भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
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2018-19

डीजीआर
DGR

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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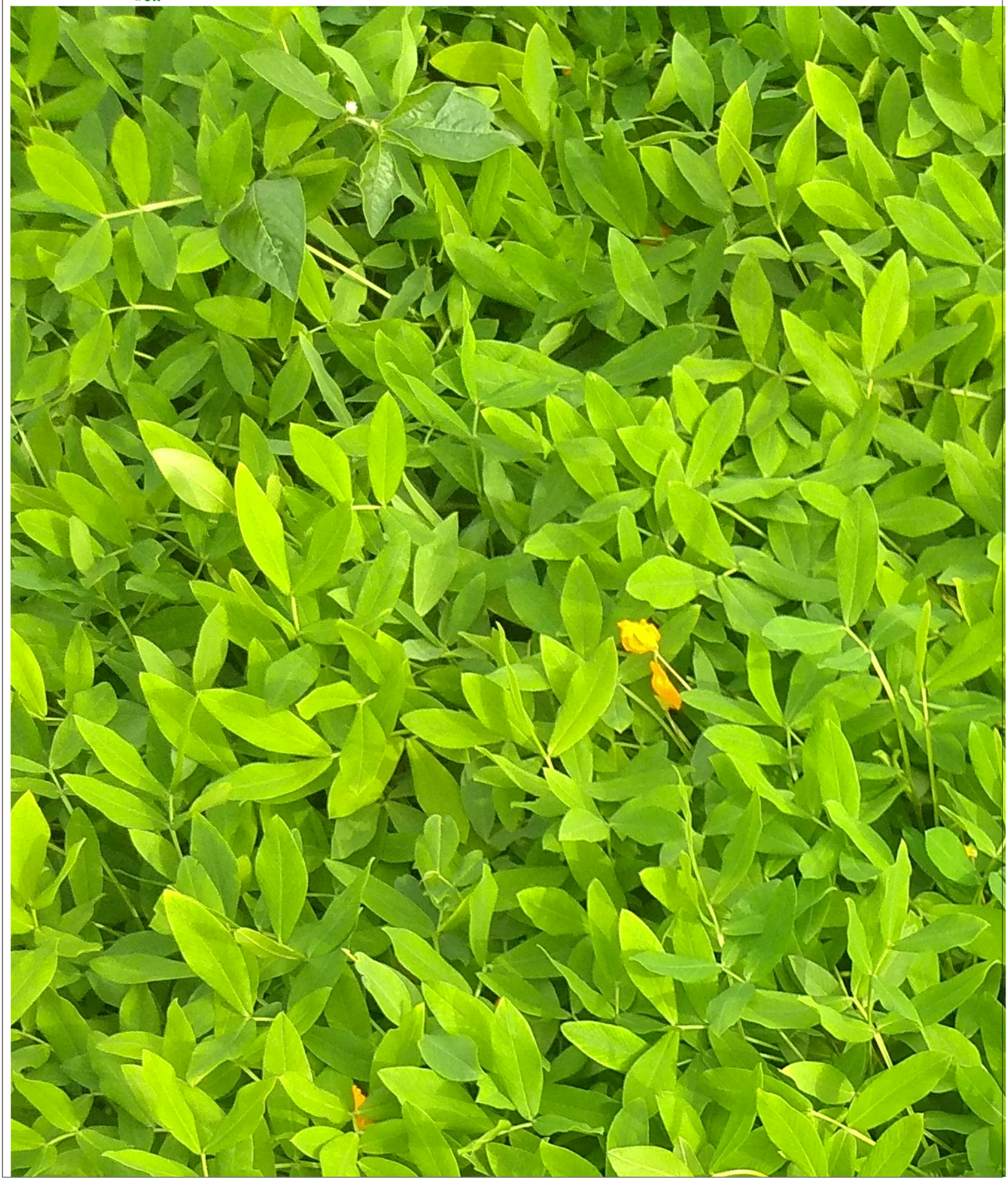

In addition to the prominent role as an oilseed, groundnut has been gaining popularity as snacks food due to its nutritive value. Though there was a reduction in the production of groundnut during the year, India's groundnut export stood at 4.89 lakh tones amounting to Rs 3298.33 crore.

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 27th December 2018 and 24th 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 22-27th 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 1.76×10^8 तथा 4.2×10^8 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

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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_1s 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 accessi ons 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

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*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_1s

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_1s 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_2s 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

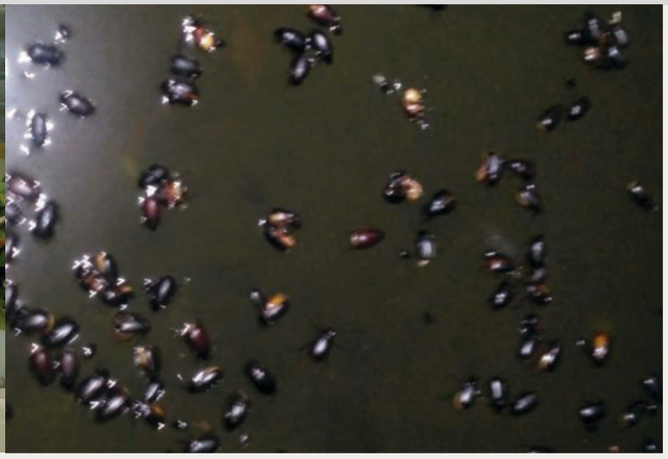
Total 60 single plant progeny (SPP) of F_4, F_5 and F_6 segregating material were raised and advancement of generations was done based on uniform pod, seed size and pods per plant during kharif, 2018. Total 190 single plants in F_4 from seven crosses, 114 single plants in F_5 from five crosses and 177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

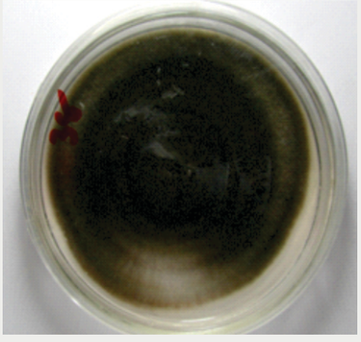
Thirumalaisamy PP and Dutta R

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

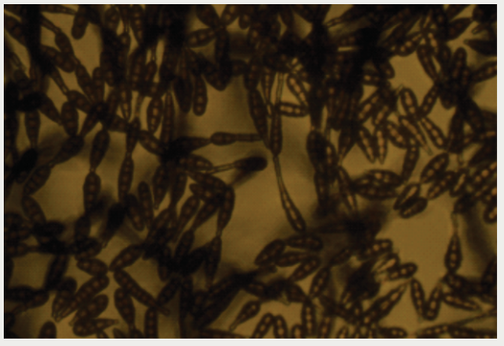
Alternaria sp. associated with the leaf blight disease of groundnut were isolated and maintained on PAD slants at 4°C. Presently 45 isolates were collected from groundnut grown in different agro-climatic regions of India. Majority of the isolates were belong to *Alternaria alternate*. All the isolates 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