ethyl malonyl- CoA mutase, malate synthase, etc. were also validated in real time by designing appropriate primers using genome sequence data. Over-expression of the genes responsible for the production of the above enzymes tanged from 4.79 fold to 12.05 folds at 20% NaCl and that at 30% of NaCl it varied from 13.56 folds to 21.54 folds for different enzymes (Table 1).

### 6. Marker-assisted gene pyramiding for foliar diseases and high oleic acid content in groundnut

***NPDF Fellow:*** *Tejas Bosamia*
***Mentor:*** *Chandramohan S*
***Funding Agency:*** *SERB, DST*
***Duration:*** *Two years (April 2017 to March 2019)*
***Fund outlay****: Rs.20 lakh for two years*

A total of four Advanced bac kcrossed lines (ABLs_216, ABLs_2, ABLs_44, ABLs_36) as female and one high oleic acid content advance backcrossed line (ABLs_5841) as male were selected based on presence of linked markers for foliar disease resistant and high oleic acid content respectively. The hybridizations between four ABLs_216, ABLs_2, ABLs_44, ABLs_36 with ABLs_5841 were generated a total of 61 individual $F_1$ plants. Of which 41 (~67%) were confirm true hybrid based on CAPs marker. The true intercross $F_1$ were selfed to generate intercross $F_2$. A total of 343 $F_2$ plants from cross between ABLs_216, ABLs_2, ABLs_44, and ABLs_36 X ABLs_5841l were screened with CAPs marker to confirm homozygosity of both mutant alleles of FAD gene. Among 343 plants 40 were confirmed for homozygous double mutant for both alleles of FAD genes. These plants were also confirmed for the QTL regions on B03/ A03 and B10/A02 by foreground screening with LLS and rust resistance-linked markers IPAHM103, GM2079, Seq8D09, GM2009, GM2301 and DGR-329. The biochemical and phenotypic evaluation was carried out of marker conformed $F_2$ introgression lines in kharif 2018. The seeds harvested from each positive plant were subjected to fatty acid profiling by gas chromatography. A total of 11 lines out of 40 lines were found to have oleic acid $\geq$ 79 per cent while estimated on Gas chromatography. However, the oleic acid content of the rest of 29 lines was ranged from 68-78 per cent. All these lines were subjected to generation advancement and phenotypic evaluation for the foliar diseases resistance in *kharif* 2018 since these lines also contained QTLs for foliar diseases resistance. These lines showed a significant level of resistance to ELS and LLS (score range 2-3) as compared to the susceptible check (score range 7-8).

# 08 Publications / HRD Activities / Meetings / Work Plan-2018-19


## Research Articles

- Ajay BC, HN Meena, AL Singh, MC Dagla, Narendra Kumar, SK Bera, K Gangadhar and A D Makwana (2018) Generation mean analysis of yield and mineral nutrient concentrations in peanut (*Arachis hypogaea* L.) J. Oil seeds Res. 35(1):14-20.
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## Lectures Delivered

### Mahatma MK

- Delivered a lead lecture on "Biotechnology for future agricultural productivity" in State level convention of Agri-vision held at Navsari on 18.11.2018.

### Narendra Kumar

- Delivered oral presentation on "Evaluation of advanced breeding lines for Alternaria leaf blight in groundnut" in the National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario (NCOS-2018) from April 7-9, 2018 at ICAR-DGR, Junagadh.
- Presented seed production achievements of 2017-18 in the XIIIth Annual Review Meeting of ICAR Seed Project-"Seed Production in Agricultural Crops" held on 9-11th May 2018 at PAJANC-OA&RI, Karaikal, Puducherry.
- Delivered a training lecture cum exposer visit on quality seed production to participants from KVK, Kodinar on dated 5th February 2019.
- Delivered a training lecture cum exposer visit on quality seed production to participants from KVK, Bhavnagar on dated 30.01.2019.

### Thirumalaisamy PP

- Invited to deliver lecture on 'IPM in groundnut with special reference to Gujarat' at Anand Agrl. University, Anand on 25.09.2018.

## Participation in Conference / workshop/Seminar/Symposia/ Meeting

### Radhakrishnan T

- Annual Groundnut Workshop at PJTSAU from 18-20th April 2018
- Attended the National Seminar on Road Map of Vegetable Oil Production by 2022 held at PJTSAU, Hyderabad from 28-29 April 2018
- Visited AICRP-G centre (UAS, Dharwad) with the QRT team from 22-23 April 2018
- Attended the meeting on Quality Characteristics of Crops/Commodities and their Availability for Commercial Scale Processing and Value Addition in India held at NASC Complex, New Delhi on 15.5.18
- Attended the meeting for discussing seed production issues of soybean held at NASC, New Delhi on 1.8.2018
- Attended the meeting of 80th Central Sub Committee on Crop Standards Notification and Release of Varieties of Agricultural Crops, under the Chairmanship of DDG (CS) held at Krishi Anusandhan Bhavan, New Delhi on 10.08.2018
- Attended the launch meeting of Seed Hub project at IIOR Hyderabad on 11.06.18
- Attended the State Level Farmers' Mela organized as directed by the DG, ICAR at Gandhinagar from 7-9 Sept. 2018
- Organized and participated the final meeting of QRT of ICAR-DGR, Junagadh held at NASC Complex on 24.09.2018
- Attended the review meeting

of Seed Hubs of pulses, oilseeds and nutri-cereals chaired by Secretary, DARE & DG, ICAR at Krishi Bhavan, New Delhi on 22.10.2018

- Visit of QRT team to AICRP-G centre at Bhubaneshwar from 12-14 May 2018
- Attended cadre review meeting to be held at NBPGR, New Delhi on 14.05.2018
- Attended the meeting on National Mission on Vegetable Oils held at Krishi Bhavan, New Delhi on 13.03.2018
- Visited the farmers' field in Sitapur, UP from 23-24 June 2018
- Attended the training-cum-product launch meeting organized by Sulphur Mills Ltd., Mumbai at Hotel the Fern Residency, Rajkot on 26.06.2018
- Attended the meeting of cadre review of the scientific posts held on at NASC Complex, New Delhi on 17.07.2018
- Attended 81th meeting of the Central Sub-Committee on Crop Standards, Notification and Release of varieties for Agricultural Crops held at Krishi Bhavan, New Delhi on 24.12.2018
- Presented before the parliamentary review committee on Rajbhasha at Jamnagar on 16.01.2019
- Attended the final meeting of QRT (2012-2016) of ICAR-DGR at NASC Complex on 22.01.2019
- Attended the Directors' Conference held at NASC Complex, New Delhi from 31.1.19 to 1.2.19
- Attended the XXV meeting of ICAR Regional Committee No.VI held at AAU, Anand from 4-5 February 2019

**Attended following Hindi (Raj bhasha) Meetings**

- Hindi (Raj bhasha) meeting held on 3rd May 2018
- नगर राजभाषा कार्यान्वयन समिति प्रथम वार्षिक छह माहि बैठक दिनांक 18 मई 2018 को हुई
- Hindi (Raj bhasha) meeting held on 25th June 2018
- Hindi (Raj bhasha) Training for the DGR staff held on 27.6.18
- Hindi (Raj bhasha) meeting held on 14.8.28
- Hindi (Raj bhasha) meeting held on 30.8.18
- 14 से 20 September 2018 तक हिंदी चेतना सप्ताह का आयोजन डी जी आर में किया गया
- नगर राजभाषा कार्यान्वयन समिति) नराकास( छह माहि बैठक वर्ष 2018 का आयोजन डी जी आर में on 27.9.18 को किया गया
- Hindi (Raj bhasha)meeting held on 18.12.18
- 16.1.19 को संसदीय राजभाषा समिति के निरीक्षण में जामनगर में भाग लिया
- Hindi (Raj bhasha)meeting held on 7.3.19
- राजभाषा कार्यान्वयन समिति की बैठक दिनांक 22.3.19 को किया गया

**Gangadhara K**

- Attended AICRP-G Annual groundnut workshop from 18-20thApril 2018 at PJTSAU, Hyderabad

**Praveen Kona**

- Undergone Professional Attachment Training (PAT) at ICRISAT, Patancheru from 11th December, 2017 to 10th March, 2018.
- Attended AICRP-G Annual Groundnut workshop at PJTSAU, Hyderabad from 18-20 April, 2018.
- Attended 21 days (14 Nov 2018 to 04 Dec 2018) winter school on "New vistas in seed production, processing, seed enhancement and marketing" at TNAU seed centre, Coimbatore.

**Ram A Jat**

- National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario organized by Indian Society for Oilseed Research and ICAR-DGR, Junagadh during 7-9 April, 2018 at ICAR-DGR, Junagadh.
- International Conference on Global Research Initiative for Sustainable Agriculture and Allied Sciences organized by Astha Foundation, Meerut, SKN Agriculture University, Jobner and others from 28-30 October, 2018 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan.
- XIV Agricultural Science

Congress on Innovations for Agricultural Transformation" organized by NAAS during Feb., 20-23, 2019 at New Delhi.

**Mahatma MK**

- National Conference on "Enhancing Productivity of Oilseeds in Changing Climate Scenario" during 7-9 April, 2018 at ICAR-DGR, Junagadh and delivered oral presentationon "*Sclerotium rolfsii* alters expression of polyamines and ethylene biosynthesis genes in groundnut (*Arachis hypogaea* L.)".
- International Conference on "Global Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2018)" during October 28-30,2018 at RARI, Durgapura, Jaipur (Rajasthan) and oral presentation on "Identification of bioactive polyphenols in groundnut kernels using LC-MS/MS".
- Food and Nutritional Conclave held at MPKV, Rahuri during 25-27 February 2019 and delivered oral presentation on "Transcriptomics of contrasting groundnut genotypes under varying temperature regimes"

**Thirumalaisamy PP**

- Participated in the Annual Workshop (AICRP-G) held at PJTSAU, Hyderabad from 18 to20th April, 2018.

**Bera SK**

- First National Genetic Congress on "Genetics for Sustainable Food Health and Nutrition Security", at IARI, N. Delhi on December, 14-16, 2018.
- 14th Agri. Science Congress on "Innovations for Agricultural Transformation, 20-23 Feb, 2019 at NASC, New Delhi

**Kiran Reddy**

- National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario organized by Indian Society for Oilseed Research and ICAR-DGR, Junagadh during 7-9 April, 2018 at ICAR-DGR, Junagadh.
- Participated in the Annual Workshop (AICRP-G) held at PJTSAU, Hyderabad from 18 to20th April, 2018.

**AL singh**

- The Management Development Programme on Research Excellence in Organisations at Administrative Staff college Institute (ASCI), Hyderabad Aug 8-10, 2018
- 5thInternational Symposium on Zinc (Zinccrops2018)for "Improving crop production and human health" from 5-7 Sept 2018 and the 6th Symposium on Phosphorus in Soils and Plants (from molecular scale to ecosystem) from 10-13 Sept 2018, both hosted by Katholieke Univer-siteit (KU), Leuven, Belgium.
- 41st All India Botanical Conference on the "ecological restoration, carbon sequestration and biotechnological approaches for biodiversity conservation"from Oct 25-27, 2018, the Indian Botanical Society at Jiwaji Univ Gwalior
- Golden Jubilee International Conference of Nutrition Society of India from Nov 15-17, 2018 at ICMR-NIN, Hyderabad
- 4th International Plant Physiology Congress from Dec 2-5, 2018 at CSIR-National Botanical Research Institute, Lucknow. p.315

**Dey R**

- Attended the National Conference on 'Enhancing productivity of Oilseeds in changing climate scenario' jointly organized by the Indian Society of Oilseeds Research, Hyderabad and ICAR-DGR Junagadh from 7-9th April, 2018
- Attended workshops on 'Problems and prospects for commercialization of *Trichoderma*' on 24th May and 'Microbe based technologies for soil health and plant nutrition' on 25th May, 2018 at NASC Complex, New Delhi.
- Attended the training programme "MDP on Priority setting, Monitoring and Evaluation (PME) of Agricultural Research Projects" from 17-22 December 2018 at NAARM.
- Attended the ICAR-DGR Industries Interface meeting on 29-12-2018
- Participated in the 13th

International Conference on Development of Drylands held at CAZRI, Jodhpur from 11-14 February 2019 and made oral presentation of a research paper

- Participated in the XIV Agricultural Science Congress held at NASC Complex, N. Delhi from 20-23 February, 2019 and presented a poster.
- Attended a 1-day training programme on ISO 9001:2005 awareness course on 25-2-2019 provided by Assistant Manager URS verification pvt. Ltd.
- Attended हिन्दी राज भाषा कार्यशाला on 27-3-2019

**Pal KK**

- Attended the National Conference on 'Enhancing productivity of Oilseeds in changing climate scenario' jointly organized by the Indian Society of Oilseeds Research, Hyderabad and ICAR-DGR Junagadh from 7-9th April, 2018 and presented oral presentation of paper.
- Visited Hyderabad, Bengaluru, Dharwar for holding QRT meeting for AICRP-G centres along with Groundnut workshop from 18-20 April, 2018.
- Visited Bhubaneswar from 12-14 May, 2018 for holding QRT meeting of AICRP-G centre
- Visited Durgapura on 18-19 May, 2018 for holding QRT meeting of AICRP-G centres
- Attended workshops on 'Problems and prospects for commercialization of Trichoderma' on 24th May and 'Microbe based technologies for soil health and plant nutrition' on 25th May, 2018 at NASC Complex, New Delhi.
- Attended 13th IMC meeting of ICAR-NBAIM Mau and joint meeting of IMC and QRT at Mau, on 29th May, 2018.
- Attended 20th IMC of ICAR-DGR Junagadh on 9th July 2018 as member IMC.
- Attended QRT meeting of ICAR-DGR, Junagadh and AICRP-G centres of Northern zone as member secretary, QRT from 5 – 9 July, 2018.
- Invited to deliver an interactive talk “Mode of action of Nitrogen fixing micro-organisms' on 11-8-2018 at Dept. of Plant Pathology, College of Agriculture, JAU, Junagadh during a Model Training Course on 'Role of Biopesticides and Biofertilizers in Sustainable Agriculture' from August 8-13, 2018.
- Attended the DPC for promotion from Scientist to Scientist (senior scale) at ICAR-NBAIM Mau on 6-9-2018, as DG nominee in the discipline of Microbiology.
- Organized and participated in the final meeting of QRT on 24-9-2018 at NASC Complex, New Delhi and finalized the report.
- Participated in the 13th International Conference on Development of Drylands held at CAZRI, Jodhpur from 11-14 February, 2019 and made oral presentation of a research paper.
- Participated in the XIV Agricultural Science Congress held at NASC Complex, N. Delhi from 20-23 February, 2019 and presented a poster.
- Attended हिन्दी राज भाषा कार्यशाला on 27-3-2019.

**Narendra Kumar**

- Attended National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario (NCOS-2018) from April 7-9, 2018 at ICAR-DGR, Junagadh.
- Attended XIIIth Annual Review Meeting of ICAR Seed Project-“Seed Production in Agricultural Crops” held on 9-11th May 2018 at PAJANC-OA&RI, Karaikal, Puducherry.
- Attended monitoring of breeder seed production and AICRP-G trials in the zone-V (Tirupti, Kadiri and Hiriyur) from 10.09.18 to 16.09.18.
- Attended and assisted in organizing Annual Groundnut Workshop from April 18-20, 2018 at Prof Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad.
- Attended training of trainers programme under skill development training progra-

mme from December 17-19, 2018 at ATARI, Kanpur.

- Attended 13th International Conference on Development of Drylands (ICDD), Converting Dryland Areas from Grey to Green from February 11-14, 2019 at CAZRI, Jodhpur, India.

## Awards/Recognition

### Ram A Jat

- Received Distinguished Scientist award in the discipline of Agronomy by Society for Scientific Development in Agriculture & Technology at GRISAAS 2018 held during 28-30 October, 2018 at RARI (SKN Agriculture University, Jobner), Jaipur.

### SK Bera

- Selected as Fellow of Indian Society of Genetics and Plant breeding on 14.12.2018

## Special assignments

### Thirumalaisamy PP

- Member, inspection team of APEDA for shelling cum grading, value addition post-harvest peanut processing units at Rajkot.
- Monitoring of AICRP groundnut trails at Dharwad, Raichur and Palem-Hyderabad from 3.10.2018 to 7.10.2018.
- Survey and collection of rusts and leaf spots of groundnut from Tindivanam, Virudhachhalam, Alangudi, Tirupati, Chittoor areas from 14. 02. 2019 to 22.02.2019

Dr. SK Bera Receiving Certificate & Memento for Fellow of Indian Society of Genetics & Plant Breeding on 14.12.2018

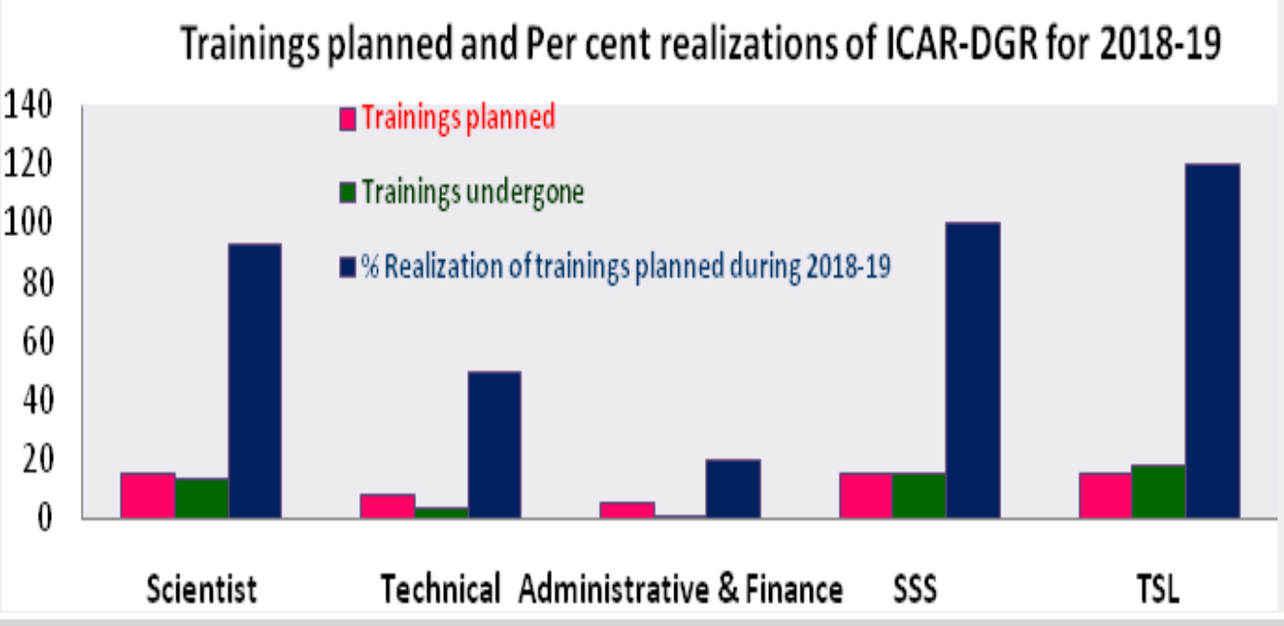
# HRD Activities at ICAR-DGR during 2018-19

To improve skills in the advanced areas of modern science, the staff members of ICAR-DGR undergone various training programs. Fourteen scientists and four technical personnel undergone training on various aspects viz., seed production and enhancement, IPR management and Bio-safety, proteomics, phytoremediation, experimental data analysis, J-gate CERA and MDP on HRD, PME and Leadership.

Five newly joined scientists successfully completed orientation programme at ICAR-DGR and later were sent for professional attachment training at ICRISAT, Hyderabad, ANGRAU, Tirupati, Directorate of Soybean Research, Indore, Directorate of Rapeseed & Mustard Research, Bharatpur and Biological Survey of India, Kolkata respectively for subject matter specialization.

### In house Training of SSS and TSLs of ICAR-DGR

Two training programmes were formulated and implemented for SSS and



TSLs of ICAR-DGR from 22-27th October 2018 with assistance of four resource persons of the institute. In order to bring awareness on general service rules among the staff, important topics covered were Advances, CEA, Leave rules, LTC, Travelling allowance, CGHS, Conduct rules, DA and HRA, Vigilance, RTI, ERP, MACP, Pension, EPF and other benefits.

| S N | Title of Training | Category of employee | Number of Participants |
|---|---|---|---|
| 1 | General rules, conduct rules, RTI, TA Rules, LTC and Medical Rules | SSS | 15 |
| 2 | General Service Rules | TSL | 18 |

Training program for TSLs from 25-27th October 2018 at ICAR-DGR, Junagadh

**Inputs:** Ram Dutta and Gangadhara K

The details of the training programs implemented/attended are as under:

| SN | Training Subjects/Title of the Training | Name of the employee | Category | Period | Venue |
|---|---|---|---|---|---|
| 1 | ProgrammePhyto-remediation: challenges and scope under heavy metal stress | Dr. S. Sushmita | Scientific | 10-30 Jul. 2018 | SDAU, Dantiwada |
| 2 | Management Development Programme on Leadership Development | Dr. A L. Singh | Scientific | 8-10th Aug. 2018 | ASCII, Hyderabad |
| 3 | IPR and Technology management | Dr. S. Chandramohan | Scientific | 24-29 Aug.'18 | NAARM, Hyd. |
| 4 | Proteomics and its applications in Agriculture | Dr. M.K.Mahatma | Scientific | 5th-14th Sept. 2018 | PAU, Ludhiana |
| 5 | New vistas in seed production, processing, seed enhancement and marketing | Dr. K. Gangadhara Dr. Kona Praveen | Scientific | 14th Nov. to 4th Dec. '18 | TNAU, Coimbatore |
| 6 | IPR and Bio-safety of Plant Genetic Resources | Dr. K. Gangadhara | Scientific | 8-17 Oct. 2018 | GKVK, UAS, Bengaluru |
| 7 | Training workshop for Vigilance Officers of ICAR Institutes | Dr. A.L. Rathnakumar | Scientific | 31st Oct. to 1st Nov. '18 | ICAR-NAARM, Hyderabad |
| 8 | J-Gate @ CeRA Regional Ambassador training programme | Dr. M.V.Gedia | Technical | 5th Nov. 2018 | MPAUT, Udaipur |
| 9 | Analysis of Experimental Data | Dr. D.L.Parmer Mr. Ranvir Singh | Technical | 6-11th Nov. 2018 | ICAR-NAARM, Hyderabad |
| 10 | MDP on Priority Setting, Monitoring and Evaluation (PME) of Agricultural Research Projects | Dr. RinkuDey | Scientific | 17-22nd Dec. 2018 | ICAR-NAARM, Hyderabad |
| 11 | Management Development Programme on Leadership Development (Pre RMP) | Dr. Ram Dutta | Scientific | 18-29th Dec. 2018 | ICAR-NAARM, Hyderabad |
| 12 | A study on solvent based extraction and determination of quality parameters and other bio-molecules in Indian Mustard | Dr. AmanVerma | Scientific | 26th Nov. 2018 to 25th Feb. 2019 | DRMR, Bharatpur |
| 13 | Studies on Black gram leaf curl virus | Mr. AnanthKurella | Scientific | 28th Nov. '18 to1st Mar. '19 | ANGRAU, Tirupati |
| 14 | Groundnut Improvement: Target traits, breeding tools and future perspectives | Mrs. Kirti Rani | Scientific | 28th Nov. '18 to 28thFeb.'19 | ICRISAT, Hyderabad, |
| 15 | Collection, preservation and identification of soil Nematodes | Mr. Rupak Jena | Scientific | 4th Dec. '18 to 23rd Feb.'19 | ZSI, Kolkata |
| 16 | Soil biological properties contributing to nutrient mobilization and assimilation in vertisols under long term rotational tillage and soybean based cropping systems | Dr. Raja Ram Chaudhary | Scientific | 24th Nov. 2018 to 23th Feb. 2019 | DSR Indore |
| 17 | Risk Assessment and Management of Non Insect Pests for sustainable Agriculture | Dr. S.D.Savalia | Technical | 7-16th Jan. 2019 | NAU, Navasari |
| 18 | Goods and Services Tax | Mr. Amit Kumar | Administ-ration and Finance | 28-29th Jan. 2019 | ISTM, New Delhi |
| 19 | Management Development Programme for HRD Nodal Officers of ICAR for effective implementation of Training Functions | Dr. Ram Dutta | Scientific | 14-16 Mar. 2019 | ICAR-NAARM, Hyderabad |

# Meetings


## QRT Meeting of ICAR-DGR, Junagadh for the period 2012-2016

The ICAR-Directorate of Groundnut Research (formerly: National Research Centre for Groundnut) was established on 1stOctober, 1979 at Junagadh to conduct fundamental research on all aspects of groundnut cultivation and to address issues concerning its productivity. The 7th Quinquennial Review Team (QRT) was constituted by ICAR to conduct external review of the programme and progress of ICAR-DGR and AICRP-Groundnut during the period 2012-2016 vide Council order F. No. CS. 12/1/2007-IA.III dated 29th December, 2017.

### The composition of QRT team

| Name | Position |
|---|---|
| Dr. P. L. Gautam | Chairman |
| Dr. Masood Ali | Member |
| Dr. S. Acharya | Member |
| Dr. S. J. Kolte | Member |
| Dr.Arun Patel | Member |
| Dr. K.V. Bhat | Member |
| Dr. K. K. Pal | Member-Secretary |

The first interactive meeting of the team was held at NASC Complex, New Delhi on 3rdFebruary, 2018 to plan the review process. The team had an interaction with DDG (CS), Dr. A. K. Singh and ADG (O&P), Dr. P. K. Chakrabarty, who briefed about the terms

of reference of the QRT and extent of its review. The team was also appraised about the ongoing activities and programme and achievements of ICAR-DGR, Junagadh and that of AICRP on groundnut for the period 2012-2016. The team had its second meeting at Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad during 18-21 April, 2018, which also coincided with the Annual Group Meeting of groundnut. In the meeting, the team reviewed the work of twelve of the AICRP-Groundnut centres, besides personal discussions with the scientists of AICRP-G. The QRT also attended the Annual Group Meeting of Groundnut held at PJTSAU during 18-21 April, 2018 and reviewed the conduct and other aspects of the group meeting. Subsequently, members of QRT visited University of Agricultural Sciences, Dharwad (22-23 April, 2018); Mahatma Phule Krishi Vidyapith, Rahuri (26-27 April, 2018); Chandra Shekhar Azad University of Agriculture & Technology, Mainpuri(9-10 May, 2018); Odisha University of Agriculture & Technology, Bhubaneswar (11-13 May 2018); Sri Karan Narendra Rajasthan Agricultural University, Durgapura (18-19 May, 2018) and finally ICAR-DGR, Junagadh during 5-9 July, 2018 (review of ICAR-DGR, Junagadh and remaining centres of AICRP-Ground-nut). The QRT members also visited all the laboratories of ICAR-DGR and the ongoing field experiments, other facilities and interacted with the scientists and other staff present in laboratories and field. The team also interacted with the staff in a general meeting. The team apprised the IMC, ICAR-DGR on 9th April, 2018 of the observations and general recommendations of the review. Finally, all the members of the team met at NASC Complex, New Delhi on 24 September, 2018 to discuss and finalise the recommendations and proceedings.

### National conference on "Enhancing productivity of oilseeds in changing climate scenario" (NCOS) organized at ICAR-DGR, Junagadh during 7-9 April 2018

A three-day (7-9 April 2018) national conference on 'Enhancing productivity of oilseeds in changing climate scenario' was organized at DGR in association with Indian society of oilseeds research (ISOR), Hyderabad. At inauguration, Director Dr. Radhakrishnan invited the honorable guests and participants. The Chairman of the inaugural session Dr. Trilochan Mohapatra, Secretary DARE and DG, ICAR, New Delhi appraised the participants on status of oilseeds in the country, and the significant achievements made so far for sustainable oil seed production and future prospects and challenges and Co-Chairman, Dr. A. R. Pathak, Hon'ble VC, JAU, Junagadh gave lead lecture on "Strategies for doubling of farmers' income"and Dr. A. Vishuvardhan Reddy, Director, ICAR-IIOR, Hyderabad gave opening remarks and presented an overview of conference and society. The conference covered six thematic areas during technical sessions.1. Development of climate resilient varieties. 2. Management strategies to mitigate impact of climate change. 3.Crop protection measures to enhance productivity. 4.


Inauguration of NCOS-2018

Processing post-harvest management and value addition for harnessing the potential of secondary sources of oil. 5. Innovative approaches for rapid adoption of technologies. 6. policy frame work for oilseed sector including doubling of income. There were in toto 19 lead lectures, 74 oral presentations, 43 poster presentations and 19 special oral presentations (for students)

## Groundnut Farmer Fair-cum-Exhibition

ICAR-DGR, with the financial support from NFSM, organised a Groundnut farmer fair-cum-exhibitionat ICAR-DGR, Junagadh on 1st October, 2018. Junagadh Agricultural University, Department of Agriculture, Govt. of Gujarat, ATMA, Junagadh, NGOs, and dealers of agricultural implements, inputs, irrigation systems and accessories have participated in the mela and exhibited their technologies and materials. More than 800 farmers from the different villages of Junagadh, Gir-Somnath, Amreli and Rajkot had attended the mela. Besides, 24 farmers from Odisha also participated in the mela. Dr. A. R. Pathak (Vice Chancellor, Junagadh Agricultural University), the chief guest of the function urged the groundnut farmers to adopt new improved varieties, crop production and protection practices besides intercropping/ crop rotations to make the groundnut cultivation more sustainable and profitable.

Dr. R K Mathur, Director, Indian Institute of Oil Palm, Pedavegi, the special guest of the function, highlighted the need for enhancing the edible oil production in the country.

Dr. Manoranjan Dutta, Advisor, NFSM had explained different schemes and supports being extended by the Government to the farmers for doubling their farm income. He also insisted for higher production of groundnut to meet out ever increasing oil demand of India. Dr. Radhakrishnan, Director, ICAR-DGR has urged the farmers to adopt the improved production technologies and further mechanization to make the groundnut cultivation more remunerative. Pamphlets in local language on the integrated white grub control, management of micronutrient deficiencies, Aflatoxin management, storage pest management in groundnut and health benefits of groundnut were distributed to the farmers. Dr. V. P. Ramani, Project Incharge, AICRP on Micro Nutrient, Anand Agricultural University, Anand delivered a lecture on "Management of micronutrient deficiencies in groundnut" and had interaction with the farmers. Progressive farmers and Sarpanch from different villages adopted by the ICAR-DGR under Mera Gaon Mera Gaurav programme shared their experiences on controlling of white grub as

per technological interventions extended by the ICAR-DGR.

## Industries Interface Meeting

Giving credence to the increasing importance and potentials of the Public-Private Partnerships in achieving higher groundnut productivity, efficiency, and diversification of value-added products and exports, and popularizing technologies, ICAR-Directorate of Groundnut Research has organized an Industries Interface meeting at this Directorate on 29 December, 2018. Dr. A. R. Pathak, Hon. Vice-Chancellor of Junagadh Agricultural University was the chief guest. Besides, Dr J. B. Misra, Technical Adviser, IOPEPC; Dr. P. K. Rai, Director (Actg.), ICAR-DRMR and Director, DGR, Junagadh were the other dignitaries. The participants include the researchers, and thirty representatives from different entrepreneurs from different parts of India and representative from the Saurashtra Oil Mills Association (SOMA). The aim of this interface meeting was to address the issues concerning export, value addition, need of polarizing high oleic groundnut oil, need of application and popularization of low-cost biofertilizers for enhancing productivity of groundnut, etc. Problems faced by the groundnut confectionery industries (sound kernels, kernel shape, colour of testa, seed size, etc.), were covered by distinguished speakers and participants.

Dr. Radhakrishnan T., Director, ICAR-DGR thanked all the delegates, which have contributed to the success of the meeting and hoped that this would surely mark a milestone in furthering the cause of all stakeholders of groundnut in increasing the productivity, popularizing the available technologies which will provide benefits to both farmers and industries through joint partnerships.

# Work Plan 2018-19

## Programme 1: Genetic improvement of groundnut

Breeding groundnut varieties for drought tolerance to enhance productivity in arid regions
*Ajay BC, Gangadhar K, Nataraj KC, Malleswari Sadhneni*

Breeding for alternaria leaf blight resistance in groundnut
*Narendra Kumar, Rathnakumar AL, Praveen Kona, Dutta R and Chandramohan Sangh*

Breeding for Fresh seed dormancy and reducing maturity duration in groundnut
*Gangadhara, K., Rathnakumar, AL, Ajay B.C., Chandramohan, S., Sushmita S. and Praveen Kona*

Genetic Enhancement and Management of Groundnut Genetic Resources
*Rathnakumar AL, Gangadhara K, Bera SK, Mahatma MK and Ajay BC*

Marker assisted breeding for fungal disease resistance and high oil quality in groundnut
*Sangh Chandramohan, Bera SK and Narendra Kumar*

Development of pre-breeding lines resistant to biotic stresses and tolerance of abiotic stress using interspecific hybridization and mutation breeding in groundnut
*Bera SK, Thirumalaisamy PP, Narendra Kumar and Meena HN*

Breeding for improvement of quality traits in groundnut
*Praveen Kona and Mahatma MK*

## Programme 2: Groundnut pests and diseases-emerging problems and their management

Refinement and validation of management module for soil borne diseases of groundnut
*Ram Dutta, Mahatma MK, Thirumalaisamy PP, Narendra Kumar*

Biology, epidemiology and management of *Alternaria* leaf blight in groundnut
*Thirumalaisamy PP and Ram Dutta*

Studies on white grub and bruchid beetle and their management in groundnut
*Harish G and Ram Dutta*

**Programme 3: Enhancing the productivity, sustainability and resilience of groundnut based production system**

Development of climate resilient groundnut production systems through precision Management Practices
*Ram A. Jat and Kiran K. Reddy*

Management of soil and irrigation water salinity through agronomic practices in groundnut
*Meena HN and Reddy KK*

Efficient utilization of soil phosphorus in groundnut production system
*Reddy KK , Meena HN and Jat RA*

**Programme 4: Biochemistry, microbiology and physiology of groundnut in relation to plant health and nutrition, photosynthetic efficiency, nutritional quality, biotic and abiotic stress tolerance**

Iron and zinc bio-fortication in groundnut
*Sushmita, Singh AL, Bishi SK and Gangadhara K*

Physiological studies in groundnut under water-deficit and salinity stresses
*Singh AL, Sushmita and Bishi SK*

Impact of heat stress on groundnut metabolism and productivity
*Bishi SK, Mahatma MK, Singh AL, and Sushmita*

Evaluation of nutritional and bioactive compounds of groundnut
*Mahatma MK , Bishi SK, Rathnakumar AL and Singh AL*

Studies on microorganisms in relation to plant health and nutrition in groundnut
*Dey R, Pal KK and Thirumalaisamy PP*

Application of microorganisms for management of biotic and abiotic stresses in groundnut
*Pal KK, Dey R, Meena HN, Mahatma MK, Harish G, Ajay BC and Reddy KK*

**Programme 5: Socio economic research and extension for groundnut in developments**

Assessment of Farm-Managerial Abilities and Resource Use Efficiency of Small and Marginal Groundnut Farmers of High and Low Productivity Areas: Suggesting Suitable Policy Measures to Double the Farm Income
*Narayanan G and Jat RA*

# 09 Staff List-2018-19 / General Information / Finance & Accounts

As on 01.04.2018 to 31.03.2019

| S.L. | Name of employees | Designation |
|---|---|---|
| 1 | Dr. T. Radhakrishnan | Director |
| 2 | Dr. A.L. Singh | Principal Scientist, Plant Physiology |
| 3 | Dr. A.L. Rathnakumar | Principal Scientist, Plant Breeding |
| 4 | Dr. S.K. Bera | Principal Scientist, Cytogenetics |
| 5 | Dr. K.K. Pal | Principal Scientist, Microbiology |
| 6 | Dr. RinkuDey | Principal Scientist, Microbiology |
| 7 | Dr. Ram Dutta | Principal Scientist, Plant Pathology |
| 8 | Dr. R.A. Jat | Senior Scientist, Agronomy |
| 9 | Dr. M.K. Mahatma | Senior Scientist, Plant Biochemistry |
| 10 | Dr. H.N.Meena | Senior Scientist (Transferred) Agronomy |
| 11 | Dr. S.K.Bishi | Scientist (Transferred), Plant Biochemistry |
| 12 | Dr. P.P. Thirumalaisamy | Senior Scientist, Plant Pathology |
| 13 | Dr. Harish G. | Scientist (Senior Scale), Entomology |
| 14 | Dr. Narendra Kumar | Scientist (Senior Scale), Plant Breeding |
| 15 | Dr. Ajay B.C. | Scientist (Senior Scale), Plant Breeding |
| 16 | Sh. M.V. Nataraja | Scientist (Senior Scale), Entomology |
| 17 | Dr. G.Narayan | Scientist (Senior Scale), Extension Education |
| 18 | Dr. K.Gangadhara | Scientist, Plant Breeding |
| 19 | Dr. Sangh Chandramohan | Scientist, Plant Biotechnology |
| 20 | Mr. Kiran Kumar Reddy | Scientist, Soil Science |
| 21 | Dr. Sushmita | Scientist, Plant Physiology |
| 22 | Dr. Kona Praveen | Scientist, Plant Breeding |
| 23 | Sh. Ananth Kurella | Scientist, Plant Pathology |
| 24 | Sh. Rupak Jena | Scientist, Nematology |
| 25 | Dr. AmanVerma | Scientist, Plant Biochemistry |
| 26 | Dr. Raja Ram Choudhary | Scientist, Agronomy |
| 27 | Ms. Kirti Rani | Scientist, Plant Breeding |
| 28 | Dr. D.L.Parmar | Chief Technical Officer |
| 29 | Sh. N.R. Ghetia | Chief Technical Officer |
| 30 | Sh. P.K. Bhalodia | Chief Technical Officer |
| 31 | Sh. P.V. Zala | Chief Technical Officer |

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| | | |
|---|---|---|
| 32 | Dr. H.K.Gor | Chief Technical Officer |
| 33 | Sh. P.R. Naik | Assistant Chief Technical Officer |
| 34 | Sh. H.M.HIngrajia | Chief Technical Officer |
| 35 | Dr. J.R. Dobaria | Chief Technical Officer |
| 36 | Dr. M.V. Gedia | Assistant Chief Technical Officer |
| 37 | Sh. Ranvir Singh | Assistant Chief Technical Officer |
| 38 | Dr. S.D. Savaliya | Assistant Chief Technical Officer |
| 39 | Mrs. V.S. Chaudhari | Assistant Chief Technical Officer |
| 40 | Sh. B.M. Chikani | Assistant Chief Technical Officer |
| 41 | Sh. D.R. Bhatt | Assistant Chief Technical Officer |
| 42 | Sh. R.D. Padvi | Technical Officer |
| 43 | Sh. H.V. Patel | Technical Officer |
| 44 | Sh. C.B. Patel | Technical Officer |
| 45 | Sh. P.B.Garchar | Technical Officer ( Death on 24.07.2018) |
| 46 | Sh. N.M. Safi | Technical Officer (Driver) |
| 47 | Sh. A.D.Makwana | Technical Assistant |
| 48 | Sh. G.G.Bhalani | Senior Technical Assistant |
| 49 | Sh. B.M. Solanki | Sr. Technical Assistant (Tractor Driver) |
| 50 | Sh. Lokesh Kumar | Sr. Technical Assistant |
| 51 | Sh. Pitabas Das | Technical Assistant |
| 52 | Sh. Indraraj Meena | Administrative Officer, |
| 53 | Sh. Amit Kumar | Finance & Account Officer, |
| 54 | Sh. R.T. Thakar | Assistant Administrative Officer |
| 55 | Mrs. Rosamma Joseph | Personal Secretary |
| 56 | Sh. Y.S. Kariya | Personal Assistant |
| 57 | Sh. L.V. Tilwani | Personal Assistant |
| 58 | Mrs. Santha Venugolan | Assistant |
| 59 | Mrs. M.N. Vaghasia | Assistant |
| 60 | Sh. M.B. KherSecurity | Supervisor |
| 61 | Sh. C.G. Makawan | Assistant |
| 62 | Sh. P.N. Solanki | Upper Division Clerk |
| 63 | Sh. R.B.Chawda | Skilled Support Staff |

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| | | |
|---|---|---|
| 64 | Sh. D.M. Sachaniya | Skilled Support Staff |
| 65 | Sh. M.B. Shaikh | Skilled Support Staff |
| 66 | Sh. J.G. Agrawat | Skilled Support Staff |
| 67 | Sh. K.T. Kapadia | Skilled Support Staff |
| 68 | Sh. V.N. Kodiatar | Skilled Support Staff |
| 69 | Sh. R.P. Sondarwa | Skilled Support Staff |
| 70 | Sh. V.M. Chawada | Skilled Support Staff |
| 71 | Sh. G.S. Mori | Skilled Support Staff |
| 72 | Mrs. D.S. Sarvaiya | Skilled Support Staff |
| 73 | Sh. P.M. Solanki | Skilled Support Staff |
| 74 | Sh. N.G. Vadher | Skilled Support Staff |
| 75 | Sh. B.J. Dabhi | Skilled Support Staff |
| 76 | Sh. C.G. Moradia | Skilled Support Staff |
| 77 | Sh. D.A. Makwana | Skilled Support Staff |
| 78 | Sh. Jay R. Purohit | Skilled Support Staff |

**1. Staff position as on 01.04.2018 to 31.03.2019**

| Category of | Sanctioned Strength as on 01.04.2017 | Filled As on 1.4.18 | Vacant As on 1.4.18 | Filled As on 31.3.19 | Vacant As on 31.3.19 |
|---|---|---|---|---|---|
| Scientific | 39+01RMP | 21+01 | 18 | 26+01 | 13 |
| Technical | 39 | 25 | 14 | 19 | 20 |
| Admn. | 17 | 11 | 06 | 11 | 06 |
| SSS | 19 | 16 | 03 | 15 | 04 |
| **Total** | **114+1 RMP** | **73+01** | **41** | **71+01** | **43** |

# General Information

### 2. DPC:

| | |
|---|---|
| 1. | DPC Held on 11.09.2018 for Scientific Staff, 01 employees |
| 2. | DPC Held on 24.01.2019 for Administrative Staff, 01 employees |

### 3. IMC

| Sr. | Name | Designation | Period |
|---|---|---|---|
| 1 | Director ICAR-DGR, Junagadh | Chairman | Ex-officio |
| 2 | Assistant Director General (OP), ICAR, KB, New Delhi | Member | 06.08.2017 to 05.08.2020 |
| 3 | Dr. S.K. Yadav. Principal Scientist. Biochemistry. CRIDA. Santoshnagar. Hyderabad-500059. Andhra Pradesh. | Member | 06.08.2017 to 05.08.2020 |
| 4 | Dr. Geetha K.S ., Principal Scientist, DMAPR. Anand. Gujarat. | Member | 06.08.2017 to 05.08.2020 |
| 5 | Dr. I.P. Singh. Principal Scientist. ICAR-Central Citrus Research Institute. Post Box No. 464. Shanker Nagar P.O. Nagpur-440010 | Member | 06.08.2017 to 05.08.2020 |
| 6 | Dr. K.K. Pal. Principal Scientist. Microbiology, ICAR-DGR Junagadh-362001 | Member | 06.08.2017 to 05.08.2020 |
| 7 | Sh. Manendrabhai Pithiya NR,Nagdada Temple, Talala Road, At. Gundran, TA Talala, Dist Gir Somnath- 362150 | Member | 06.08.2017 to 05.08.2020 |
| 8 | Sh.Vraj Lal (Vajubhai), Jiva bhai, Hirpara A-107, Chanakya Apartment, NR. Nehru Park, Junagadh- 362001 (Mobile No. 987914544} | Member | 06.08.2017 to 05.08.2020 |
| 9 | Administrative Officer,DGR, Junagadh | Member Secretary | Ex-officio |

### 4. Retirement:-

| | |
|---|---|
| 1. | Shri R.B. Chawda, SSS, 30.04.2018 |
| 2. | Sh. Shri A.D. Makwana, TA, 30.06.2018 |
| 3. | Shri H.M. Hingrajia, CTO, 30.09.2018 |
| 4. | Dr. H.K. Gor, CTO, Voluntary Retirement on 31.10.2018. |
| 5. | Shri G.G.Bhalani, Sr. TA. 31.12.2018 |
| 6. | Smt. Rossama Joseph, PS, 31.03.2019 |

### 5. Transfer:-

| | |
|---|---|
| 1. | Dr. H.N.Meena, Sr.Scientist, ICAR-DGR, Junagadh to ATARIV, Jodhpur (23.06.2018) |
| 2. | Dr. S.K.Bishi,Scientist,ICAR-DGR, Junagadh to IIAB, Ranchi (23.06.2018) |
| 3. | Shri Anil kumar Maurya,Sr.TA,ICAR-DGR,Junagadh to IISR-Lucknow (28.06.2018) |

### 6. Institute Joint Staff Council:-

| | |
|---|---|
| 1. | Chairman:-Director,ICAR-DGR, Junagadh-362 001,Gujarat. |

**Members: Staff side**

| | |
|---|---|
| 1. | Shri Y.S. Karia, Secretary-IJSC and Member CJSC. |
| 2. | Smt. M.N. Vaghasia, Member |
| 3. | Shri G.G.Bhalani, member-Retired |
| 4. | Shri A.K.Maurya, Member-Transfer |
| 5. | Shri B.J.Dabhi, Member |
| 6. | Shri C.G.Moradia, Member |

**Members:- Office side**

| | |
|---|---|
| 1. | Dr. R. Dey, Pr. Scientist, DGR, Junagadh. |
| 2. | FAO, DGR, Junagadh. |
| 3. | AO, DGR, Junagadh. |

### 7. Contractual Staff

| | | |
|---|---|---|
| 1 | RA | 02 |
| 2 | SRF | 02 |
| 3 | YP-2 | 01 |
| 4 | YP-1 | 15 |
| 5 | High Skilled worker | 01 |
| 6 | Skilled Helper | 02 |
| 7 | Security Staff -Ex. Army | 24 |

# Finance and Accounts

**Budget DGR Main Unit (Rs. in lakhs)**

| Budget Head | Allocation | Total Expenditure |
|---|---|---|
| Establishment charges | 904.00 | 902.11 |
| Wages | 91.00 | 90.75 |
| Administrative Expenses | 239.15 | 239.13 |
| Pension | 239.39 | 238.91 |
| T.A. | 30.83 | 30.83 |
| Research and Operational Expenses | 161.68 | 161.68 |
| HRD | 2.48 | 2.48 |
| Works | 66.38 | 66.38 |
| Equipment | 45.53 | 45.53 |
| Furniture | 16.90 | 16.90 |
| IT | 2.35 | 2.35 |
| Books | 0.00 | 0.00 |
| Vehicles | 7.09 | 7.09 |
| Other | 1.80 | 1.80 |
| Miscellaneous | 15.86 | 15.86 |
| TSP | 30.00 | 0 |
| **TOTAL(Rs. in lakhs)** | 1854.44 | 1821.80 |

**AICRP-G (Rs. in Lakhs)**

| Budget Head | Allocation | Total Expenditure |
|---|---|---|
| Pay & Allowance | 618.21 | 617.96 |
| TA | 191.33 | 191.18 |
| Recurring Contingency & Need Based Research | | |
| TSP | 40.00 | 21.46 |
| **TOTAL(Rs. in lakhs)** | **849.54** | **830.60** |

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch