भाकृअनुप
ICAR

डीजीआर
DGR

वार्षिक प्रतिवेदन
ANNUAL REPORT
2017 - 18

भाकृअनुप–मूँगफली अनुसंधान निदेशालय

इवनगर रोड, पोस्ट बॉक्स नं. 5, जूनागढ 362001, गुजरात, भारत

ICAR-Directorate of Groundnut Research

Ivnagar Road, PO Box No. 5, Junagadh 362001, Gujarat, India

वार्षिक प्रतिवेदन
ANNUAL REPORT
2017 - 18

भाकृअनुप–मूँगफली अनुसंधान निदेशालय
इवनगर रोड, पोस्ट बॉक्स नं. 5, जूनागढ 362001, गुजरात, भारत
ICAR-Directorate of Groundnut Research
Ivnagar Road, PO Box No. 5, Junagadh 362001, Gujarat, India

Citation:
Annual Report 2017-18,
ICAR-Directorate of Groundnut Research,
Junagadh- 362 001, Gujarat, India

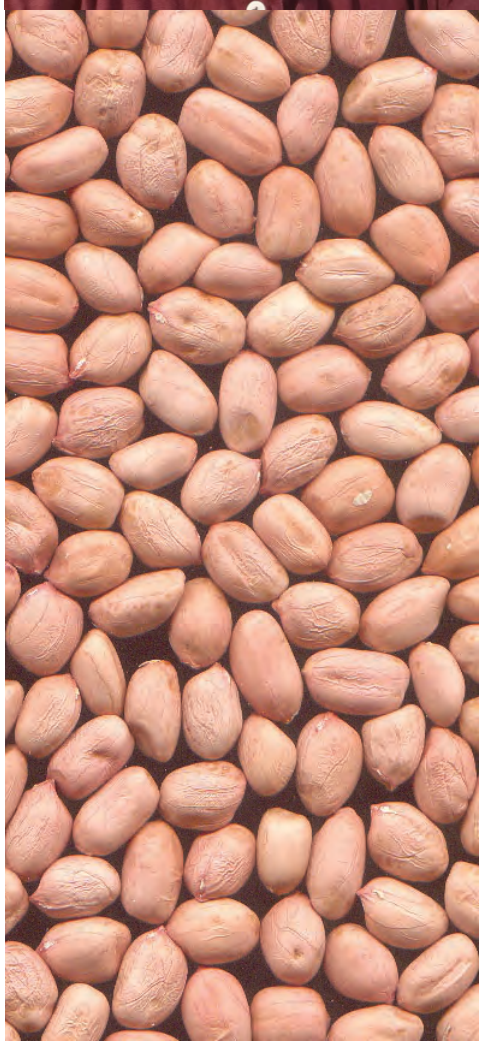
Editors:
Mahesh K Mahatma
Kiran K Reddy
Radhakrishnan T

Front Cover Illustration:
Groundnut Crop and Products

Published By:
Director,
ICAR-Directorate of Groundnut Research
Post Box 05, Ivnagar Road, Junagadh- 362 001,
Gujarat, India

Printed At:
Art India Offset
Lohana Vidhyarthi Bhavan,
College Road, Junagadh - 362 001.
Phone: +98795 41275

Preface



Groundnut is the third major source of edible in India with a production of 8.94 million tons in 2017-18. This increase in production was due to good monsoon and intervention of good agricultural practices and supply of quality seeds.The highest state average yield of 2,380 kg/ha was estimated for Rajasthan which was followed by 1,879 kg/ha for Gujarat, 1,382 kg/ha for Maharashtra, 1,272 kg/ha for Andhra Pradesh and the lowest of 874 kg/ha for Karnataka.India is one of the largest exporters also in the world and competes closely with Argentina, USA and China by commanding a share of 20- 25% in global markets.

During the year, a total of 7648 qt breeder seed comprising 45 varieties was produced. To demonstrate the new and improved technologies on groundnut production on the farming community we have organized 558 field level/ front line demonstration. Besides this, two farmer's fair cum exhibition were organized at Seed Production Centre, Bikaner and DGR, Junagadh to familiarize farmers for the latest production technologies, and about White grub management.To address the needs of groundnut farmers at Sitapur (UP), training programme was arranged for more than 700 farmers. Being the national repository of groundnut germplasm we have been conserving more than 9000 accessions of groundnut from 84 counties. Looking forward for the future of the groundnut as a food crop, the DGR has developed high oleic groundnut which are under advanced stages of evaluation trials. Through the AICRP on groundnut, two varieties have been identified for release. During 2017-18, the DGR Scientists published 42 research articles, 8 books chapters and presented 03 papers in conference and symposia. Utilization of the grants was to the tune of Rs1600.61 lakhsfor DGR and Rs. 758.48lakhs 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 thank the editorial committee for compiling and editing this report.

(Radhakrishnan T)

Contents

Executive Summary

Crop Improvement

- 229 single plant progenies selected from different segregating generations.
- 270 promising advanced breeding lines multiplied.
- 28 promising genotypes identified with pod yield higher than check K6 after screening more than 700 genotypes.
- Fourteen crosses were effected in *kharif* 2017 to develop improved varieties resistance of *Alternaria* leaf blight, leaf spot and rust, stem rot.
- A total 346 single plants have been identified as hybrids in all the twelve crosses during summer (133) and *kharif* 2017 (213).
- Progenies of 54 crosses were advanced to different filial generations (F_2-F_6), among them 35 crosses in early generations (up to F_4) and 19 in advanced generation.
- Eighteen new advanced high yielding breeding lines (two of Spanish and sixteen of Virginia habit group) were developed during *kharif* - 2017.
- Supplied segregating materials of 42 different crosses from four segregating generations (F_3 and F_6) to ten AICRP-G centres for *kharif* 2017.
- Advanced breeding line PBS-12209 for was found significantly superior over the best check variety JL-501 (69%) for shelling outturn (73%).
- An advanced breeding line PBS-22092 recorded average less than 10% collar rot incidence in three consecutive *kharif* season at ARC, Bikaner. Hence identified as resistant to collar rot.
- Advanced breeding line PBS-12190 recorded a score <4 on 1-9 scale and found resistant to *Alternaria* leaf blight.
- In the hybridization programme, about 256 hybrid plants were identified during summer-2017 and about 397 pods harvested from different crosses with highest success rate in cross TAG × Girnar 1 (41.02%) during kharif-2017
- Germplasm lines Girnar 1, TAG 24, TLG 45, NRCG 14407, SG 99 and TG 26 were found to be early flower initiation, day to 50 per cent flowering as well as low SLA and high SCMR during summer-2017. For pod yield per plant Girnar 3, GG 20, TLG 45 and GJG 17 and TAG 24, Dh 98, Dh 101, GG2, TG 26 and TG 39 were found to be early maturing and NRCG 8763, NRCG 7627 and GG 6 were early flower initiation. LLS Tolerant germplasm accessions identified are NRCG 10983, NRCG 14350, NRCG 143 79, NRCG 14386, NRCG 14457, NRCG 14473, NRCG 14485 and NRCG 1449 and AK 12-24, Girnar 1, GJG 17, GJG 31 and LGN 2.
- NRCG CS 254 was found to be superior for pod yield per plant, early flower initiation whereas NRCG CS 313 was found interesting for tolerance to LLS, short duration and pod yield per plant.
- Advanced breeding lines PBS 15022, PBS 16038, PBS 30001 and PBS 30044 were found to be early maturing

during rabi/summer-2017 at Junagadh. Advanced breeding lines PBS 11086, PBS 11091, PBS 15048 and PBS 16015 early in initiation of flowering and PBS 15056 and PBS 16027 found superior pod yield per plant during kharif-2017.

- The popular groundnut variety TPG 41 was mutagenized with EMS mutagen with different concentrations from 0.2 % to 0.6 % and 130 mutants were derived. The superior mutants isolated for different traits includes Line number 27, 100 and 130 for pod yield per plant and line number 34, 45 and 62 for sound mature kernel (%).
- New advanced breeding lines (PBS 19035, PBS 19036, PBS 19037, PBS 19038, PBS 29236, PBS 29237, PBS 29238, PBS 29239, PBS 29240, PBS 29241, PBS 29242, PBS 29243, PBS 29243, PBS 29244) developed were multiplied for yield evaluation trials.
- Three advanced breeding lines (PBS 15022 (Entry level), PBS 15044 (IVT-II), PBS 19018 (AVT) and PBS 19022 (AVT) were multiplied for AICRP trials.
- A total of 106 accessions under 6 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. Seeds seven amphidiploid derivatives have been field established for further use in crop improvement programme
- 30 wild *Arachis* accessions were acquired from ICRISAT. In summer, 323 germplasm accessions of cultivated groundnut were supplied to 18 indenters and in kharif 478 germplasm accessions for use in the crop improvement programme. These germplasm were supplied to the scientists of DGR (562), AICRP-G centres (50), other State Agricultural Universities (149), and others (35) to identify promising lines for WUE, diseases and nematode tolerance, large seeded types and to use in crop improvement programmes
- A total of 70 accessions (South American collection) were multiplied in summer 2017. In kharif 2017, a total of 1611 germplasm accessions have been multiplied which include accessions of Crop Cafeteria (45), Mini-core (184), Released Varieties (200), sub-set of working collection (167), accessions with low Carbon Isotope Discrimination (30), and of accessions for rejuvenation (985).
- Based on days to germination and germination (%) *per se*; duration for flower initiation to fifty percent flowering and seventy five percent flowering and pod yield, promising germplasm accessions (NRCGS 14405, 14376) and released varieties (TAG 24, TG 26, Dh 86, ICGV 00350) could be identified for high temperature tolerance which are currently being evaluated at Bawal (Hisar) and Raigarh (Chhatisgarh) for validation.
- In *kharif* 2017, a set of 103 accessions (HYB: 71; HYR: 11; VUL: 05 and FST: 16) belonging to Bolivia has been characterized for 16 qualitative and 28 quantitative traits. Promising germplasm could be identified for medium maturity (110 days) two accessions, NRCGs 8967 and 9238; NRCG 13140 for more number of mature pods per plant (13.3); NRCG 8965 for high pod yield per plant (14.7 g); and NRCG 11946 for high shelling out-turn (73.2%); NRCG 11890 for hundred pod mass (155.2 g) and NRCGs 8964 (51.8 g) and 10877 (52.2 g) for high Hundred seed mass.
- Another set of 107 accessions (HYB: 08; HYR: 08; VUL: 68 and FST: 23) originating from Argentina has been characterized for 16 qualitative and 28 quantitative traits. In this set also NRCGs 12716 for early maturity (103 days); for medium (108 d) maturity NRCGs 14189, 13388, 7337 and 6890; NRCG 8297 and NRCG 13350 for more number of

mature pods per plant (17.5); NRCG 13368 for high pod yield per (12.5 g); and NRCG 10331(75.9%) and NRCG 8364 for high (78.6%) shelling out-turn.

- 417 accessions of working collection and few advanced breeding lines have been evaluated for oil, and protein in kharif 2017. The oil content in 417 general accessions ranged from 43.6%-56.1%; protein content ranged from 20.8%-36.3% and sugar content ranged from 3.32% to 6.64%. Among the germplasm accessions, one accession exhibited high oil (52%) with low protein (26%) and low sugar (4%) content; four accessions were found to have high protein (36%) with low oil (44%) and high sugar (6.5%) content.
- Development of two mapping population GJG 17 x GPBD 4 and GJG 22 x ICGV 86590 which are currently in F_8 and F_6 generation which can be further used to mapping and RIL development. The F_1 were identified for the cross TMV 2 x CS 196 and F_2 mapping population was developed consisting of 350 individuals.
- Newly developed markers from EST were used to map F_2 population for LLS and rust disease resistance.
- One QTL identified for rust flanked by marker DGR 329 and IPAHM 103 on LG 1 which showed 6.14 % Phenotypic Variability Explained (PVE).
- Two QTLs for LLS, one flanked by markers (DGR 662 and DGR 258) and showed 2.65 % PVE, another flanked by markers (DGR 2401 and DGR 308) and showed 2.67 % PVE.
- Development of 91 introgression lines for foliar disease resistance derived from the cross GJG 17 x GPBD 4.
- Development of 64 lines for high oleic acid content derived from the cross GPBD 4 x SunOleic 95R. Few lines has shown more than 80% oleic acid content.
- Four crosses were initiated for gene pyramiding of foliar disease resistance and high oleic acid content viz. ABLs_216 X ABLs_5841, ABLs_44 X ABLs_5841, ABLs_36 X ABLs_5841, ABLs_2 X ABLs_5841. AS-PCR and CAPS asses were used to confirm presence of *ahFAD2B* mutant allele.

Basic Sciences

- The Fe and Zncontent in cultivars their Pod morphology and seed size studied.
- Zinc biofortification in seed through Zn solubilizing microbes application was studied.
- All Zn sources increased Zn content as well as Fe content of groundnut seed
- The seed dressing of various Fe sources tried for Fe-biofortification in seeds
- 100 groundnut cultivars and 114 breeding line screened for iron chlorosis
- Photosynthetic efficiencies of Indian groundnut cultivars determined
- Pod zone moisture contents, a factor for yields losses and aflatoxin contamination
- Wide plasticity observed among groundnut cultivars of various drought situations
- Growth regulators influenced the seed size and pod yield of groundnut
- The organic matter and gypsum ameliorate drought
- Salt tolerant mechanism and cultivars in groundnut identified
- High temperature affected negatively oil content and positively protein content and the effect were more prominent in Virginia.
- The O/L ratio was negatively affected by high temperature stress during pod filling.
- *AhHSF13* possibly plays an important role in heat stress tolerance in groundnut.
- Among 31cultivars, only 5 cultivars had more than 2.0 O/L ratios, among that GG20, GG18 and GG22 had 2.9 O/L ratio while TPG 41 had 2.4 and BAU13 had 2.04 O/L ratio.
- TAG24 had highest blanching

quality (94%) , followed by Girnar2 (93%),TKG19A (92%), TLG5 (89%) and GPBD4 (87%), while Kadiri7 had lowest (29%).

- Antioxidant activity was strongly correlated with phenol content.
- Coumaric and cinnamic acid are predominant phenolics in groundnut kernels followed by kaempferol, syringic acid and salicylic acid.
- Formulations of DAPG-producing *Pseudomonas putida* DAPG4 and *Pseudomonas putida* FP86, which have 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. While formulation 8 maintained the population of $6.15X10^{10}$cfu/ml after 270 days of inoculation at RT, the same formulation also helped *Pseudomonas putida* FP86 to maintain a population of $3.85X10^{10}$cfu/ml after 210 days of inoculation at RT.
- Seed inoculation with eight new competitive strains of groundnut rhizobia resulted in significant enhancement of pod yield (15–36%) 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 like *Bacillus firmus* J22, *Pseudomonas pseudoalcaligenes* SEN29, and *Bacillus subtilis* REN51 prevented the reduction in yield losses by improving the yield by 28%, 20%, and 18%, respectively (749 kg/ha in control and 886-963 kg/ha with these endophytes) at soil EC of around 5.2 at harvest in susceptible cultivar TG37A.
- Application of *Bacillus firmus* J22 alleviated salinity stress in groundnut at Bhuj besides improving yield over control by 17.9% in farmers' field. On an average, increase in Net returns due to seed treatment was 10% over the control.
- Application of *Bacillus firmus* J22 at Anantapur improved pod yield by 36% over uninoculated control in farmers' field.
- Endophytes like *Bacillus subtilis* R51 and *Pseudomonas pseudoalcaligenes* SEN29 showed plant growth promoting traits and enhanced pod yield of groundnut by 16.5% and 11%, respectively under rainfed situation.
- Yield evaluation of C3-CAM variants of TG37A under rainfed condition indicated significant yield improvement in DGRMB3, DGRMB5, DGRMB19, DGRMB24, DGRMB31, and DGRMB32 as compared to its wild type.
- Overexpression of C3-CAM in variants of TG37A resulted prevention of biomass loss from 59% in TG37A to 38% in DGRMB5 at soil salinity of 5.2 EC at the time of harvest.

Crop Production

- Groundnut pod and haulm yield was higher under 3:1 ratio while pigeonpea grain and stover yield and GPEY was higher under 2:1 ratio. Groundnut pod and haulm yield was higher when pigeonpea was relay sown 50 DAS while pigeonpea grain and stover yield and GPEY was higher when pigeonpea was relay sown 30 DAS.
- Application of paclobutrazol @100 ppm increased number of flowers and mature pods per plant and significantly increased pod yield as compared to control.
- Groundnut pod and haulm yield, seed cotton yield and stalk yield, and GPEY was not significantly affected by tillage practices but pigeonpea grain and stover yield was significantly higher with normal tillage. Retention of residues could not significantly affect yield of all the three crops. Groundnut pod yield was significantly higher under groundnut+ pigeonpea intercropping system while GPEY was higher under groundnut+ cotton intercropping system.
- Significantly higher pod yield

was recorded in TG 37A and TAG 24 under Spanish group during summer seasons under salinity conditions.

- Significantly higher pod yield was recorded in JL 776 and GJG 9 under Spanish group during *kharif* season under salinity conditions.
- The higher pod yield was recorded at 2 dS/m (50 %) as compared to 6 dS/m saline irrigation water.
- The higher pod yield was recorded under straw mulch (32%) and under polythene mulch (32%) as compared to without mulch (control)
- Interaction effect of salinity x mulching revealed that pod yield under polythene mulch and straw mulch was recorded 47 and 52%, higher at 6 dSm^{-1}, respectively as compared to control.
- Addition of FYM has appreciably boosted the acid phosphatase, alkaline phosphatase, and Soil dehydrogenase activities and organic carbon (%) at 45 DAS and 60 DAS compared to harvest
- Increase in incubation time, incubation temperature and P dosage has extensively diminished the availability of Olsen-P in *Vertisols* (black soils) compared to *Aridisols* (sandy soils)
- Order of P-fixation in *vertisols* is Ca-P>Fe-P>Al-P>Saloid-P and in sandy soils it is Ca-P> Fe-P>Saloid-P>Al-P. Al-P and Fe-P was markedly higher in *vertisols* at 45°C than at 15°C, which is *vice-versa* with respect to Ca-P

Crop Protection

- Variety Kadiri-3 was found promising for resistance to stem rot.
- Organic formulations DGROF1 and DGROF2 gave maximum inhibition of stem rot.
- Module M17A supported maximum inhibition of stem rot and yield in refinement.
- Module-M4V supported maximum inhibition of stem rot in validation
- Saurashtra region was found to be hot spot for Alternaria leaf blight disease in summer. In recent years, the disease was also recorded at the end of *kharif* season.
- Iron deficiency, attack of groundnut crop by thrips and jassids, growing groundnut at 4dsm or above, water stress were made the groundnut more susceptible to Alternaria leaf blight.
- Symptoms of leaf blight cum wilt observed on groundnut crop grown during kharif in Jodhpur and Bikaner districts of Rajasthan state was characterized based on morphological and molecular tools and identified as *Fusarium incarnatum.*
- In the survey conducted in seven districts covering 28 villages, five white grub's species have been identified viz. *Phyllognathus dionysius, Holotrichia serrate*, *Holotrichia* sp. and *Holotrichia reynaudi*
- *Acorus calamus* (vacha, sweet flag) at 20 per cent was found effective to manage bruchid beetle in storage.

Social Sciences

- The study on farm-managerial abilities, resource-use efficiency and technicale fficiencies among small and marginal farmers revealed that the determinants of outputamong these groups are land preparation, seed and post-harvest handling practices, Resources used were more on these components.
- The frontier function model on technical efficiency revealed that 24 to 37 per cent ofoutput losesnoted among 88 per cent of small and marginal farmers. As far as farmmanagerial abilities were concerned most them fell in medium categories.

कार्यकारी सारांश

फसल सुधार

- विभिन्न पृथ्ककृत वंशो से 229 एकल पौध वंशों का चयन किया गया।
- 270 आशाजनक विकासोन्मुख प्रजनन लाइनों का गुणन किया गया।
- 700 से अधिक जीन प्रकारों की जाँच के पश्यात् नियंत्रण के-6 की तुलना में फलियों की उपज के संदर्भ में अधिक उपज प्रदान करने वाले 28 आशाजनक जीन प्रकारों की पहचान की गई।
- अल्टरनेरिया पर्ण झुलसा, पत्ती धब्बा, रतुआ एवं तना सड़न के प्रति सुधारित प्रतिरोधी किस्मों के विकासार्थ 14 संकरी का खरीफ 2017 के अंतर्गत परिक्षण किया गया।
- रबी (133) एवं खरीफ 2017 (213) के दौरान 12 संकरों में से कुल 346 एकल पौधों की संकरों के रू प में पहचान की गई।
- 54 संकर वंशों को विभिन्न सहयक वंशों ($एफ_2$-$एफ_3$), जिसमें 35 संकर प्रारंभिक वंशों में ($एफ_4$ तक) एवं 19 को अग्रवर्ती वंशों में अग्रसरित किया गया।
- खरीफ 2017 के दौरान 18 नये अग्रवर्ती, उच्च उपज, संकर किस्मों को विकसित किया गया (स्पेनिस किस्म की दो तथा 16 वर्जिनिया समूह के अंतर्गत)।
- 4 पृथ्ककारी वंशों ($एफ_3$ एवं $एफ_6$) से प्राप्त 42 पृथक्ककारी संकर सामग्री की आपूर्ति 10 एआईसीआरपी-जी केन्द्रों को खरीफ 2017 के दौरान की गई।
- अग्रवर्ती संकर किस्म पीबीएस-12209 को नियंत्रण किस्म जेएल-501 की तुलना में छिलका निकाली (69 प्रतिशत) के संदर्भ में सार्थक उत्कृष्ट (73 प्रतिशत) पाया गया।
- एआरसी, बीकानेर पर लगातार तीन खरीफ काली के दौरान पीबीएस-22092 अग्रवर्ती संकर किस्म में मूल-संधि सड़न की घटनाओं में 10 प्रतिशत की औसत कमी दर्ज की गई, अतएव इस किस्म की मूल-संधि सड़न के प्रतिरोधी किस्म के तौर पर पहचान की गई।
- अग्रवर्ती संकर किस्म पीबीएस-12190 में अलटनेरिया पर्ण झलसा के संदर्भ में 1 से 9 के पैमाने पर मात्र < 4 घटनाएं दर्ज की गई।
- ग्रीष्म 2017 के दौरान संकरण कार्यक्रम के अंतर्गत 256 संकर पौधों की पहचान की गई तथा खरीफ 2017 में विभिन्न संकरों से लगभग 397 फलियाँ प्राप्त की गई जिसमें संकर टीएजी x गिरनार-1 में उच्चत्तम सफलता दर (41.02 प्रतिशत) दर्ज की गई।
- जनन द्रव्य किस्में गिरनार-1, टीएजी-45, एनआरसीजी-14407, एसजी-99 एवं टीजी-26 को अगेती पुष्पन प्रारंभ, 50 प्रतिशत के लिए दिनों की आवश्यकता तथा कम एसएलए एवं उच्च एससीएमआर ग्रीष्म 2017 में पहचान की गई। फली उपज प्रति पौध के संदर्भ में गिरनार-3, जीजी-420, टीएलजी-45, एवं जीजेजी-17, तथा टीएजी-24, डीएच-98, डीएच-101, जीजी-2, एवं टीजी-39, में अगेती परिपक्वता तथा एनआरसीजी-8763, एनआरसीजी-7627, एवं जीजी-6, में अगेती पुष्पन देजी गई। एलएलएस सहनशील जनन द्रव्य प्रविष्ठियों के अंतर्गत एनआरसीजी-10983, एनआरसीजी-14350, एनआरसीजी-14379, एवं जीजी-6 में अगेती पुष्पन देखी गई। एलएलएस सहनशील जनन द्रव्य प्रविष्ठियों के अंतर्गत एनआरसीजी-14386, एनआरसीजी-14457, एनआरसीजी-14473, एनआरसीजी-144485, एवं एनआरसीजी-1449 तथा एके-12-24, गिरनार-1, जीजेजी-17, जीजेजी-31, एवं एलजीएन-2 की पहचान की गई।
- एनआरसीजी-सीएस-254 को प्रति पौध फली उपज तथा अगेती पुष्पन प्रारंभ के संदर्भ में उत्कृष्ट पाया गया जबकि एनआरसीजी-सीएस-313 को एलएलएस के प्रति सहनशील, कम अवधि एवं प्रति पौध फली उपज के संदर्भ में आशाजनक पाया गया।
- रबी । ग्रीष्म 2017 के दौरान जूनागढ में अग्रवर्ती संकर किस्मों पीबीएस-15022, पीबीएस-16038, पीबीएस-30001 एवं पीबीएस-30044 की अगेती परिपक्वता के लिए पहचान की गई। अग्रवर्ती संकर किस्में पीबीएस-11086, पीबीएस-11091, पीबीएस-15084, एवं पीबीएस-16015 में अगेती पुष्पन प्रारंभ

तथा पीबीएस-15056 एवं पीबीएस-16027 को प्रति पौध फली उपज के संदर्भ में खरीफ 2017 के दौरान उत्कृष्ट पाया गया।

- लोकप्रिय मूँगफली किस्म टीपीजी-41 का इएमएस उत्परिवर्ती के विभिन्न सांद्रता अर्थात 0.2 प्रतिशत से 0.6 प्रतिशत के द्वारा उत्परिवर्तन कराया गया जिससे 130 उत्परिवर्ती प्राप्त किये गये। विभिन्न गुणधर्मो के आधार पर पृथ्ककृत उत्परिवर्तियों में किस्म क्रमांक 27, 100 एवं 130 को प्रति पौध फली उपज एवं किस्म क्रमांक 34, 45 एवं 62 को स्वस्थ्य परिपक्व दानों के लिए उत्कृष्ट पाया गया।
- विकसित नये अग्रवर्ती संकर किस्मों (पीबीएस-19035, पीबीएस-19036, पीबीएस-19037, पीबीएस-29236, पीबीएस-29237, पीबीएस-29238, पीबीएस-29239, पीबीएस-29240, पीबीएस-29241, पीबीएस-29242 एवं पीबीएस-29244) का गुणन किया गया एवं उपज के लिए इनका मूल्यांकान किया गया।
- तीन अग्रवर्ती संकर किस्मों (पीबीएस-15022 (प्रवेशस्तर), (पीबीएस-15044, (आईवीटी-11), (पीबीएस-19018 (एवीटी) एवं (पीबीएस-19022 (एवीटी) का गुणन एआईसीआरपी परीक्षण हेतु किया गया।
- 6 अनुभागों के अंतर्गत कुल 106 प्रविष्टियों अर्थात अरेचिस (54), कुलोराईजे (1), इरेक्टोइड्स् (7), हिटीराइन्थे (7), प्रोकम्बेंटेस् (6) एवं राइजोमेटोसे (40) को प्रक्षेत्र जीन बैंक में प्रतिपालित किया गया। अरेचिस अनुभाग के वार्षिक प्रजातियों से बीज प्राप्त किये गये एवं संरक्षित किये गये।
- 7 एम्फीडीप्लायड उत्पादों के बीजों को भविष्य में फसल कार्यक्रम के लिए स्थापिता किया गया। इक्रीसेट से 30 वनीय अरेचिस प्रविष्टियां की गई। ग्रीष्म काल के दौरान 323 कृषय मूँगफली जनन द्रव्य प्रविष्टियों की आपूर्ति 18 मांगकर्ताओं को की गई तथा खरीफ के अंतर्गत 478 जनन द्रव्य प्रविष्टियों को फसल सुधार कार्यक्रम के अंतर्गत उपयोग हेतु रखा गया। डब्ल्यूयूई के लिए आशाजनक किस्मों की पहचान, रोग एवं सूत्रकृमि प्रतिरोधिता, बड़े दाने युक्त किस्म तथा फसल सुधार कार्यक्रम में उपयोग हेतु जनन द्रव्यों की आपूर्ति डीजीआर के वैज्ञानिकों (562), एआईसीआरपी-जी केन्द्रों (50), अन्य राज्यों के कृषि विश्वविद्यालयों (149) तथा अन्य (35) को की गई।
- कुल 70 प्रविष्टियों (दक्षिण अमेरिका से संग्रहित) का गुणन ग्रीष्म 2017 में किया गया। खरीफ 2017 में कुल 1611 जनन द्रव्य प्रविष्टियों का गुणन किया गया जिसमें क्राप केफेटेरिया (45), मिनकोर (184), विमोचित किस्में (200), व्यावहारिक संग्रह का एक उप समूह (167), अल्प कार्बन आइसोटोप विभेदन प्रविष्टियां (30) एवं पुनर्जनन के लिए प्रविष्टियां (985) सम्मिलित हैं।
- अंकुरण के लिए दिनों की आवश्यकता एवं अंकुरण प्रतिशत, पुष्पन प्रारंभ अवधि एवं 50 एवं 75 प्रतिशत पुष्पन अवधि तथा फली उपज के आधार पर आशाजनक जननद्रव्य प्रविष्टियां (एनआरसीजीएस-14405, 14376) तथा विमोचित किस्मों (टएजी-24, टीजी-26, डीएच-86, आईसीजीवी-00350) की पहचान उच्च तापमान प्रतिरोधिता के लिए की गई जिन्हें वैध्यता के लिए वर्तमान में बलबल (हिसार) एवं रायगढ (छत्तीसगढ) में मूल्यांकित किया जा रहा है।
- बोलिविया समूह की 103 प्रविष्टियों के समूह (एचवायबी: 71; एचवायआर: 11; वीयूएल: 05 एवं एफएसटी: 16) का खरीफ 2017 के दौरान 16 गुणात्मक एवं 28 मात्रिक गुणधर्मो के लिए अध्ययन किया गया। मध्यम परिपक्वता (6110 दिन) के लिए आशाजनक जनन द्रव्यों की पहचान की गई जिसमें दो प्रविष्टियां एनआरसीजी-9267 एवं 9238 सम्मिलित है। प्रति पौध अधिक संख्या में परिपक्व फलियों के लिए प्रविष्टि एनआरसीजी-13140 (13.3); प्रति पौध अधिक फली उपज के लिए प्रविष्टि एनआरसीजी-8965 (14.7 ग्राम) तथा अधिक छिलका उतराई (73.2 प्रतिशत) के लिए एनआरसीजी-11964; प्रति 100 फली भार के लिए प्रविष्टि एनआरसीजी-11890

(155.2 ग्राम); एनआरसीजी-8964 (51.8 ग्राम) एवं एनआरसीजी-10877 (52.2 ग्राम) की पहचान प्रति 100 बीज अधिक भार के लिए की गई।

- अर्जेन्टीना से प्राप्त 107 प्रविष्टियों के समूह (एचवायवी: 08; एचवायआर: 08; वीयुएल: 68; एवं एफएसटी: 23 का अध्ययन 16 गुणात्मक एवं 28 मात्रीकृत गुणधर्मो के लिए किया गया। इस समूह में एनआरसीजी-12716 को अगेती परिपक्वता (103 दिन), एनआरसीजी-14189, 13368, 7337 एवं 6890 को मध्यम अवधि में परिपक्वता (108 दिन) एवं एनआरसीजी-13350 को प्रति पौध अधिक संख्या में परिपक्व फलियों (17.5); एनआरसीजी-13368 को अधिक फली उपज प्रति पौध (12.5 ग्राम); एनआरसीजी-10331 (75.9 प्रतिशत) एवं एनआरसीजी-8364 को अधिक छिलका उतराई (78.6 प्रतिशत) के लिए मूल्यांकित किया गया।
- 417 कार्यरत प्रविष्टियों एवं कुछ अग्रवर्ती प्रजनन किस्मों को तेल एवं प्रोटीन की मात्रा के लिए खरीफ 2017 में मूल्यांकित किया गया। 417 सामान्य प्रविष्टियों में तेल की मात्रा 43.6 से 56.1 प्रतिशत; प्रोटीन की मात्रा 20.8 से 436.3 प्रतिशत तथा शर्करा की मात्रा 3.32, से 6.64 प्रतिशत के मध्य थी। जननद्रव्य प्रविष्टियों में से एक प्रविष्टि में अधिक तेल की मात्रा (52 प्रतिशत) तथा कम शर्करा (4 प्रतिशत) दर्ज की गई। 4 प्रविष्टियों में अधिक प्रोटीन की मात्रा (36 प्रतिशत), कम तेल (44 प्रतिशत) एवं अधिक शर्करा (6.5 प्रतिशत) दर्ज की गई।
- विकसित एफ$_8$ एवं एफ$_6$ वंश के अंतर्गत 2 किस्मों जीजेजी-17 x जीपीडी-4 एवं जीजेजी-22 x आईसीजीबी-86590 का उपयोग चित्रण एवं आरआईएल विकास के लिए किया जा सकता है।
- इएसटी से विकसीत नये चिन्हकों का उपयोग एफ$_2$ संख्या में एलएलएस एवं रतुआ (रस्ट) रोग की पहचान हेतु किया गया।
- रतुआ के लिए पहचाना गया एक क्यूटीएल जिसे एलजी-1 पर डीजीआर-329 एवं आईपीएएचएम-103 चिन्हकों से घिरा पाया गया, में 6.14 फिनोटीपिक विविधता व्याख्या दर्ज की गई।
- एलएलएस के लिए 2 क्यूटीएल में से एक जो कि डीजीआर-662 एवं डीजीआर-258 चिन्हकों घिरा पाया गया, द्वारा 2.65 प्रतिशत पीवीई दर्शाया गया तथा डीजीआर-2401 एवं डीजीआर-308 चिन्हकों से घिरे दूसरे क्यूटीएल द्वारा 2.67 प्रतिशत पीवई दर्शाते पाया गया।
- पर्णिय रोग प्रतिरोधिता के लिए जीजेजी-17 x जीपीबीडी-4 प्रजनन से प्राप्त 91 अंतर्गमन लाइनों को विकसित किया गया।
- जीपीबीडी-4 x सनओलिक-95 आर के प्रजनन से प्राप्त 64 लाइनों को उच्च ओलिक अम्ल की मात्रा के लिए विकसित किया गया। कुछ लाइनों में ओलिक अम्ल की मात्रा 80 प्रतिशत से अधिक पाई गई।
- पर्णिय रोग प्रतिरोधिता एवं उच्च ओलिक अम्ल की मात्रा के लिए जीन पिरामिडिंग का कार्य चार प्रजननकों में प्रारंभ किया गया अर्थात एबीएलएस-216 x एबीएलएस-5841, एवं एबीएलएस-44 x एबीएलएस-5841, एबीएलएस-36 x एबीएलएस-5841, एबीएलएस-36 x एबीएलएस-5841, एबीएलएस-2 x एबीएलएस-5841। एएस-पीसीआर एवं सीएपीएस का उपयोग एएचएफएडी 2 बी उत्परिवर्ति एलील की उपस्थिति को निश्चित करने के लिए किया गया।

मूलभूत विज्ञान

- मूँगफली की विभिन्न किस्मों में लौह एवं जसत की मात्रा, उनके फली की आकारिकी एवं बीज के आकार का अध्ययन किया गया।
- जिंक विलेयक सूक्ष्म जीवों के उपयोग द्वारा बीजों में जिंक फोर्टीफिकेशन का अध्ययन किया गया।
- सभी जिंक स्त्रोतों के द्वारा मूँगफली के दानों में जिंक एवं लौह की मात्रा में वृद्धि दर्ज की गई।
- बीजों में लौह बायो फोर्टीफिकेशन हेतु विभिन्न लौह स्त्रोतों के द्वारा बीज विलेपन किया गया।
- लौह हरिद्रोग की पहचान हेतु 100 मूँगफली किस्मों एवं 114 प्रजनन

लाइनों का परीक्षण किया गया।

- भारतीय मूँगफली किस्मों में प्रकाश संश्लेषण कुशलता का पता लगाया गया।
- उपज हानि एवं एफलाटॉक्सिन संदूषण में फली क्षेत्र आर्दता की मात्रा को एक महत्वपूर्ण घटक पाया गया।
- विभिन्न शुष्कता अवस्थाओं के अंतर्गत मूँगफली किस्मों में काफी लचीलापन देखा गया।
- विकास नियंत्रकों का मूँगफली के बीज आकार एवं फली उपज पर प्रभाव पाया गया।
- मृदा में जैविक तत्व एवं जिप्सम की मात्रा को सूखे की अवस्था से बचाने में उपयोगी पाया गया।
- अधिक तापमान का तेल की मात्रा पर ऋणात्मक एवं प्रोटीन की मात्रा पर घनात्मक प्रभाव दर्शाता है तथा वर्जिनिया किस्म में यह प्रभाव स्पष्ट रूप से दर्ज किया गया।
- फली भराव के दौरान ओ/एल अनुपात पर उच्च तापमान का ऋणात्मक प्रभाव था।
- मूँगफली में ताप प्रतिबल सहनशीलता में एएचएचएसएफ-13 की संभवतया महत्वपूर्ण भूमिका रहती है।
- 31 किस्मों में से केवल 5 किस्मों में ओ/एल अनुपात 2.0 से अधिक था। जीजी 20, जीजी-18 एवं जीजी-22 में ओ/एल अनुपात 2.9 था जबकि पीपीजी-41 में यह 2.4 पाया गया जबकि बीएयू-13 में ओ/एल अनुपात 2.04 था।
- टीएजी-24 में विवरणता गुणवत्ता अधिक (94 प्रतिशत) थी, इसके पश्यात् के क्रम में गिरनार-2 (93 प्रतिशत), टीपीजी-19ए (92 प्रतिशत), टीएलजी-5 (89 प्रतिशत) एवं जीपीबीडी-4 (87 प्रतिशत) का क्रम था जबकि कदीरि-7 में यह न्यूनतम (29 प्रतिशत) पाया गया।
- फिनॉल की मात्रा के साथ एन्टी-ऑक्सीडेन्ट गतिविधि का सार्थक सहसंबंध पाया गया।
- मूँगफली के दानों में फिनोलिक के अंतर्गत कौमारिक अम्ल एवं सीनेमिक अम्ल प्रमुख थे। इसके पश्चात् के क्रम में कैमफेरॉल, सिरिंजक अम्ल एवं सैलिसिलीक अम्ल पाये गये।
- स्यूडोमोनास प्यूटीडा डीएपीजी-4 एवं स्यूडोमोनास प्युटीडा एफपी-86 उत्पादक सूत्रीकरणों, जिसे मूँगफली में पौध विकास वृद्धि, उपज एवं पोषण उद्ग्रहण तु मँगफली में तना एवं बंध सड़न के लिए संस्तुत किया गया है, को विभिन्न मिश्रणों में विकसित किया गाय है। सूत्रीकरण 8 के द्वारा आरटी के दौरान टीकाकरण से सूक्ष्म जीवों की संख्या 6.15 x 10^{10} सीएफयू प्रति मिली 270 दिन उपरांत पाई गई। इस सूत्रीकरण को आरटी के दौरान टीकाकरण पर 200 दिनों के उपरांत स्यूडोमोनास प्यूटीडा एफपी-86 सूक्ष्म जीवों की संख्या को 3.85 x 10^{10} सीएफयू प्रति मिली तर परिपालित करने में सहायक पाया गया।
- मूँगफली राईजोबिया के आठ नये स्पर्धी प्रजातियों द्वारा बीज टीकाकरण के परिणामस्वरूप मूँगफली किस्म टीजी-37ए की फली उपज में सार्थक वृद्धि (15-36 प्रतिशत) हुई।
- मूँगफली के 5 जिंक विलेयकारी एवं 16 पोटेशियम विलेयकारी राईजोबियस पृथ्ककृतों की पहचान की गई।
- अल्टेर्नेरिया एवं पर्ण धब्बा रोगजनकों के विरूद्ध उपयोगी पर्ण अधिपादप जीवाणु विविक्तों की पहचान की गई।
- बेसिलस फरमस जे-22 स्यूडोमोनास सुडोअलकेलीजनस एसईएन-29 तथा बेसिलस सबटीलिस आईइएन-51 अंत: पादप के प्रयोग से मृदा की 5.2 विद्युत चालकता मान पर संवेदनशील किस्म टीजी37ए में उपज घटाव से सुरक्षा प्रदान करते हुए उपज में क्रमश: 28 प्रतिशत, 20 प्रतिशत एवं 18 प्रतिशत की वृद्धि (नियंत्रण में 749 किग्रा/हे. तथा इन अधिपाक्षों के उपयोग से 886-963 किग्रा/हे.) प्राप्त हुई।
- बेसीलस फरमस जे-22 का भुज में लवणता प्रतिबल में उपयोग से इसमें कमी तथा मूँगफली की उपज में 17.9 प्रतिशत सुधार नियंत्रण की तुलना में 10 प्रतिशत बढोतरी हुई।
- अनंतपुर में बेसीलस फरमस जे-22 का किसान के खेत में उपचार से अनोपचारित नियंत्रण की तुलना में

फली उपज के संदर्भ में 36 प्रतिशत सुधार था।

- बेसीलस सबटीलिस आर-51 तथा स्यूडोमोनास सुडोअल केलीजीन्स एसईएन-29 जैसे अंत:पादपों के उपयोग से मूँगफली में पादप विकास वृद्धि जैसे लक्षण एवं फली उपज में वृद्धि क्रमश: 16.5 प्रतिशत एवं 11 प्रतिशत बारानी अवस्था में दर्ज की गई।
- बारानी अवस्था में टीजी37ए के प्रकार सी३-सीएएम के उपज मूल्यांकन से डीजीआरएमबी-3, डीजीआरएमबी-5, डीजीआरएमबी-19, डीजीआरएमबी-24, डीजीआरएमबी-31 एवं डीजीआरएमबी-32 की उपज में इसके वनीय किस्म की तुलना में सार्थक वृद्धि दर्शाता है।
- टीजी37ए के प्रकारों में सी3-सीएएम के अधिक अभिव्यक्ति के परिणामस्वरूप टीजी 37 ए में 59 प्रतिशत व डीजीआरएमबी-5 में मृदा लवणता व 5.2 ईसी की स्थिति में कटाई के समय 38 प्रतिशत जैवभार हानि से सुरक्षा देखी गई।

फसल उत्पादन

- 3:1 अनुपात में मूँगफली की फलियों की उपज एवं भूसे की मात्रा अधिक दर्ज की गई जबकि 2:1 अनुपात में अरहर का वानस्पतिक अवशेष तथा जीपीईवाई की उपज अधिक थी। अरहर की छिटकाव विधि के द्वारा मूँगफली में बुवाई के 50 दिनों पश्चात् बुवाई से मूँगफली की फलियों की उपज तथा भूसे की मात्रा अधिक थी जबकि 30 दिन अरहर की बुवाई पश्चात् अरहर में वानस्पतिक अवशेष एवं जीपीईवाई अधिक मात्रा में प्राप्त हुई।
- 100 पीपीएम की दर पर पेक्लो-ब्यूट्राजोल के छिडकाव से नियंत्रण की तुलना में पुष्पों की संख्या में वृद्धि प्रति पौध परिपक्व फलियों की संख्या तथा फली उपज में सार्थक वृद्धि दर्ज की गई।
- जुताई विधियों का मूँगफली की फली उपज व भूसे की मात्रा, कपास की उपज तथा डंठल की मात्रा व जीपीईवाई पर कोई सार्थक प्रभाव नहीं प्राप्त हई जबकि सामान्य जुताई के द्वारा अरहर के दानों तथा वानस्पतिक अवशेष की मात्रा पर सार्थक उच्च प्रभाव पाया गया।
- इन तीनों फसलों के उपज पर वानस्पतिक अवशेष को यथावत छोड़ने का कोई सार्थक प्रभाव नहीं पाया गया।
- मूँगफली + अरहर अंतर सस्यन प्रणाली में मूँगफली की फलियों के उपज में सार्थक वृद्धि दर्ज की गई जबकि सपीईवाई का उच्च मान मूँगफली + कपास अंतर सस्यन प्रणाली में दर्ज किया गया।
- स्पेनिश समूह की किस्मों में ग्रीष्म काल के दौरान टीजी37ए एवं टीएजी24 में सार्थक अधिक फली उपज देखी गई।
- खरीफ काल के अंतर्गत स्पेनिश समूह की किस्म जेएल-776 तथा जीजेजी-9 में सार्थक अधिक उपज दर्ज की गई।
- 6 डेसी सीमन/मी. सिंचाई जब की तुलना में 2 डेसी सीमन/मी. लवणता युक्त सिंचाई जल द्वारा सिंचाई से अधिक फली उपज (50 प्रतिशत) दर्ज की गई।
- बिना पलवार उपयोग (नियंत्रण) की तुलना में पुआल के पलवार तथा पॉलीथीन पलवार में 37 प्रतिशत अधिक उपज दर्ज की गई।
- लवणता एवं पलवा के परस्पर प्रभाव से ज्ञात होता है कि 6 डेसी सीमन/मी. लवणता पर पॉलीथीन पलवार व पुआल के उपयोग से फली उपज में क्रमश: 47 प्रतिशत एवं 52 प्रतिशत वृद्धि, नियंत्रण की तुलना में दर्ज की गई।
- घरेलु खाद के उपयोग से अम्लीय फास्फेटस, क्षारीय फास्फेटस, मृदा डी-हाइड्रोजीनेस गतिविधियों एवं जैविक कार्बन की मात्रा (प्रतिशत) में 45 दिन बुवाई पश्चात तथा 60 दिन बुवाई पश्चात फसल कटाई के समय की तुलना में अधिक वृद्धि दर्ज की गई।
- फसल कटाई के समय जड़ आयतन प्रति पौध को छोड़कर पौध विकास तथा उपज मापदण्डों पर विभिन्न फास्फोरस उपचारों का (बिना फास्फोरस, 10 टन प्रति हेक्टेयर गोबर की खाद, 50 किग्रा फास्फोरस) कोई प्रभाव नहीं पाया गया।

- ऊष्मायन अवधि, ऊष्मायन तापमान एवं फास्फरस की मात्रा में वृद्धि के कारण उपलब्ध ओलसन-फास्फोरस की मात्रा में भारी कमी ऐरिडीसोल (बलूई मृदा) की तुलना में वर्टीसोल (काली मृदायें) में दर्ज की गई।
- वर्टीसोल मृदाओं में फास्फोरस स्थिरीकरण का क्रम इस प्रकार था - कैल्शियम-फास्फोरस > लौह-फास्फोरस > इल्यूमिनियम-फास्फोरस > सेलॉयड- फास्फोरस, जबकि बलूई मृदाओं में इसका क्रम कैल्शियम-फास्फोरस > लौह-फास्फोरस > एल्यूमिनियम-फास्फोरस > सेलॉयड-फास्फोरस था। वर्टीसोल मृदाओं में एल्यूमिनियम-फास्फोरस एवं लौह-फास्फोरस की मात्रा को 45 डिग्री सेन्टीग्रेड पर 15 डिग्री सेन्टीग्रेड की तुलना में अधिक दर्ज किया गया, जबकि कैल्शियम-फास्फोरस के संदर्भ में इसका क्रम विपरित पाया गया।

फलस सुरक्षा

- तना सड़न प्रतिरोधिता के संदर्भ में किस्म कादिरी-3 को आशाजनक पाया गया।
- जैविक सूत्रीकरणों में डीजीआरओएफ-1 एवं डीजीआरओएफ-2 द्वारा अधिकतम तना सड़न नियंत्रण प्राप्त हुआ।
- मॉड्यूल एम17ए द्वारा तथा सड़न में अधिक नियंत्रण एवं अधिक परिषकृत उपज दर्ज की गई।
- वैध्यीकरण के दौरान मॉड्यूल एम4वी से तना सड़न नियंत्रण में अधिक सहायता प्राप्त हुई।
- ग्रीष्म काल के दौरान सौराष्ट्र क्षेत्र में अल्टेनरिया पत्ती झुलसा रोग की अधिकतम समस्याएं दर्ज की गई। वर्तमान वर्ष के दौरान खरीफ काल के अंत में इस रोग की घटनायें देखी गई।
- लौह की कमी, थ्रिप्स एवं जेसिड के द्वारा मूँगफली फसल पर संक्रमण, 4 डेसी मीटर प्रति मीटर से अधिक लवणता पर मूँगफली की खेती तथा जल की कमी मूँगफली को अल्टेनैरिया पत्ती झुलसा के प्रति अधिक संवेदनशील बनाता है।
- राजस्थान के जोधपुर एवं बीकानेर जिलों में खरीफ काल के दौरान मूँगफली की फसल पर पत्ती झुलसा एवं उकठा रोग के लक्षण देखे गये जिनका आकारिकी एवं आण्विक उपायों द्वारा परीक्षण करने के पश्चात् इसे फ्यूजेरियम इन्कार्नेटम द्वारा प्रेरित पाया गया।
- 7 जिलों के 28 गाँवों में सर्वेक्षण के द्वारा 5 सफेद कीट डिंभों की पहचान की गई जिसमें फाइलोग्नेथस डीयोननिसियस, होलोट्रीपिया सिरेट, होलोट्रीकिया प्रजाति एवं होलोट्रीकिया रियानोदी सम्मिलित है।
- भण्डारण के दौरान ब्रुचीड बिटल की समस्या के प्रबंधन में एकोरूस केलेमस (वाचा, स्वीट फ्लैग) का 20 प्रतिशत की दर पर उपयोग को प्रभावकारी पाया गया।

सामाजिक विज्ञान

- प्रेक्षेत्र प्रबंधन कुशलता, संसाधन उपयोग कुशलता एवं लघु तथा सीमान्त किसानों में तकनीकी कुशलता के अध्ययन से ज्ञात होता है कि इस समूह के द्वारा उत्पादन को निर्धारित करने में भूमि तैयारी, बीज एवं शस्योत्तर रख-रखाव विधियों का प्रभाव पड़ता है। इन घटकों पर संसाधनी का उपयोग अधिक था।
- तकनीकी कुशलता ज्ञात करने के लिए फ्रंटियर फंक्शन के उपयोग से ज्ञात होता है कि 88 प्रतिशत लघु एवं सीमान्त किसानों में 24 से 37 प्रतिशत उत्पादन हानि प्रमुख थी। प्रेक्षेत्र प्रबंधन क्षमता के अनुरूप उपरोक्त सभी मध्यम वर्ग के अंतर्गत आते हैं।

1 Genetic improvement of groundnut

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

(Ajay BC, Gangadhar K, Nataraj KC, Malleswari Sadhneni)

Hybridization, selection and generation of advancement in segregating generations

Six fresh crosses were attempted in *kharif* 2017 to enhance fresh seed dormancy, tolerance to drought stress and yield attributes and more than 1100 hybrid pods were harvested with 33% crossing success. In summer 17 probable hybrid pods from five crosses attempted in kharif 2016 were raised and F_2 hybrids were harvested as single plants. Seventeen crosses in F2 generation were raised in Anantapur under rainfed conditions and 87 and 88 single plant progenies (spp) belonging to Spanish and Virginia group were selected. From 9 different crosses in F4 generation 32 and 22 single plant progenies (spp) belonging to Spanish and Virginia group were selected.

Multiplication of promising breeding lines

Around 270 most promising 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. Among the checks K6 had high pod yield and M 13 had high haulm yield. Genotypes NRCG 7249, 11289, 11865, 11551, 12651, 14342, 14365 and TIR 27 had high pod yield than the superior check. Similarly, more than 20 genotypes had high haulm yield and 10 genotypes had high RWC.

Screening Spanish DSN for drought tolerance at nantapur

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. Among the checks K6 had high pod yield and M 13 had high haulm yield. Genotypes JUN 30, PBS 16013, 11090, 30027 and 30044 had high pod yield per plant when compared to superior check. Genotypes PBS 15013, 16016, 11090, 16021, 16023 and 15045 had high haulm yield per plant.

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 21117, 21097, 25050, 25070, 25058, 25085 and 25118 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 CS-237 and CS-386 had high pod yield per plant; CS-19, CS-369, CS-498 and CS-567 had high haulm yield; and CS-124, CS-173, CS-386 and CS-573 had high RWC.

Screening of new set of DSN for drought tolerance at Anantapur

A set of 76 new DSN were screened for drought tolerance along with six 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 PBS 24102, 24104, 24157, 24081, 24105 and 24128 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 per plant, haulm yield per plant and harvest index. Cultivar R 2001-1 and ICGV 86031 had pod high yield and haulm yield when compared to K6 and K9.

Breeding for alternaria leaf blight resistance in groundnut

(Narendra Kumar, Rathnakumar AL, Dutta R and Chandramohan Sangh)

Hybridization

Fourteen crosses were effected in *kharif* 2017 to develop improved varieties resistant of *Alternaria* leaf blight, leaf spot and rust, and stem rot. The

Dr. Peter Carberry, DDG, ICRISAT interacting with DGR Scientists

Selection in segregating generation

number of harvested crossed pods varied from 82 (KDG-128 × NRCGCS-19) to 245 (TG-37A × NRCGCS-74) in ten crosses. The mean success rate (%) of the hybridization programme in ten crosses was 37.2, which ranged from 23.6 to 50.3%. Four crosses were made by PI of this project in which average success rate of these crosses was 67.4% which ranged from 43.2 to 88%.

Identification of hybrids

Ten different crosses were raised in summer 2017 to identify F_1's effected for developing resistant genotypes to stem rot, *Alternaria* leaf blight, collar rot and leaf spot and rust diseases. A total 133 probable single plants have been identified as hybrids in all the ten crosses and it ranged from 1-38. A maximum number of F_1's have been identified in the cross TG 37A × CS 319 (38) followed by Dh 86 × CS 74 (24) andGG 7 × KDG 123 (23).

Two crosses were raised in *kharif* 2017 to identify F_1's effected for developing resistant genotypes to leaf spot and rust. A total 213 probable single plants have been identified in both the crosses. A maximum number of F_1's have been identified in the cross TG 37A × GPBD 4 (172) followed by GG20 × GPBD 4 (41).

Advancement of different filial generations

The breeding materials generated earlier were advanced to next higher filial generation. Progenies of 54 crosses were advanced in *kharif* 2017 to different filial generations (F_2-F_6), among them 35 crosses in early generations (up to F_4) and 19 in advanced generation. At the time of harvest one cross were rejected due to large proportion of poor recombinants and absence of desirable trait of interest in the recombinants. In F_6 generation, individual plant progenies of 11 crosses were raised to identify high yielding stable genotypes, among these one cross was rejected and from the remaining ten crosses eighteen new advanced high yielding stable breeding lines (SB-2, VB-16) were identified and given nomenclature according to objective and their botanical group.

Yield evaluation of advanced breeding lines

A. Summer 2016-17

A total 20 Spanish bunch advanced breeding lines evaluated with four checks (TAG 24, TG-37A, Dh 86 and TPG 41) in RBD with three replications for yield and its component traits during two consecutive summer 2016-17. The results revealed that none of the genotype significantly surpass the best check Dh 86 for pods/plant, pod and kernel yield (kg/ha) and TPG-41 for SOT (%). Among the test entries only one advanced breeding line PBS-12204B found at par with best check Dh-86 for pod and kernel yield.

Yield evaluation trials in summer 2017

B. *Kharif*-2017

Spanish bunch (Second year):
A total eleven Spanish bunch genotypes evaluated along with two high yielding checks varieties TG-37Aand JL-501 in five rows of 5m row length for yield and its component traits in a RBD with three replications during *kharif*-2016 and *kharif*-2017. The results revealed that none of the genotype significantly superior over best check for all the traits excepts two advanced breeding line PBS-12209 (73%), PBS-12211 (74%) were significantly superior over the best check JL 501(70%) for shelling outturn. It can be used as donor parent for improving shelling outturn in Spanish groundnut.

Virginia bunch (Second year):
Total twelve genotypes of Virginia bunch along with three high yielding recommended checks *viz*. GG-20, KDG-123, KDG-128 used for evaluation in five rows of 5m length for yield and its component traits in RBD with three replications for *kharif* 2015 & 2017. The results revealed that none of the genotype significantly surpass the best check variety KDG-128 for no. of pods/plant (20), pod and kernel yield (3400, 2377kg/ha), shelling outturn (70%).

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

I. Development of new advanced breeding lines

A total eighteen new advanced high yielding breeding lines were developed from advanced materials during *kharif* 2017, of which two lines belongs to Spanish bunch (PBS 12228, PBS 12229) and sixteen lines belongs to Virginia bunch habit group (PBS 22138, PBS 22139, PBS 22140, PBS 22141, PBS 22142, PBS 22143, PBS 22144, PBS 22145, PBS 22146, PBS 22147, PBS 22148, PBS 22149, PBS 22150, PBS 22151, PBS 22152, PBS 22153).


Yield evaluation trials in *Kharif*-2017

II. Multiplicationand maintenanceof breeding materials

A. Summer-2017:
A total 45 advanced breeding lines multiplied during summer-2017 to get sufficient seed for conducting yield and screening trials.

B. *Kharif*-2017:
A total 483 advanced breeding lines, cultivars, germplasm lines and new advanced breeding lines were mass multiplied during *kharif*-2017 to got sufficient seed for conducting yield and screening trials.

III. Multiplication and status of AICRP-G lines

During *kharif*-2017, seed of three elite breeding lines (PBS-12196, PBS-12200 and PBS-12201) were mass multiplied to get sufficient seed required for AICRP-G trials and among them seed of one elite breeding line PBS-12196 was evaluated in IVT-I (SB) in *kharif*-2017. One elite breeding line PBS-12200 will be proposed for testing under AICRP-G trials in *kharif*-2018.

Genotype	Summer-2017		Sub Total	*Kharif*-2017		Sub Total	Total
	SB	VB		SB	VB		
ABLs for conducting trials	14	11	25	08	07	15	40
ABLs for maintenance	0	0	00	60	62	22	122
New ABLs	5	4	09	05	04	09	18
Cultivars/Minicore	9	0	09	111	180	291	300
AICRP-G lines	0	0	00	03	00	03	03
			45			**440**	**483.0**

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

The breeding material of 46 different crosses from three segregating and two advanced generations (F_3 and F_7) was selected in *kharif*-2017 and supplied to nine AICRP-G centres to effect location specific selections for different biotic stresses for *kharif* 2018. Besides that 24 advanced breeding lines developed for tolerance of collar rot were also supplied to PAU, Ludhiana for screening for resistance of collar rot. Twelve and ten high advanced breeding lines also supplied to RVSKVV, Gwalior and UBKV, Cooch Behar respectively for yield evaluation in station trials.

PBS-12196

PBS-12200

PBS-12201

List of segregating materials supplied to different AICRP-G centers for *kharif*-2018

SN	Name of crosses	Purpose of crosses	Wt. (gm)	AICRP-G Centre
Segregating generation: F_3				
1	TG 37A × CS 319	High yield and stem rot resistance	400	Ludhiana
2	TG 37A × CS 186	High yield and resistance of Alternaria leaf spot	200	Udaipur
3	Dh 86 × CS 74	High yield and resistance of Alternaria leaf spot	450	Udaipur
4	JL-776 × OG-52-1	High yield and tolerance of collar rot, Spodoptera and thrips	180	Bhubaneswar
5	GG-7 × KDG-123	High yield and foliar disease resistance	140	Udaipur
Segregating generation: F_4				
1	CS 319 × TG 37A	High yield and stem rot resistance	85	Ludhiana
2	TG 37A × CS 186	High yield and resistance of Alternaria leaf spot	2100	Mainpuri, Palem, Udaipur
3	CS 186 × TG 37 A	High yield and resistance of Alternaria leaf spot	190	Udaipur
4	Dh 86 × CS 74	High yield and resistance of Alternaria leaf spot	900	Mainpuri, Bhubaneswar
5	CS 74 × Dh 86	High yield and resistance of Alternaria leaf spot	450	Mainpuri, Bhubaneswar
6	JL 776 × KDG 123	High yield, FDR and tolerance of Spodoptera and thrips	870	Bhubaneswar and Hiriyur
7	JL 776 × KDG 128	High yield multiple tolerance of Spodoptera, leaf miner, jassid, and thrips	400	Raichur Hiriyur
8	GG 7 × RHRG 06083	High yield and foliar disease resistance	80	Gwalior
9	TG 37A × CS 319	High yield and stem rot resistance	2180	Ludhiana, Latur, Palem
10	TPG 41 × CS 186	High yield and resistance of Alternaria leaf spot	1050	Mainpuri, Udaipur
11	GJG 17 × GPBD 4BC1F4	High yield and foliar disease resistance	1345	Gwalior, Raichur Bhubaneswar

Contd...

SN	Name of crosses	Purpose of crosses	Wt. (gm)	AICRP-G Centre
Segregating generation: F_5				
1	TG 37A × ALR 1	High yield and foliar diseases resistance	950	Hiriyur, Bhubaneswar
2	GG 7 × GPBD 4	High yield and foliar diseases resistance	385	Raichur, Gwalior
3	GG 2 × RHRG 06083	High yield and foliar diseases resistance	960	Udaipur, Gwalior
4	GG 2 × ICG 1697 (NCAc 17090)	High yield and foliar diseases resistance	1300	Mainpuri, Gwalior
5	GG 2 × CS 74	High yield and resis. of Alternaria leaf spot	145	Udaipur
6	JL 776 × KDG 128	HY multiple tol of spodo, LM, jassid, and thrips	270	Raichur
7	GG 20 × CS 319	High yield and stem rot resistance	510	Ludhiana
8	TG 37A × CS 319	High yield and stem rot resistance	780	Latur
9	GG 20 × CS 319	High yield and stem rot resistance	265	Latur
10	TG 37A × CS 319	High yield and stem rot resistance	475	Ludhiana
11	VRI 2 × Kadiri 9	High yield and foliar diseases resistance	1300	Hiriyur/ Palem
12	Kadiri 9 × VRI 2	High yield and foliar diseases resistance	460	Palem
13	BAU13 × CS196	High yield and foliar diseases resistance	110	Bhubaneswar
14	GPBD 4 × CS 196	High yield and foliar diseases resistance	175	Raichur
Segregating generation: F_6				
1	TAG 24 × CS 349	Tolerance to Alternaria leaf spot	225	Mainpuri
2	GG20 × JCG 88	HY, wider adap and tol to A. flavus	190	Palem
3	CTMG 6 × BG 2	HY and tolerance to Spodoptera	460	Hiriyur
4	TG 37A × NRCG 357	High yield and wide adaptation	160	Mainpuri
5	GG 20 × GBPD 4	High yield and foliar diseases resistance	90	Gwalior
6	GG 20 × CS 196	High yield and foliar diseases resistance	1000	Raichur, Gwalior
7	GPBD 4 × CS 196	High yield and foliar diseases resistance	350	Raichur

Contd...

SN	Name of crosses	Purpose of crosses	Wt. (gm)	AICRP-G Centre
Segregating generation: F_7				
1	GG 20 × CS 19	High yield and stem rot resistance	1550	Ludhiana, Latur
2	J 11 × GG 20	High yield tolerance of collar rot	1150	Ludhiana, Latur
3	ICGV 00350 × JSP 39	Tolerance to stem rot	1600	Latur, Palem
4	RHRG 06083 ×	High yield and multiple tolerance of FDR, insect pest and PBND resistant	690	Mainpuri, Raichur
5	BAU13 × CS196	High yield and foliar diseases resistance	1280	Gwalior, Bhubaneswar
6	GG 20 × GBPD 4	High yield and foliar diseases resistance	590	Gwalior, Udaipur
7	GPBD 4 × CS 196	High yield and foliar diseases resistance	1060	Raichur, Udaipur
8	TG 37A × CS 85	High yield and Tolerance to stem rot	125	Ludhiana
9	GJG 17 × GPBD 4	High yield and foliar diseases resistance	600	Gwalior, Udaipur

List of advanced breeding lines developed for tolerance of collar rot and supplied to PAU, Ludhiana for screening of resistance to collar rot

SN	Advanced breeding line	SN	Advanced breeding line	SN	Advanced breeding line
1	PBS-12009	9	PBS-18037	17	PBS-22087
2	PBS-12018	10	PBS-18038	18	PBS-22089
3	PBS-12223	11	PBS-18055	19	PBS-22092
4	PBS-12224	12	PBS-18057	20	PBS-22130
5	PBS-18006	13	PBS-18062	21	PBS-22131
6	PBS-18029	14	PBS-18064	22	PBS-22132
7	PBS-18033	15	PBS-22075	23	PBS-22133
8	PBS-18035	16	PBS-22086	24	PBS-28014

List of high advanced breeding lines supplied to RVSKVV, COA, Gwalior for adaption trial

SN	Advanced breeding line	Habit type	SN	Advanced breeding line	Habit type
1	PBS 22059	VB	7	PBS 22116	VB
2	PBS 22062	VB	8	PBS 22122	VB
3	PBS 22063	VB	9	PBS 22132	VB
4	PBS 22066	VB	10	PBS 12196	SB
5	PBS 22067	VB	11	PBS 12200	SB
6	PBS 22080	VB	12	PBS 12201	SB

SB- Spanish bunch, VB-Virginia bunch

Screening of advanced breeding lines for foliar disease resistance

Summer 2016-17

A total 27 genotypes were screened for resistant to *Alternaria* leaf blight with resistant check *viz*., NRCSCS-349, NRCSCS-74 and NRCSCS -186 during summer-2016-17.The experiment was conducted under field condition with infector row technique in RBD with three replications. Maximum disease pressure was observed in infector row PBS-12205 (score 6.7 & 7 on 1-9 scale in 2016 & 2017). Based on the two year data only one advanced breeding line PBS-12190 had disease score ≤4.3 which was at par with resistant genotypes.

A total 78 groundnut genotypes including advanced breeding lines, cultivars and interspecific derivatives were screened in the augmented design for resistant to *Alternaria* leaf blight by infector row technique during summer-2017. Genotype NRCSCS-74 was used as resistant check for screening (4.0 disease score on 1-9 scale). Maximum disease incidence was observed in the cultivar Narayani (score 7.0 on 1-9 scale). Results revealed that six cultivars *viz*., Kaidiri-9, Kadiri Haritendra, GPBD-5, TG-38B, ICGV-00348 and GJG-17; six advanced breeding lines *viz*., PBS-12183, PBS-12185, PBS-12186, PBS 22131, PBS 22132 and PBS 22133; five interspecific derivatives *viz*., NRCGCS-85, NRCGCS-176, NRCGCS-180, NRCGCS-196 and NRCGCS-298 found resistance and recorded a disease score 3 on 1-9 scale. These genotypes need to be screen at least three more season/year to confirm resistance across the years.

Kharif 2017

A total 42 genotypes along with resistant check *viz*., GPBD 4 (high yielding leaf spot and rust resistant variety) were screened in replicated trial under natural condition for resistance of foliar diseases (early, late leaf spot and rust) during *kharif*, 2017. The maximum disease pressure for early leaf spot (ELS), late leaf spot (LLS) and rust was 9.0, 4.3 and 3.3 respectively on modified 1-9 point scale.In general in *kharif* season, the disease incidence of ELS was higher than LLS and rust incidence was almost absent in all the genotypes.

For early leaf spot, none of the genotypes showed resistance score ≤3 on 1-9 scale. Genotypes viz., PBS 22113, PBS 22118, PBS 22066, PBS 22126, KDG 123 and KDG 128 showed tolerance reaction with score ≤6 on 1-9 scale. Disease incidence of LLS and rust incidence was not high enough for distinguishing genotypes based disease score.

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 CSWRI-ARC, Bikaner during *kharif* 2017. Data were recorded on plant mortality up to 45 DAS. The average collar rot incidence ranged from 12 and 70% during studied period. Results revealed that one advanced breeding lines PBS-22092 recorded average ≤ 10% disease incidence in all the replications which is less than disease incidence reported by tolerant genotype OG-52-1 (12%) and J-11(15%). Advanced breeding line PBS-22092 also recorded less than 10% disease incidence during 2015 (8.5%) and 2016 (6.6%). This breeding line need to be screen one more year at Bikaner to registered as a novel source of resistance to collar rot in groundnut.

Breeding for Fresh seed dormancy and reducing maturity duration in groundnut

(Gangadhara, K., Rathnakumar, AL, Ajay B.C., Chandramohan, S. and Sushmita S.)

Screening germplasm collections for early maturity and productive traits

About 98 germplasm lines were evaluated for early maturity during summer 2017. Among the germplasm collections evaluated for early maturity and drought tolerant droughts genotypes, Girnar 1, TAG 24, TLG 45, NRCG 14407, SG 99 and TG 26 were showed early flower initiation and day to 50 per cent flowering as well as low SLA and high SCMR

Evaluation of advanced breeding lines for early maturity and productive traits

During summer-2017, twenty three advanced breeding lines were evaluated by following simple RBD design in three replications for early maturity and drought related traits. Significant differences were observed among the advanced breeding lines for both maturity and drought related traits. Advanced breeding lines PBS 15022, PBS 16038, PBS 30001 and PBS 30044 were found to be early maturing during rabi/ summer-2017 at Junagadh. Advanced breeding lines PBS-15059 (DFI), PBS- 15061 and PBS- 15059 (DFF), PBS- 15022 (YLD), PBS- 11077 and PBS-15059 (HKW), PBS-30001 (SP), PBS- 15044 and PBS- 16029 (SCMR) and PBS-15041(SLA) were found promising for both traits.

Hybridization and hybrid identification

F_1s from ten crosses generated during *kharif* -2016, were raised along with their parents during summer-2017 and total of 256 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 and NRCG 14338 for short duration and fresh seed dormancy.

During *kharif* 2017, ten crosses were effected for short duration, fresh seed dormancy and foliar disease resistance. A total of 397 pods were harvested from ten crosses involving different parents *viz.,* PBS 19022, PBS 15044, GPBD 4, Chico, TAG 24, TG 26, Girnar 1, JL 24, NRCG 6255, NRCG 14368 and NRCG 14338. The success rate was highest in cross TAG × Girnar 1 (41.02%) and lowest success rate was in PBS 15044 × Chico (21.52%).

Evaluation of Spanish Bunch Advanced breeding lines early maturity trial (SBEMT)

About 55 Spanish advanced breeding lines were evaluated for maturity and drought related traits by following Augmented RBD design with five checks during *kharif* 2017. Advanced breeding lines PBS 11086, PBS 11091, PBS 15048 and PBS 16015 for days to initiation of flowering; PBS 15052 and PBS 11091 for high SCMR ; PBS 15024, PBS 15036, PBS 16039 and PBS 16040 for low SLA and PBS 15056 and PBS 16027 for pod yield per plant were found superior over checks.

Evaluation of interspecific derivatives for early matirtuy and foliar diseases

Twelve interspecific derivatives evaluated for late leaf spot incidence and yield contributing traits in RBD design with three replications during *kharif* 2017. NRCG CS 254 was found to be superior for pod yield per plant, early flower initiation. Another interspecific derivative NRCG CS 313 was found interesting for tolerance to LLS, short duration and pod yield per plant.

Studies on genetic diversity in collection of elite verities and germplasm collections

About 97 germplasm collections consists of released varieties and gene bank collections were evaluated for maturity and productive traits during *kharif* 2017 by following RCBD design in two replications. Promising Germplasm identified for different traits are Girnar 3, GG 20, TLG 45 and GJG 17 for pod yield per plant; TAG 24, Dh 98, Dh 101, GG2, TG 26 and TG 39 for days to maturity; NRCG 14463, NRCG 14386 for SLA; NRCG 8763, NRCG 7627 and GG 6 for days to first flower initiation. LLS Tolerant germplasm accessions identified are NRCG 10983, NRCG 14350, NRCG 143 79, NRCG 14386, NRCG 14457, NRCG 14473, NRCG 14485 and NRCG 1449 and among the released varieties AK 12-24, Girnar 1, GJG 17, GJG 31 and LGN 2 were found tolerant to LLS during *kharif* 2017.

Generation advancement

Different segregating generation were advanced later generations and the individual number of plants selected were 162 (F_2), 19(F_3), 16 (F_4), 25 (F_5) respectively from total of twenty five crosses during *kharif* 2017 for PBS 11091 for high SCMR ; PBS 15024, PBS 15036, PBS 16039 and PBS 16040 for low SLA and PBS 15056 and PBS 16027 for pod yield per plant were foproductive and large seeded and foliar disease resistance.

Screening of mutant population (M_4) for physical and biochemical traits

A total of 130 mutants derived from TPG 41 variety were evaluated for physico-productive traits in M_4 generation. The popular groundnut variety TPG 41 was mutagenized with EMS mutagen with different concentrations from 0.2 % to 0.6 %. The superior mutants isolated for different traits are Line number 27, 100 and 130 for pod yield per plant; line number 34, 45 and 62 for sound mature kernel (%). und superior over checks.

Field view of different advanced breeding lines

Morphological variation in M_4 generation of TPG 41

Multiplication of ABL's

During *kharif*- 2017, total of 19 advanced breeding lines consists of both Spanish and Virginia types (PBS 19035, PBS 19036, PB 19037, PBS 19038, PBS 29236, PBS 29237, PBS 28398, PBS 29239, PBS 29240, PBS 29242, PBS 29243 and PBS 18244) were multiplied for further maintenance and yield evaluation trials. Twenty three advanced lines were maintained for future breeding programmes.

Maintenance of advanced breeding lines

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 programmmes.

New advanced breeding lines developed

New advanced breeding lines (PBS 19035, PBS 19036, PBS 19037, PBS 19038, PBS 29236, PBS 29237, PBS 29238, PBS 29239, PBS 29240, PBS 29241, PBS 29242, PBS 29243, PBS 29243, PBS 29244) were multiplied for yield evaluation trials.

Multiplication of promising elite advanced breeding lines for AICRP trials

Three advanced breeding lines (PBS 15022 (Entry level), PBS 15044 (IVT-II), PBS 19018 (AVT) and PBS 19022 (AVT) were multiplied for AICRP trials.

Genetic Enhancement and Management of Groundnut Genetic Resources

(Rathnakumar AL, Gangadhara K, Bera SK, Mahatma MK and Ajay BC)

Field maintenance of Wild *Arachis* germplasm

A total of 106 accessions under 6 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. Seeds seven amphidiploid derivatives have been field established for further use in crop improvement programme.

Acquisition, distribution and utilization of germplasm accessions

In summer, 2017, three (TCGS 1157, ICGV 07222, GKVK-5) pre-release varieties from SAUs and 30 wild *Arachis* germplasm from ICRISAT were acquired A total of 323 germplasm accessions of groundnut were supplied to 18 indenters for use in the crop improvement programme. These germplasm were supplied to the scientists of DGR (168), State Agricultural Universities (115), ICAR (5), ICRISAT (28) and others (7) to identify promising lines for WUE, diseases and nematode tolerance, large seeded types and to use in crossing programmes.

During kharif 2017, seeds of three Mini-core germplasm accessions were acquired from ICRISAT. A total of 478 germplasm accessions of groundnut were supplied to 15 indenters for use in the crop improvement programme. These germplasm were supplied to the scientists of AICRP-G (50), DGR (394), and State Agricultural Universities (34) to identify promising lines for WUE, diseases and nematode tolerance, large seeded types and to use in crossing programmes.

Multiplication and conservation of germplasm accessions

A total of 70 accessions (South American collection) were multiplied in summer 2017. A total of 1611 germplasm accessions have been multiplied in kharif 2017: Crop Cafeteria (45), ICRISAT Mini-core (184), Released Varieties (200), sub-set of working collection (167), accessions with low Carbon Isotope Discrimination (30), and of accessions for rejuvenation (985).

Screening for low and high temperature tolerance under feild 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 germination 36 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 2017) to evaluate effect of low temperature on germination and reproductive traits and late (31 March 2017) 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. 3 Feb 2017.

Weather

First year (Summer, 2016):

However, the temperature was in the range of 10° to 30°C during the week followed by sowing. Subsequently, in February (13°C-37°C); March (22.7°C-40°C); April (21.6°C-39.4°C) and May (25.5°C-40.2°C) the effect of low temperature could not be ascertained on germination and reproductive traits. However the pod yield under this condition was 445 g (GJG 17), closely followed by ICGV 00350 (400g) per 3m row. Among the mini-core accessions NRCG 14383 (VUL) exhibited 320 g of pod yield and NRCG 14424 with 305 g/3m row under late sown conditions.

Second year (Summer 2017):

At the time of early sowing (19th of January) the air temperature was in the range of 12.0 to 28.9°C. Soil temperature at 5-10 cm depth was around 22°C; in February (12°C-32°C) and soil temperature was 22.3 to 23.6°C; March (18°C-36°C); April (23.0°C-41.0°C) with soil temperature ranging from 32.6 to 33.8°C and in May (25.2°C-40.0°C) and soil temperature was 33.6-33.9°C. Subsequently in June 192.4 mm rainfall was received in 11 rainy days. Hence the effect of low and high temperature could not be ascertained on germination and reproductive traits in both the years.

However, under both early and late sown conditions genetic variations for days to germination and germination (%) *per se*; duration for flower initiation to fifty percent flowering and seventy five percent flowering varied widely among mini-core accessions and released varieties evaluated. Based on the above criteria promising accessions (NRCGS 14405, 14376) and released varieties (TAG 24, TG 26, Dh 86, ICGV 00350) could be identified which are currently being evaluated at Bawal (Hisar) and Raigarh (Chhatisgarh).

Characterisation of South American collection

In *kharif* 2017, a set of 103 accessions (HYB: 71; HYR: 11; VUL: 05 and FST: 16) belonging to Bolivia has been characterized for 16 qualitative and 28 quantitative traits. NRCGs 8967 and 9238 matured in 110 days whereas NRCGs 11896, 11950 and 11934 matured in 111 days. Number of mature pods per plant ranged from 10.8 (NRCG 8965) to 13.3 (NRCG 13140). Pod yield per plant ranged from 11.8 g (NRCG 8968) to 14.7 g (NRCG 8965). Shelling out-turn ranged from 71.9% (NRCG 13140) to 73.2% (NRCG 11946). There was wide variation in hundred pod mass which ranged from 119.5 g (NRCG 11944) to 155.2 g (NRCG 11890). Hundred seed mass ranged from 46.0 g (NRCG 11946) to 52.2 g (NRCG 10877). Two accessions showed HSW >50 g i.e. NRCGs 8964 (51.8 g) and 10877 (52.2 g).

Another set of 107 accessions (HYB: 08; HYR: 08; VUL: 68 and FST: 23) originating from Argentina has been characterized for 16 qualitative and 28 quantitative traits. NRCGs 12716 matured in 103 days whereas NRCGs 14189, 13388, 7337 and 6890 matured in 108 days. Number of mature pods per plant ranged from 11.3 (NRCG 8297) to 17.5 (NRCG 13350). Pod yield per plant ranged from 8.8 g (NRCG

13127) to 12.5 g (NRCG 13368). Shelling out-turn ranged from 75.9% (NRCG 10331) to 78.6% (NRCG 8364).

Hundred pod mass ranged from 88.2 g (NRCG 13344) to 98.8 g (NRCG 13357) whereas Hundred Seed Mass ranged from 36.6 g (NRCG 14142) to 39.4 g (NRCG 12969 and 13369).

Analysis of quality (oil, protein) of working collection accessions

417 accessions of working collection and few advanced breeding lines have been evaluated for oil, and protein in kharif 2017. The oil content in 417 general accessions ranged from 43.6%-56.1%; protein content ranged from 20.8%-36.3% and sugar content ranged from 3.32% to 6.64%. Among the germplasm accessions, one accession exhibited high oil (52%) with low protein (26%) and low sugar (4%) content; four accessions were found to have high protein (36%) with low oil (44%) and high sugar (6.5%) content.

Testing of the five candidate varieties of groundnut under DUS project

Five candidate varieties: Western Vardan, Lal, Badam LO, Govardhan GL, and 'Ramkrishna' received from PPV & FRA, New Delhi under different registration numbers have been sown under DUS Project for characterization along with eight reference varieties of different habit groups: 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 have been recorded at appropriate growth stages in the format given by PPV and FRA, New Delhi under DUS Test guidelines; this includes 13 qualitative 5 quantitative descriptor traits.

Another set of five candidate varieties JHUMKUL, INDOORI, MANOHAR MOONGFALI, BHADELIFALLI, SOTHAFALLI, and JEET BADAM have been received by this centre but only after completion the normal sowing time in Gujarat. Hence these were multiplied for seed enhancement so that these can be accommodated in the next *kharif* season for DUS testing.

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

(Sangh Chandramohan, Bera SK, Abhay Kumar, Bishi SK, Narendra Kumar)

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

Groundnut F_2 mapping population of 328 segregating for two important foliar fungal diseases *viz*., Late leaf spot (LLS) and rust was developed by crossing susceptible parent GJG 17 and resistant parent GPBD 4. The F_2 seeds were sown in the field and artificial disease epiphytic conditions were created by "spreader row technique" using susceptible lines. Genotyping was done with 54 identified polymorphic SSR markers and phenotyping data wasrecorded for both LLS and rust performed at the time of harvesting using modified 9-point scale and other important morphological traits for which parents were diverse. Further, the genotypes in which SSR primers not amplified were sorted and again PCR was performed with same set of primers and genotyped.

The linkage map was constructed using software ICIM QTL multipoint analysis with minimum LOD score of 3.0 and maximum recombination fraction (θ) of 0.5 was set as threshold for linkage group determination. Out of 910 SSR markers screened, only 54 were found to be polymorphic between parents (GJG 17 × GPBD 4) of the F_2 mapping population. Almost all markers showed typical Mendelian segregation ratio (expected 1:2:1). All the 54 markers were used for linkage map construction. A total of 44 markers were mapped on 10 linkage groups (LGs spanning 1225.4 cM) and 10 markers remained ungrouped. The lengths of linkage groups were ranging from 4.26 cM (LG 6) to 916 cM (LG 1) with an average distance of 27.88 cM.

The linkage map constructed based on GJG 17 x GPBD 4 was used for identification and mapping of QTL for resistance to LLS and rust besides agronomic traits.

The F1 hybrids obtained from the cross CS196 x TMV 2 was confirmed using SSR markers and these were used to develop the 350 F2 mapping population. Further the F2 population was phenotyped in kharif 2017 for LLS and Rust.

Generation advancement of development RIL population

The 1761 F_2 lines from the cross GJG 17 x GPBD 4 were sown in the field in kharif 2014 and subsequently taken for generation advancement by single seed descent method (SSD). A total of 1260 F_5 lines were obtained from F_4 lines in kharif 2016. These F6 lines are in the field in current season (Summer 2017). The F_7 lines will be obtained and further could be used as RIL mapping population for LLs and rust and also for other morphologically important traits. Similarly 600 F_5 lines were grown in summer 2017 and F_6lines were obtained and will be taken for generation advancement for RIL development.

Marker assisted selection for fungal foliar disease resistance:

Two fresh crosses were effected to develop high yielding improved varieties resistant of leaf spot and rust (TG-37A × GPBD-4 and GG-20 × GPBD-4). The hybrids were raised in *kharif* 2017 to identify F_1's for developing resistant genotypes to leaf spot and rust. These hybrids were identified using diagnostic marker for leaf spot. Conformed F1 were used as male parent to cross with female parents TG 37A and GG 20 and obtained BC1 Plants for transferring the resistance gene in recurrent parent background.

QTL mapping for foliar fungal disease resistance

QTL analysis was performed by Composite Interval Mapping (CIM) using phenotypic and genotypic data of LLS, Rust and for other morphological traits with help of ICIM software. One QTL identified for rust flanked by marker DGR 329 and IPAHM 103 on LG 1 which showed 6.14 % Phenotypic Variability Explained (PVE). Two QTLs for LLS, one flanked by markers (DGR 662 and DGR 258) and showed 2.65 % PVE, another flanked by markers (DGR 2401 and DGR 308) and showed 2.67 % PVE.

One major QTL was identified for pod constriction which showed 11.0 % PVE and flanked by marker DGR 2401 and DGR 308 on LG1. Two QTLs for pod reticulation, one flanked by markers (DGR 508 and DGR TC11H06) and showed 3.45 % PVE, and another flanked by markers (TC11H06 and DGR 1550) and showed 3.40 % PVE. Two QTLs for stem thickness, one flanked by markers (DGR 258 and GM 2079) and showed 5.69 % PVE, and another flanked by markers (DGR 2401 and DGR 308) and showed 5.38 % PVE.

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 was tested for foliar diseases resistance in *Kharif* 2017. 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 checks 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 atomized 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 recorded score of 6.5 (LLS) and 6.0 (rust) and susceptible check recorded score of 7.5 for both diseases at that time.

Fatty Acid Profiling:

The parents (GPBD4 and SunOleic 95R) and ILs identified after genotyping were subjected to GC analysis for fatty acid compositionto ascertain successful introgression of target trait. A total of 11 different fatty acids were detected in theseintrogression lines; among which oleic, linoleic and palmiticacids were predominant fatty acids constituting more than 80% of total oil fatty acids**.** The oleic acid content in introgression lines ranged from 67.72% to 81.32% with the mean of 77.95%, while, the linoleic acid content ranged from 1.80 to 13.51% having mean of 3.98%. There were no significant differencesbetween donor parent SunOleic95R and 18 different ILs for oleic acid content, while it was at par with donor parent in another 16 ILs. A total of 57 ILs were found significantly similar with SunOleic95R among 64 ILs developed for linoleic acid content. With respect to recurrent parent (RP), 32.52-59.14% increment was recorded among the ILs for oleic acid content with an average increase of 52.54%; on the contrary, linoleic acid showed 48.32-93.11% decrease as compared to recurrent parent. In our study among 64 ILs only five ILs possess below 75% of oleic acid and six ILs above 5% of linoleic acid while only four had O/L ratio of below than industrially acceptable ratio of 9. The palmitic acid content was varied from 5.88 to9.08% with an average of 7.02%, which is a reduction of 36.36%comparedto the recurrent parent. Saturated fatty acids; steric, arachidic, and behenic acid contents were did not significantly differ among the ILs as well as parents.

Statistical analysis revealed significant differences of two growth conditions for palmitic, palmitoleic, linoleic, O/L ratio, erucic and lignoceric acid content among ILs. The introgression lines recorded higher content of all saturated and monounsaturated fatty acids when cultivated under glasshouse condition however, during rainy season these fatty acids reduced with increase in content of polyunsaturated fatty acids. Mean oleic content between different two generation (F_4- F_6, BC_1F_4-BC_1F_6, BC_2F_3- BC_2F_3 and BC_3F_3-BC_3F_4) of ILs was not significantly affected while, linoleic acid found significantly different only between F_4 and F_6 generation. Along with oleic acid, palmitoleic, linolenic, gadoleic and erucic acids were also not significantly changed due to generation advancement.

Correlations among different fatty acids

The Pearson's correlation coefficient among the fatty acid components of all the introgression lines was carried out to determine the effect of variation in fatty acids and growth conditions together or independently. Palmitic acid of glasshouse condition was significantly negative correlated with saturated fatty acid; stearic (r= -0.390),arachidic(r= -0.310) and lignoceric acids (r= -0.486) (from glasshouse) as well as oleic, gadoleic, behenic, erucic acids from both glasshouse and field conditions. Highly significant negative correlation was observed between oleic acid and linoleic acid (r = -0.975 in the field and -0.940 in the glasshouse condition). The oleic acid from glasshouse condition showed significant negative correlation with fatty acids;arachidic (-0.506), behenic (-0.478) and lignoceric (r= -0.292) acids from

glasshouse condition while same fatty acids were not in significant correlation under filed conditions. Under glasshouse condition behenic acid had a strong significant positive correlation with stearic acid (r = 0.725) and arachidic acid (r=0.856). The gadoleic acid was also in significant positive correlation with erucic acid (r= 0.775 for glasshouse and r=0.880 for field condition) and lignoceric acid (r= 0.856 for glasshouse and r=0.877 for field condition). O/L ratio from both the situations were significant negatively correlated with linolenic and significant positively with oleic acid under both the conditions.

Gene pyramiding for foliar disease resistance and high oleic acid in groundnut:

Advance backcrossed lines were derived from crosses made of GJG17 X GPBD4 and GPBD4 X SunOleic95R for foliar diseases and high oleic acid content respectively was used for the present study. ABLs_216, ABLs_44, ABLs_36 lines used as female in current study. Lines were developed by crossing of GJG17 X GPBD4 as parents. ABLs_5841was used as male in current study which were developed by crossing of GPBD4 X SunOleic95R as parents.A total of five plants from each female line (ABLs_216, ABLs_44, ABLs_36, and ABLs_2) were crossed with the male line (ABLs_5841). Hybridization was carried out under favourable environment in pots kept in glass house at ambient environment.

A total of 30 seeds from each cross (ABLs_216 X ABLs_5841, ABLs_44 X ABLs_5841, ABLs_36 X ABLs_5841, ABLs_2 X ABLs_5841) were sown in small pots. Each plant was subjected to DNA isolation to detect *ahFAD2B* mutant allele. AS- PCR and CAPS asses were used to confirm presence of *ahFAD2B* mutant allele. Positive plants were transferred to large size pots and kept under controlled glass house condition for selfing and generation advancement.

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

(Bera SK, Thirumalaisamy PP, Narendra Kumar and Meena HN)

Hybridization

In 2017 *kharif* season, three back crosses (*A. hypogaea* // *A.* hypogaea /*A. diogoi*, *A. hypogaea* // *A. hypogaea* / *A. pusilla* and *A. hypogaea* // *A. hypogaea* / *A. duranensis*) and two direct crosses (*A. hypogaea* / *A. correntina* and *A. hypogaea* / *A. villosa*) were made. Probable cross pods will be planted in 2018 *kharif* season.

Screening pre-breeding lines for resistance to PBND

Field screening of 34 inter-specific pre-breeding lines with susceptible checks (KRG-1 and TMV-2) was done at UAS, Raichur, in 2017 *rabi* season. Lines were planted in Randomized Block Design with three replications and 45 x 10 cm spacing between lines and plants, respectively. Each line was planted in one line on four-meter bed with recommended crop management practices. Disease scoring was done at harvest. Among 34 interspecific breeding lines, 16 lines were found resistant, while 16 lines were moderately resistant and 2 lines were found moderately susceptible. More than 55% disease incidence was observed in the susceptible check (TMV-2) confirming high disease pressure in experimental plotunder normal field conditions.

Screening of interspecific breeding lines for resistance to stem rot

Interspecific breeding lines, 50 in numbers, were screened using robust screening technique, under artificially inoculated pot conditions in rainy season. Mortality, recorded after 15 days of inoculation, ranged from 71% to 100%. While, mortality at harvest ranged from 74% to 100%.

Confirmation of selected RILs for resistance to stem rot in Net house

A total of 47 RILs (F6) of GG-20 x CS-19 were screened, using robust screening technique for confirmation of resistance to stem rot found in *rabi* season. Out of which five lines were

showed resistant with less than 20% plant mortality.

Yield evaluation of selected drought tolerant advanced breeding lines

Selected 14 advanced breeding lines were tested for yield at both Anantapur and Junagadh in 2017 *kharif* season. In Anantapur variety K9 was used as local check, while in Junagadh GG-20 was used as local check. None of them were out yielded than local checks both at Anantapur and Junagadh. However, pod yield of two advanced lines were at par with K9 at Anatapur, while pod yield of three advanced breeding lines were at par with GG20 at Junagadh. One advanced breeding line was at par with local checks in both the locations. The result will be confirmed in 2018 *kharif* season.

Yield evaluation of selected stem rot resistant advanced breeding lines

Selected advanced breeding line, (GG-20 x CS-19)-4-8, resistant to stem rot, was tested during 2017 *kharif* season. Pod yield of the advanced breeding line was statistically at par with check varieties.

Phenotyping of RILS for resistance to stem rot

Groundnut genotype GG-20 is susceptible to stem rot disease, while NRCGCS-319 is a interspecific advanced breeding line, resistant to stem rot. A total of 193 RILs (F_{5-6}) of a cross, GG-20 x NRCGCS-319 were screened using robust screening technique in both 2017 *Rabi* and *kharif* seasons. Mortality ranged among the lines from 25.9 to 100% over two seasons. GG-20 and NRCGCS-319 were found susceptible and moderately resistant with mortality of 93.1% and 27%, respectively. Single line was found moderately resistant to stem rot with less than 30% mortality.

Phenotyping of RILs for resistance to Peanut Bud Necrosis Disease (PBND)

Groundnut cultivar JL 24 is susceptible to PBND, while NRCGCS-85 is a interspecific advanced breeding line, resistant to PBND. A total of 118 lines of a cross JL-24 x NRCGCS-85 along with parents and check varieties were screened at UAS, Raichur in 2017 *rabi* season. High disease incidence (42%) observed in the susceptible check TMV-2 ascertained screening under high disease pressure. JL 24 and NRCGCS-85 had 39% and 15% disease scoring, respectively. A total of 22 lines were found with less than 10% disease scoring.

Testing of advanced lines in AICRP-G

Altogether six advanced breeding lines were proposed for AICRPG in 2017 *kharif* season. Out of which four advanced breeding lines (NRCGCS-588, NRCGCS-589, NRCGCS-590 and NRCGCS-591) were proposed for high yield, while one advanced breeding line (NRCGCS-592) was proposed for both high yield and resistant to stem rot and one advanced breeding line (ICGV 15327) for high yield with high oil content.

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

(Bera SK, Gangadhara K, and Chandramohan S)

Hybridization

In 2017 *kharif* season two crosses were attempted using GG 20 and TG 37A as female parents and Sunoleic 95R as male parent for enhancing oleic acid content in recurrent parents by marker assisted introgression of *ahFAD2* alleles. Probable cross pod ranging from 73 to 145 were harvested and would be planted in next season for genotyping with diagnostic markers and further use.

Phenotyping of RILs and selection high oil content lines

Selected 305 RILs were planted, for confirmation of high (≥55%) oil content, in 2017 *kharif* season. Out of which four RILs were confirmed with ≥55% oil over two years.

Multi location testing of high oleate introgression line (IL)

NRCGCS-587, a high oleic acid content lines developed from a cross ICGV6100 x Sunoleic 95R by MABC, were sown in five different locations and tested for

oil and fatty acid profile. Oil content was observed as 54.74%, 54.46% and 55.10% in samples collected from ICRISAT, RRS, Tirupati and DGR, respectively. Oleic acid content was 79.77%, 79.63% and 81.18% in the samples of ICRISAT, RRS, Tirupati and DGR, respectively. While, linoleic acid content was 3.0%, 3.51% and 3.23% in samples of ICRISAT, RRS, Tirupati and DGR, respectively. On the other hand, palmitic acid content was found as 6.51%, 6.35% and 7.84% in samplesof ICRISAT, RRS, Tirupati and DGR, respectively. Pod yield of NRCGCS587 was found highest (2445 kg/ha) in ICRISAT followed by RRS, Tirupati (1420 kg/ha) and DGR(1080 kg/ha).

Phenotyping of high oleate introgression lines (IL)

Phenotyping of 21 ILs, developed from a cross ICGV-5141 x Sunoleic 95R by MAS, was done for oil, protein and fatty acid composition. A wide variation in oil content was observed in21 introgression lineswhich ranged from 49.7% to 57.9% with an average of 53.3%.HOP-IL$_{_MAS}$-116 and HOP-IL$_{_MAS}$-172 were poor oil yielder lines than the recurrent. While rest of the introgression lines were high oil content lines and contain oil at par with recurrent parent. Protein content varied from 21.25% to 25.01% in introgression lines.

Oleic acidcontent in introgression lines ranged from 57.8% to 80.5%. Majority of the introgression lines contain above 70% oleic acid except HOP-IL$_{_MAS}$-123, HOP-IL$_{_MAS}$-164, HOP-Il$_{_MAS}$-166 and HOP-IL$_{_MAS}$-171over two seasons. Majority of introgression lines contain less than 10% linoleic acid except HOP-IL$_{_MAS}$-123, HOP-IL$_{_MAS}$-144, HOP-IL$_{_MAS}$-164, HOP-IL$_{_MAS}$-166 and HOP-IL$_{_MAS}$-171. Over all, palmitic acid varied from6.6% to 10.5% in introgression lines. There was 1.8% to 44.2% increase in oleic acid, 3% to 89% decrease in linoleic acid and up to 0.6% decrease in palmitic acid in introgression lines in caparison to recurrent parent.

Indeed peanut genotypes with both high oleic acid and high oleic to linoleic acid (O/L) ratio is more desirable which varied from 2.5 to 30.9 in introgression lines.Out of which nine lines were found with O/L ratio more than 15.8 along with ~80% oleic acid content.

Besides, 21 ILs were tested for yield and related traits. Pod yield/plotwas 1453 kg and 1323 kg in recurrent parent (ICGV-05141) and local elite cultivar (GG-20), respectively. While in introgression lines pod yield/ plot varied from 722 kg to 2151 kg. Significantyield superiority over recurrent parent was observed in five introgression lines (HOP-IL$_{_MAS}$-130, HOP-IL$_{_MAS}$-145, HOP-IL$_{_MAS}$-163, HOP-IL$_{_MAS}$-181 and HOP-IL$_{_MAS}$-191). Besides, additional five introgression lines (HOP-IL$_{_MAS}$-116, HOP-IL$_{_MAS}$-144, HOP-IL$_{_MAS}$-171, HOP-IL$_{_MAS}$-172 and HOP-IL$_{_MAS}$-201) yielded at par with the recurrent parent. Shelling per cent varied from 65% to 74% in introgression lines. Hundred-kernel weight varied from 26 g to 39 g.

Testing of advanced lines in AICRP-G

A total of three high oleic acid content genotypes (ICGV 15080, ICGV 15083 and ICGV 15090) were proposed for AICRPG testing in 2017 *kharif* season.

2 Groundnut pests and diseases-emerging problems and their management

Refinement and validation of management module for soil borne diseases of groundnut

(Ram Dutta, Mahatma MK, Thirumalaisamy PP, Narendra Kumar)

Screening of cultivated varieties for resistance to stem rot

The experiment was conducted with three replications in the sick plot developed at field. The same set of genotypes was laid in the sick plots developed in the concrete blocks. Altogether, 24 cultivated varieties were screened for resistance to stem rot disease in field during summer 2017 and *Kharif* 2017.

Summer 2017:

The minimum (7.2%) stem rot was recorded with variety Kadiri-3 followed by R-8808 (8.4%). However, the maximum (17.6%) disease was recorded with variety DH-8 in field sick plot. However, minimum (18.8%) stem rot was recorded with variety R-8808 followed by SG-99 (29.7%) in concrete block sick plot. However, the maximum (92.3%) disease in concrete block sick plot was recorded with variety DH-86. Theminimum (10.3%) variation was noticed with variety R-8808, followed by SG-99 (18.2%) and maximum (79.2%) variation being with variety DH-86 from field to concrete block sick plot.

***Kharif* 2017:**

The minimum (11%) stem rot was recorded with variety Kadiri-3 followed by ICGS 76 (12%). However, the maximum (23%) disease was recorded with variety LGN 2 in field sick plot. However, in Concrete block sick plot, minimum (26%) stem rot was recorded with variety Tirupati 3 followed by ICGS 76 (30%). Whereas maximum (90%) disease was recorded with variety ICGV 86235. The variation in stem rot from field to concrete block sick plots was minimum (11%) with variety LGN 2, followed by Tirupati 3 (13%). The maximum (70%) variation in the incidence was noticed with variety ICGV 86235.

The genotypes having maximum stability of tolerance (i.e. minimum variation in incidence from low disease pressure to high disease pressure) of 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 2017:

The maximum inhibition (45%) of stem rot was recorded in treatment of DGROF2 followed by DGROF1 (40%) with spraying at 30 and 60 DAS (Days after sowing), and soil application at 45 and 75 DAS over farmers' practice. Whereas maximum pod yield of 1600 kg/ha was supported by organic formulation 'DGROF3' followed by DGROF4 (1582 kg/ha). However, maximum fodder yield of 4125kg/ha was supported by DGROF2 followed by DGROF1 (4021 kg/ha).

***Kharif* 2017:**

The maximum inhibition (61%) of stem rot was recorded in treatment of DGROF2 followed by DGROF1 (50%) with spraying at 30 and 60 DAS (Days after sowing), and soil application at 45 and 75 DAS over farmers' practice. Whereas, maximum pod yield of 1901 kg/ha was supported by organic formulation 'DGROF2' followed by DGROF4 (1810 kg/ha). However, maximum fodder yield of 6438kg/ha was supported by DGROF2 followed by DGROF1 (5271 kg/ha).

Refinement of different modules for stem rot and collar rot disease

The experiment was initiated during *Kharif* 2017. Altogether, 7 promising modules identified from previous project are being refined with different species of *Trichoderma* for soil borne diseases 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

Stem rot:

The maximum (85%) inhibition of stem rot was achieved by Module M-17A i.e. Deep summer ploughing with mould board plough+ seed of variety GG-20+ 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, followed by Module-M11A (67%)i.e. Deep summer ploughing with mould board plough+ seed of variety GG-20+ seed treatment with Tebuconazole @ 1.5 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 (-18% inhibition) over farmers' practice.

Pod yield:

The maximum pod (1944 kg/ha) yield was supported by Module M-17A followed by Module-M11A (1841 kg/ha) over farmers' practice being increase of 20% and 14% respectively over farmers practice.

Fodder yield:

Similarly maximum fodder (6500 kg/ha) yield was supported by Module M-17A followed by Module-M11A (6083 kg/ha) over farmers' practice being increase of 47% and 38% respectively over farmers practice.

Effect of modules against collar rot and yield

Collar rot:

The maximum (86%) inhibition of collar rot was achieved by Module M-17A i.e. Deep summer ploughing with mould board plough+ seed of variety GG-20+ 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, followed by Module-M15A (54%) i.e. Deep summer ploughing with mold board plough+ seed of variety GG-20+ seed treatment with PGPR @625g/ for per ha of seed + soil application of *T.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. However, Module-M2 received maximum stem rot (-32% inhibition) over farmers' practice.

Pod yield:

The maximum pod (1879 kg/ha) yield was supported by Module M-17A followed by Module-M15A (1751 kg/ha) over farmers' practice being increase of 15% and 7% respectively over farmers practice.

Fodder yield:

Similarly maximum fodder (6389 kg/ha) yield was supported by Module M-17A followed by Module-M15A (6056 kg/ha) over farmers' practice being increase of 41% and 34% respectively over farmers practice.

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

The experiment was undertaken at Aliyarnagar, Vridhachalam, Kadiri, Jalgaon and Bhubaneshwar centres.

At Aliyarnagar, maximum (72%) stem rot inhibition was recorded with M10V. Whereas, maximum pod yield of 3099 kg/ha was recorded with M11V. Again M10V supported maximum haulm yield of 5997 Kg/ha. The pod and haulm yields were 24% and 6% over the farmers practice. At Vridhachalam, maximum stem rot (69%), collar rot (57%) and dry root rot (75%) inhibition was recorded with M4V, which also supported maximum pod yield of 2380 kg/ha and haulm yield of 2877 Kg/ha which were 35% and 24% over the farmers practice. At Kadiri, maximum stem rot (62%) and dry root rot (38%) inhibition was recorded with M4V and collar rot inhibition (54%) with M5V. M4V also supported maximum pod yield (1855 kg/ha) and haulm yield (2440 Kg/ha) which was 21% and 32% over the farmers practice. At Jalgaon, maximum stem rot (47%), collar

rot (39%) inhibition was recorded with M4V, which also supported maximum pod yield (1484 kg/ha) and haulm yield (3987 Kg/ha) which were 14% and 24% over the farmers practice. At Bhubaneshwar, maximum stem rot (42%) and, collar rot (82%) inhibition was recorded with M4V being at par with M17V. Maximum (45%) dry root rot inhibition was recorded with M5V. However, M4V supported maximum pod yield (1856 kg/ha) and M10V supported maximum haulm yield of 3897 Kg/ha which was 34% and 29% over the farmers practice.

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

(Thirumalaisamy PP and Ram Dutta)

Collection of isolates of Alternaria sp. associated with leaf blight disease of groundnut

Alternaria sp. associated with the leaf blight/leaf spot disease of groundnut were isolated and maintained on PAD slants at 4°C. Presently 42 isolates were collected from groundnut grown in different agro-climatic regions of India.

Epidemiological factors responsible for disease development

Weather factors (temperature, relative humidity, rainfall, and wind speed), host factor (age of the crop, variety), biotic (sucking pests-thrips, jassids) and abiotic (water stress, nutrient deficiency, and quality of irrigation water, etc) factors associated in the epidemiology of *Alternatia* leaf blight in groundnut were focused in addition to virulence of the pathogen and quantity of pathogen propagule that initiate and spread the diseases in epidemic form. Based on mutilocational data analysis, *Saurashtra* region was found to be hot spot for this disease in summer. Recent years, the disease was also recorded at the end of *kharif* season. Iron deficiency, attack of groundnut crop by thrips and jassids, raising groundnut at 4dsm^{-1} or above, water stress were made the groundnut more susceptible to *Alternaria* leaf blight.

Pathogenecity of occurrence of new disease in Rajasthan

During the past few years (since 2012), leaf blight cum wilt was observed on groundnut crop grown during June to October in Jodhpur and Bikaner districts of Rajasthan state. The diseased plants produced leaf blight, later its stem turns to flaccid with drooping of foliage, devoid of any disease symptoms or signs on roots. The disease appeared in patches, with high disease intensity during the subsequent years. Samples were collected for isolation of the pathogen and voucher specimen was submitted to the *Herbarium Cryptogame Indo Orientalis* (HCIO 52165) at Pusa campus, New Delhi, India. The pathogen produced abundant aerial mycelium, initially off white and becomes brown with age. Macroconidia and microconidia were observed. Chlamydospores were observed in mycelia and in conidia. Amplified internal transcribed spacer region of ribosomal DNA (rDNA-ITS) region, translation elongation factor 1-a (TEF-1a) gene and part of RNA polymerase II subunit (*rpb2*) gene from genomic DNA of this fungus were sequenced and submitted to the NCBI-GenBank (Accession Nos.: MG543799 to MG543804, MG986904 to MG986911). Sequences were blast searched at *Fusarium MLST* (http://www.cbs.knaw.nl/Fusarium) and at *blastn* (https://blast.ncbi.nlm.nih.gov), and identified *as Fusarium incarnatum-equiseti* species complex (FIESC) based on the sequence homology (>98%). Koch's postulates were proved on groundnut cultivar, Girnar 2 using conidia of *F. incarnatum-equiseti* @ 1x 10^5/ml. This is the first report of *F. incarnatum-equiseti* causing leaf blight cum wilt of groundnut in Rajasthan, India.

Studies on white grub and bruchid beetle and their management in groundnut

Harish G, Ram Dutta and Yadav RS

Survey for collection and identification of white grub species

Survey was conducted in following villages, samples were collected and sent for identification species were identified as *Phyllognathus dionysius, Holotrichia serrate*, *Holotrichia* sp. and *Holotrichia reynaudi*

Leaf blight and wilt – disease of unknown etiology at Bikaner

Conidia

Alternaria leaf blight

Sl. No.	District	Areas from where the incidence have been reported
1.	**Junagadh**	Chokli, Mendarda, Bilkha, Keshod,Maliya (Hatina), Visavadar, Vanthali, Manavadar
2.	**Porbandar**	Porbandar, Ranavav, Kutiyana
3.	**Gir Somnath**	Veravel
4.	**Rajkot**	Jetpur, Upleta, Dhoraji, Gondal, KotdaSangani, Jasdan
5.	**Amreli**	Dhari Padadhari, Dhrol, Amreli, Bagasara
6.	**Jamnagar**	Jamjodhapur, Bhanvad
7.	**Bhavnagar**	Mahuva, Talaja

Monitoring of insect pests of groundnut

Monthly sowing was done to monitor the insect pests of groundnut, sucking pests were estimated using sweep net catches and defoliators were monitored using light traps.

Host tree infested by white grub

Spraying on host trees

Management of bruchid beetles in stored groundnut

Acorus calamus 20 per cent was found effective in managing bruchid beetle in storage

Dead white grub adults

Adult white grub

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

Development of climate resilient groundnut production systems through precision Management Practices

(Ram A. Jat and Kiran K. Reddy)

Précising plant stand and time of sowing of relay crop of pigeonpea in groundnut crop

A field experiment was conducted during *kharif* 2017 to find out suitable row ratio and timing of relay sowing of pigeonpea in bunch and semi-spreading varieties of groundnut. The objectives of study are to maximize productivity and profitability per unit of land, decrease cost of cultivation, enhance resource use efficiency, and sustainable intensification of groundnut based cropping systems. Two row ratios of 2:1 and 3:1 (groundnut: pigeonpea) were allotted in main plots and three relay sowings of pigeonpea i.e. 30, 40, and 50 days after sowing of groundnut were applied in subplots. The experiment was conducted in split plot design with three replications. Two separate experiments with same set of treatments were replicated with two groundnut varieties (TG 37A; Spanish bunch) and (GJG 22; Virginia bunch) (Fig. 1). Groundnut varieties TG 37A and GJG 22 were sown on 20th June, 2017 at 30 x 10 and 45 x 10 cm spacing and harvested on 2nd and 13th October, 2017, respectively. Pigeonpea variety BDN 2 was relay sown after every 2 or 3 rows of groundnut as per the treatments on 20th July, 30th July, and 09th August, 2017 which coincided 30, 40, and 50 days after sowing of groundnut. Both groundnut and pigeonpea were applied 100 percent of RDF through urea, SSP and MOP. Two interculturings were done at 25 and 45 DAS with mini tractor in GJG 22 and manually in TG 37A.

The pod and haulm yield of both TG 37A and GJG 22 was obtained higher under 3:1 ratio but differences were not significant except haulm yield of GJG 22.

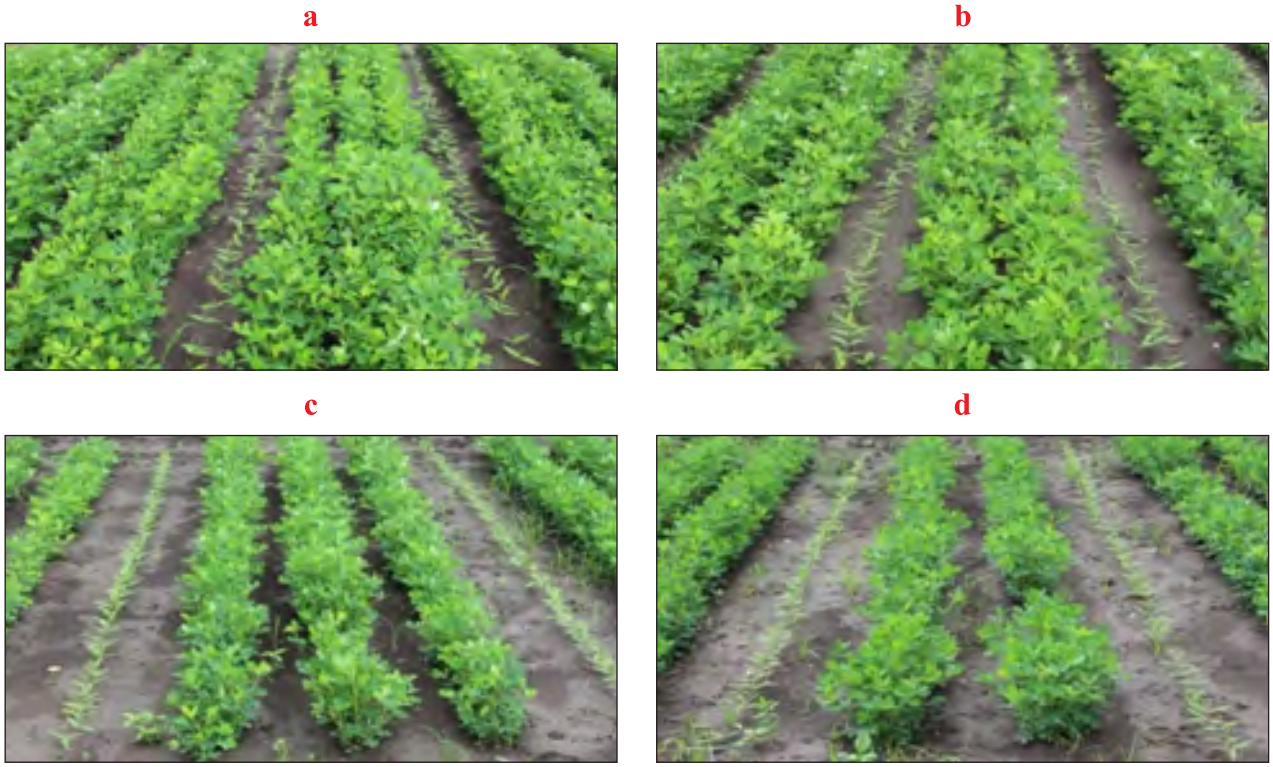


Fig. 1. Pigeonpea relay sown 30 days after sowing of groundnut in 3:1 and 2:1 ratio in groundnut variety TG 37A (a, b) and GJG 22 (c,d).

Similarly, pod and haulm yield of both the varieties increased with consecutive delays in relay sowing of pigeonpea, being highest at relay sowing of pigeonpea at 50 days after sowing of groundnut. However, the differences were not significant except the haulm yield of GJG 22 which was significantly higher with relay sowing at 40 and 50 DAS over that with 30 DAS. In case of pigeonpea, grain yield and stover yield was higher under 2:1 ratio, relay sown in both TG 37A and GJG 22, but differences were significant for stover yield only. The significantly higher grain and stover yield of pigeonpea was obtained when relay sown at 30 DAS of groundnut in both the groundnut varieties. The consecutive delays in relay sowing of pigeonpea decreased pigeonpea grain and stover yield significantly in both the groundnut varieties. The GPEY was higher with 2:1 ratio in both the groundnut varieties but differences were not significant. The GPEY was found significantly higher with relay sowing of pigeonpea at 30 DAS of groundnut in both the varieties.

Identifying suitable growth regulators to enhance groundnut yield under rainfed conditions

A field experiment was conducted during kharif 2017 to evaluate the effects of growth hormones on productivity of groundnut. The objective of study was to enhance the yield of kharif groundnut by enhancing the number of flowers and mature pods per plant and retarding the excessive vegetative growth. The treatments were: control (water spray), paclobutrazol @75 ppm, paclobutrazol@100 ppm, NAA@40ppm, and GA@ 20ppm. The experiment was conducted in randomized block design with three replications. The groundnut variety GJG 22 was sown on 16th June, 2018 at 45 x 10 cm spacing.

Application of paclobutrazol @ 100 ppm was found to reduce plant height at harvest significantly as compared to control (Fig. 2). LAI was also reduced remarkably at 45 DAS with the application of paclobutrazol@100 ppm but not much differences was found in LAI at 75 DAS as compared to control as the paclobutrazol treated plants grew rapidly about 20 days after the treatment. Similarly, treatment with paclobutrazol @100 ppm increased number of flowers (76.3), immature (5.1) and mature (13.4) pods per plant as compared to control (65.2, 2.9, and 12.0, respectively). The increase in yield attributes with the application of paclobutrazol@100 ppm resulted into significant increase in pod yield which was 12.7 percent higher as compared to control. However, haulm yield was decreased with the application of paclobutrazol@ 100 ppm (3509 kg/ha) as compared to control (3970 kg/ha).

Assessing impacts of Conservation Agriculture on yield and soil health in groundnut+pigeonpea/cotton inter cropping system

A field experiment was conducted for consecutive third year during *kharif* 2017 to assess the impact of Conservation Agriculture on yield and soil health in groundnut + pigeonpea and groundnut + cotton cropping systems in black soils of

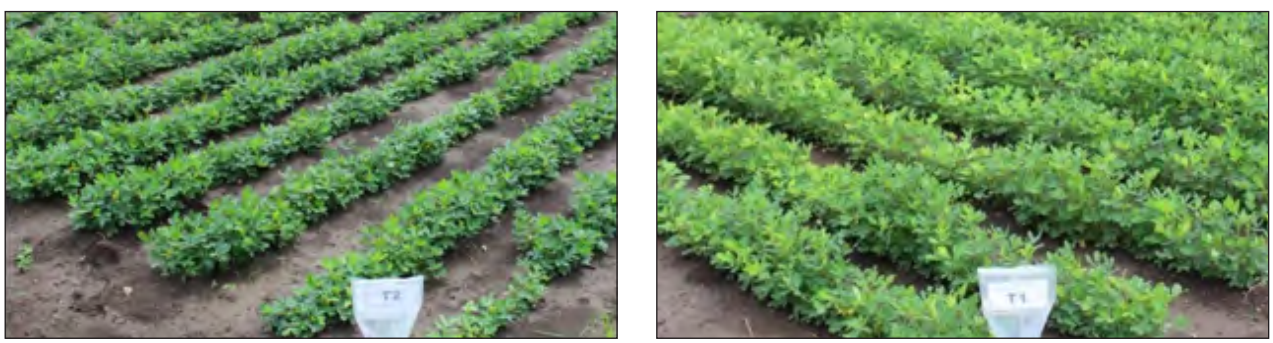


Fig. 2 Groundnut crop sprayed with paclobutrazol@ 100 ppm (left) and control (right) at 45 days after sowing

Fig. 3. Groundnut crop with relay sown pigeonpea (left) and intercropped cotton (right) under minimum tillage

Saurashtra. The objectives of study are to find out minimum tillage for groundnut+ pigeonpea /cotton cropping system to promote CA, proper management of pigeonpea and cotton residues, reduce cost of cultivation, improve soil health, and develop sustainable and climate resilient groundnut based cropping systems. The treatments were: four tillage practices viz. normal tillage, minimum tillage, zero tillage, and rota-till in main plots; two residue management practices viz. no residue, and residue application in sub-plot; and two cropping systems viz. groundnut+ pigeonpea, and groundnut+cotton intercropping systems in sub-sub-plots (Fig. 3). The experiment was laid out in split-split plot design with three replications. For residue application pigeonpea and cotton residues were used.

The highest pod and haulm yield was obtained with rota-tillage followed by minimum tillage while lowest yield was obtained with zero-tillage. However, the differences were not significant at 5 percent probability. Pigeonpea grain and stover yield was significantly higher with normal tillage while lowest was with zero tillage. Seed cotton yield and stalk yield was higher with minimum tillage while lowest was with rota-tillage but differences were not significant. The pod and haulm yield of groundnut, grain and stover yield of pigeonpea, and GPEY was higher when residues were removed but differences were not significant. However, seed cotton yield and stalk yield was slightly higher with residue retention. Among the cropping systems, groundnut pod and haulm yield was significantly higher with groundnut+ pigeonpea system while GPEY was higher with groundnut+ cotton intercropping systems due to higher yield of cotton.

Management of soil and irrigation water salinity through agronomic practices in groundnut

(Meena HN and Reddy KK)

Evaluation of released cultivars of groundnut under salinity stress during *summer* & *kharif* season

Groundnut crop was planted in summer-2017 to test the eight released varieties namely GG-2, JL-776, TG-37A, GJG-9, GJG-31, TAG-24, ICGV-91114 and ICGV-86590 under Spanish bunch habit group. Varieties were planted in the saline environment having salinity levels of 0.5 (control), 2, 4 and 6 dS m^{-1}. The five meter rows length of each variety and eight to nine supplementary saline irrigations were given. It was observed that the pod yield of all the varieties at 2 dS m^{-1} saline water irrigation were at par with the control, while haulm yield was significantly reduced at 2 dS/m saline water irrigation and also in higher level of salinity. Significant difference in pod yield was recorded at a water salinity of 4dS m^{-1} in comparison to 0.5 dS m^{-1} (control). Almost similar trend was observed for other yield contributing characters like plant height, number of branches,

number of pods per plant, 100 pods weight, and 100-kernel weight under saline environment. Further, the significant difference in pod and haulm yield was also recorded between varieties and significant higher pod yield was recorded in TG-37A and TAG-24 while significant haulm yields was recorded in GJG-9, ICGV-91114 and ICGV-86590.

The same experiment was repeated in kharif-2017 at same site of field to evaluate the similar set of varieties under similar level of salinity. However two supplementary saline irrigations were given in place of eight/nine irrigations given during summer season. It was observed that the haulm yields of all the varieties at 2 dS m^{-1} saline irrigation water were at par with the control but significant difference was recorded at a water salinity of 4dS m^{-1}. While pod yield was significantly reduced at 2 dS/m and also in higher salinity levels. Further, the significant difference in pod and haulm yield was also recorded between varieties and significantly higher pod yield and haulm yield were recorded in JL-776 and GJG-9, respectively during kharif season.

Effect of different mulching on groundnut yield under different salinity stress

The experiment was conducted during summer 2017 to ameliorate the effect of salinity with application of different mulches under different salinity levels. The treatment consisted of four levels of salinity (0.5, 2, 4 and 6 dS m^{-1}) in main plot, three levels of mulching [without mulch (control), polythene mulch and straw mulch] in sub plot. The results revealed that significantly higher pod yield was recorded with the application of 2 dS/m saline irrigation water but significant reduction was recorded at 6 dS/m as compare to other treatments. The 50% higher pod yield was recorded at 2 dS/m as compared to 6 dS/m saline irrigation water but haulm yield of groundnut was significantly reduced at 2 dS/m and also in higher salinity levels. Further, significant differences were also recorded between types of mulching. Similar incremental effect in pod (32%) and haulm yield (4%) was observed under both type of mulching over control. Although, interaction effect of salinity x mulching revealed that as the level of saline irrigation water increases pod and haulm yield of groundnut significantly increase under polythene mulching and straw mulching as compare to without mulching. In 6 dSm^{-1} of irrigation water, pod yield under polythene mulch and straw mulch was 47% & 52% higher as compared to control.

Efficient utilization of soil phosphorus in groundnut production system

(Reddy KK, Meena HN and Jat RA)

Solubilization and exploitation of soil phosphorus using phosphate solubilizing microorganisms

An experiment was conducted in Summer 2017 in split-plot design (cv. TG37A; Plot size-5 m*4.5 m; DGR experimental farm L6; Soil-calcareous black) using three P treatments in main plots (P1-Native P; P2-FYM @10t/ha; P3-RDP @50kg P_2O_5/ha) and four PSB cultures in sub-plots (PSB1, PSB2, PSB3, PSB4). We found that plant growth and yield parameters are non-significantly affected by different treatments except fresh weight/plant at 60 DAS (3.87 g under PSB4 treatment), root volume/plant at (1.10 ml under P3 treatment, on par with P2). Acid phosphatase activity (µg p-nitrophenol g^{-1} h^{-1}) significantly ($p<0.05$) increased in different treatments from 45 DAS (P2-102.06, PSB3-100.7) to 60 DAS (P3-112.8, PSB2-110.13) but drastically reduced at harvest (P2-24.47, PSB1-23.84). Alkaline phosphatase activity (µg p-nitrophenol $g^{-1}h^{-1}$) was significantly ($p<0.05$) exalted at 45 DAS (P2-159.6, PSB1-186.4), then to a snooping low at 60 DAS (P1-25.05, PSB4-25.96) only to resume at harvest (P2-103, PSB4-110.29). Dehydrogenase activity (µg TPF g^{-1} h^{-1}) was substantially elevated at 45 DAS (P2-18.33, PSB4-17.94), only to drop by 6-fold at 60 DAS (P2-5.86, PSB2-7.52) and to become non-significant at harvest. It is

noteworthy to mention that FYM has considerably augmented the enzymatic activities at different stages of plant growth. Available N (kg/ha) was significantly heightened at 45 DAS (15.75), only to reduce by 10-fold at harvest (1.10). Organic carbon (%), Organic Matter (%) and Organic N (%) was significantly exalted at 60 DAS (O.C %; P2-1.04, PSB1-0.94) compared to 45 DAS (O.C %; P2-1.23, PSB3-1.02) and harvest (O.C %; P1-0.74, PSB1-0.71). No single PSB culture tended to improve all the soil enzymatic activities, rather each culture had their own niche and behaved differently

Study of soil P-fractions in different soil textures under varying P-dosages, incubation times and temperatures

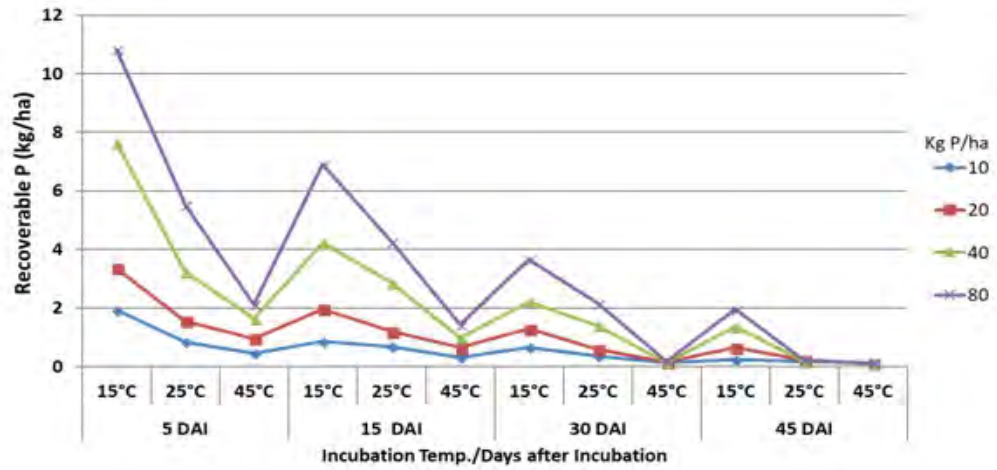
In-vitro lab studies were conducted in *kharif*-2016 to check out the differences in soil-P fractions of different types of soils. Black calcareous *vertisols* of Junagadh and sandy soils of Bikaner were taken for analysis. pH and EC of the soils are 8.2, 0.15 dS/m and 8.3, 0.18 dS/m for Junagadh and Bikaner respectively. Olsen P was found to be high in Sandy soils (20.2 kg/ha) than in *vertisols* (15.26 kg/ha). Total P was found to be more in *vertisols* (420 ppm) followed by sandy soils (285 ppm). $CaCO_3$ (%) was 19.60% in Typic Haplustepts (Black soils) and 2.20% in Typic Haplocambids (Sandy soil).

Study of soil P-fraction under varying P doses:

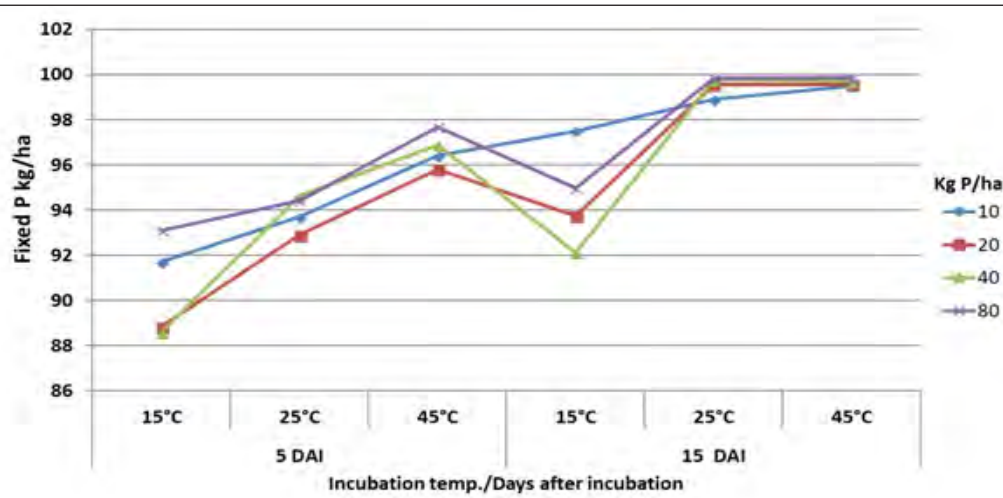
The experiment consisted of control (no P applied), 10 kg P/ha, 20 kg P/ha, 40 kg P/ha, 80 kg P/ha with four incubation periods like 5 DAI (days of incubation), 15 DAI, 30 DAI, 45 DAI. KH_2PO_4 served as P-source. Recoverable P ranged from 0.8 to 5.5 kg/ha, fixed P 9.2 to 74.5 kg/ha, P fixation capacity (%) ranged from 92% to 93.12% in *vertisols* at 5DAI. P fixation capacity (%) increased linearly from 5 DAI to 45 DAI. In Sandy soils, P fixation capacity (%) ranged from 75% to 89% at 5DAI. The maximum fixation is observed at 30 DAI. Surprisingly, P fixation decreased at 45DAI. In *vertisols*, among the various forms of P analyzed, Ca-P was found to be abundant (165 kg/ha) followed by Fe-P (35 kg/ha), Al-P (10 kg/ha) and Saloid-P (26.4 kg/ha)., where as in sandy soils Ca-P was found to be dominant (102 kg/ha) followed by Fe-P (48.2 kg/ha), Saloid–P (26.4 kg/ha) and Al-P (2.2 kg/ha). So, the order of P-fixation in *vertisols* is Ca-P>Fe-P>Al-P>Saloid-P and in sandy soils it is Ca-P> Fe-P>Saloid-P>Al-P. In a gist, labile-P was more abundant in sandy soils compared to black soils. Applied P is fixed in range of 75% to 94% due to absorption and desorption phenomenon in different soils. Since the chemistry of soil-P fractions is complex, monitoring of the pH of the soil may to a certain extent reduce the p fixation capacity of these soils. We also observed that with increase in dosage and incubation time, P-fixation capacity (%) increased.

Study of P-fraction dynamics at varying incubation temperatures:

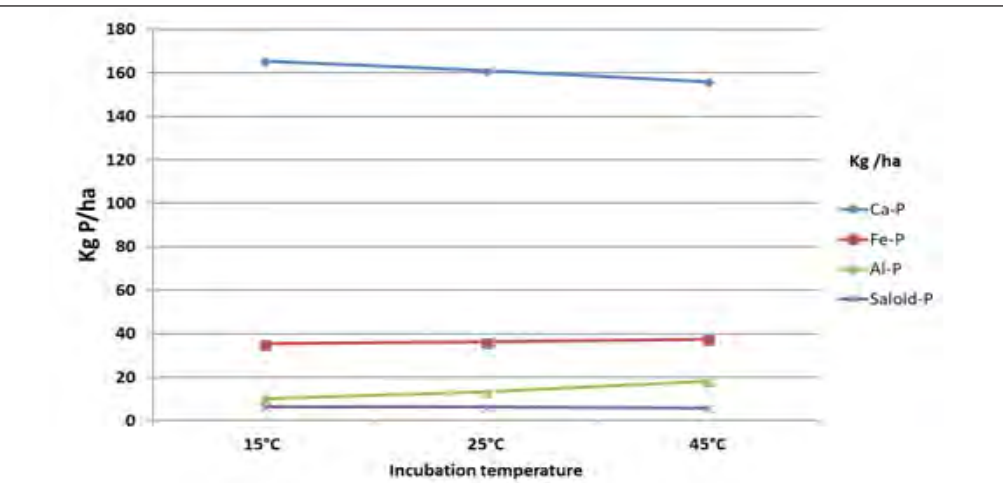
The experiment set-up consisted of three incubation temperature Viz., 15°C, 25°C, 45°C and four incubation periods like 5 DAI, 15 DAI, 30 DAI, 45 DAI. In black soils P-fixation (%) ranged from 82.5% to 96.3% and in sandy soils the range is from 71% to 92% at 5 DAI. Al-P and Fe-P was markedly higher in *vertisols* at 45°C than at 15°C, which is *vice-versa* with respect to Ca-P. Similar trend was observed in sandy soils, but with lower values than black soils. In essence,P-fixation increased with increase in incubation temperatures, irrespective of incubation time and dosage. Soils with more clay and $CaCO_3$ has more P-fixation which reduces the equilibrium-P in soil solution.



Availability of Olsen-P in sandy soils under interaction of different parameters



P-fixation capacity in calcareous black soils under interaction of different parameters



Soil-P fractions in *Vertisols* at different incubation temperatures at 5 DAI

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

Iron and zinc bio-fortification in groundnut

Sushmita, Singh AL, Bishi SK and Gangadhara K

Zinc biofortification through Zn solubilizing microbial application

In a field experiment four Zn-solubilizing microbes (FP 82, FP 93, BHU-1, BM-6) were and compared with application of zinc sulphate (2kg Zn /ha) in 10 groundnut cultivars for enhancement in pod yield and Seed Zn content. The study revealed that the response of Zn-solubilizers on growth and pod yield of groundnut were similar to that of zinc sulphate and among the Zn-solubilizers, FP 82 and FP 93 showed their better response. The seed samples of these produce are being analysed for Zn –biofortification in seed.

The Zn and Fe content in seed in relation to Pod morphology and seed size

The Fe and Zn contents in seeds of 100 groundnut cultivars grown under rainfed as well as under protected conditions were analyzed along with many other nutrients where a wide range in the Zn and Fe concentrations in seed were observed. From these 13 groundnut cultivars with high Zn and 11 cultivars with high Fe in their seed were identified. The phytic acid contents in seeds of high Zn cultivars are in progress. Twenty eight advance breeding lines were analysed for various nutrients and a few high Fe and Zn lines identified.

The pod morphological characteristics (beak, constriction and reticulation) and seed size and color of 190 groundnut cultivars in relation to their Fe and Zn content in seeds were studied. Out of these, 9 were very large seeded with prominent pod reticulation while a few showed variegated seed color. The 100 seed weight of these ranged from 25- 70g. Pod length and width ranged 2.2-4 cm and 1-1.8 cm respectively. The seeds of these cultivars are being analyzed for Fe and Zn content.

Zinc and Fe biofortification through various Zn-sources

Five commercial grade Zn sources (Shruti, Energy high Zn, Swarna, Hydrogel + Zinc sulphate, and Monzin) were tested in a field experiments using 10 groundnut cultivars during rainy season where all these increased yield with varied responses. The seed samples of these produce are being analysed for Zn and Fe enrichments.

The seed of groundnut cultivars, grown under influence of zinc sulphate and Zn-EDTA application (soil and foliar) during previous year when analysis both of these increased the Zn content in seed though showed variations among cultivars. Thus application of Zn fertilizer is recommended to increase Zn content of groundnut seed.

Zinc biofortification through zinc sulphate underrainfed

In a field experiment soil and foliar application of zinc sulphate was studied for Zn enrichment in seed in 100 groundnut cultivars grown both under rainfed and protected conditions during rainy season where application of Zn controlled over growth, and increased pod yield. The seed samples of these produce are being analysed for Zn enrichments.

Zn and Fe biofortification in various seed-size groundnut

The Fe and Zn biofortification in various seed size groundnut was studied in field taking 50 genotypes varying in their pod structure and sizes and grown at various combination with fertilizers (T1-control, T2-Samridhi an organic sources), T3-T2 + 2 kg Zn as Monzin,) where a large variation in the response depending upon the seed size was observed. The organic fertilizer and Zn through Monzin was beneficial and enhanced yield. Seeds of these produce are being analysed for Fe and Zn contents.

Screening groundnut genotypes for iron-deficiency chlorosis

A total of 114 advanced breeding lines from various sections were screened for their reaction to lime-induced iron-chlorosis (LIIC) in a screening plot, categorized under various classes of their tolerance and finally from these 12 were identified as tolerant to

iron chlorosis. Also 100 cultivars were screened for LIIC,and 16 tolerant and5 sensitive were identified.

Physiological studies in groundnut under water-deficit and salinity stresses

Singh AL, Sushmita and Bishi SK

Physiological efficiencies among Indian groundnut cultivars

The photosynthesis (P_N), transpiration (E), stomatal conductance (g_s), chlorophyll fluorescence, SCMR and yields were studied in 100 groundnut cultivars grown during *Kharif* season, where large variability was observed. The study identified several cultivars as high and low in P_N, E and g_s. There was a positive correlation between, P_N and g_s, P_N and E,P_N and number of pods, SCMR and pod yield, SCMR and WUE, haulm yield and plant height, haulm yield and pods, and a negative correlations between SCMR and plant height, SCMR and E, and E with WUE.

Elasticity of tolerance to various drought situations

The 36 recent groundnut cultivars were grown under protected (P), rainfed (RF), RF+ hydrogel as well as exposed to mid season (MSD, 50-70 DAS) and late season drought (LSD, 70-90 DAS) under ROS and their elasticity of drought tolerance were studied. The rainfed crop faced three droughts of one small spell (10-17th July) during early growth stages and two long spell (4-20thAugust) and 10th Sept onward (no rain at all after that) where pod and haulm yields were affected due to drought. The data revealed that the cultivars with early flowering, high SCMR, low SLA, high yield and HI and early maturity showed escape mechanism and were considered as highly suitable for rainfed cultivation under drought situation. Accordingly several cultivars suitable for rainfed, MSD and LSD were identified. Interestingly a few cultivars performed well under both MSD and LSD and also a few cultivars showed most elasticity and performed well under all the 5 situations.

Four year of study reveals that in Junagadh the rainfed crop faces 2-3 drought spell of various intensity (period) causing yield losses from 5-60 % depending upon the cultivars. Though varietal differences were observed, the LSD was most detrimental to crop hence should be avoided. Interesting mild water stress during the cropping period was beneficial

Pod zone moisture contents influences yield, yield attributes and aflatoxin

Twenty four groundnut cultivars were exposed to various moisture content (on dry wt basis) in their pod zone (>19.6, 17.2-19.6, 15.0-17.1, 12.4-14.8, and <12.4 % moisture content) from 50 DAE in a micro-plot study through drip irrigation. Though the cultivars behaved differently, there was no pod yield losses till the soil moisture content in the pod zone was >15.0 %, below which drastic reductions in pod yield were observed. There were variations in the other physiological parameters also. When the drought of various intensity was exposed, there was few days early maturity in groundnut of determinate nature with more immature pods in the highly stressed crop.

The exposure of drought in the pod zone caused fungal invasion followed by contamination of aflatoxin with a contrast differences in the aflatoxin content in the seed of the groundnut grown above and below 12.4 % pod zone soil moisture. However there were varietal differences and a few cultivars showing resistance. At <12.4 % moisture content in pod zone more than 13 cultivars, out of 24 cultivars, showed >10 ppb aflatoxin in seed. These cultivars number, however reduced when grown keeping >12.4 % moisture content and was nil at 19.6 % moisture content.

Water requirement of groundnut cultivars for their cultivation under drought

In micro-plot, 40 groundnut cultivars grown, separately, at

400, 500 and 600 mm of total water during cropping season behaved differently as their water requirement (WR) varied during summer season. Finally there were 6, 9 and 4 cultivars which showed >275 g m^2 pod yield, at a total irrigation of 400, 500 and 600 mm, respectively, distributed as per requirement of crop growth stages and hence ideal for growing crops. Interestingly there were a few cultivars which with having maximum elasticity performed well under all the three situations and hence should be preferred.

The LAI (Leaf area index) and Chlorophyll fluorescence when were recorded to study the effect of three different levels of irrigation treatments. The cultivars with dense canopy reflected greater LAI (6-8) while in other the LAI ranged 2-5. Chlorophyll fluorescence values ranged from 0.75-0.88 in the genotypes having higher values of photosynthetic rate and stomatal conductance while the sensitive genotypes displayed the values for chlorophyll fluorescence ranging from 0.55-0.70.

Amelioration of drought through integrated approaches under raifed

The drought management approaches (Gypsum at 2 t ha^{-1}, Geo green an ogranic at 2 t ha^{-1}, Hydrogel at 2.5 kg ha^{-1} and Salicylic acid spray of 500 ppm) were evaluated by growing 10 groundnut cultivars under under rain-fed conditions in a field and compared with the one grown under protected conditions to minimise the yield losses. The crop faced droughts of one small spell (10-17th July) and two long spell (4-20th August) and 10th Sept onward (no rain at all after that). Though the study revealed several interesting results, these effect varied with cultivars, all these ameliorated drought in groundnut under rainfed conditions and increased pod yield as evident from their comparison with the yield of protected one.

Influence of growth regulators on seed size

The commercial growth regulators (Lihocine, Planofix, Chamatkar, Progibb and Herbozymes) applied as foliar spray of (thrice at 40, 60 and 75 DAS) showed varied influence on growth, pod and fodder yields and shelling of two groundnut GG 7 and TG 37A cultivars, but all these increased seed size and further germination. Among these Chamatkar, Progibb and Herbozymes helped in increasing pod yield and HI. The Lihocine and Progibb arrested the over growth.

Studied on soil salinity tolerance mechanism

Fifty seven groundnut cultivars were grown in field at two salinity levels (2 dS m^{-1} and 4 dS m^{-1}) and based on germination, plant survival, and yield attributes identified five cultivars showing comparatively high tolerance with reasonable pod yield at 4 dS m^{-1} salinity and hence detail mechanism were worked out and recommended for their cultivation.

Impact of heat stress on groundnut metabolism and quality

(Bishi SK, Mahatma MK, Singh AL, and Sushmita)

Forty groundnut cultivars (19 spanish and 21 virginia) were characterized for their thermo-tolerance in field condition using staggered sowing with 20 days interval between each sowing date (D_1:21st Jan, D_2:10th Feb and D_3:2nd Mar) to ensure that the plant experienced different temperature conditions at flowering stages i.e. (D_1: 35.6/18.6, D_2:37.8/20.9 and D_3: 41.1/25.7 ^{0}C). The second date of sowing coincides with the normal sowing of groundnut crop. Different physiological and biochemical parameters such as days to emergence, 50% flowering, pollen viability, MSI yield; quality attributes like content of oil and protein, fatty acid profiling were recorded.

Salient Findings:

1. The increase in temperature enhances the rate of seedling emergence during seed germination
2. Higher temperature imparts earliness in flowering which differ from genotype to genotype
3. The pollen viability is signi-

ficantly reduced in D_3 as compared to D_2

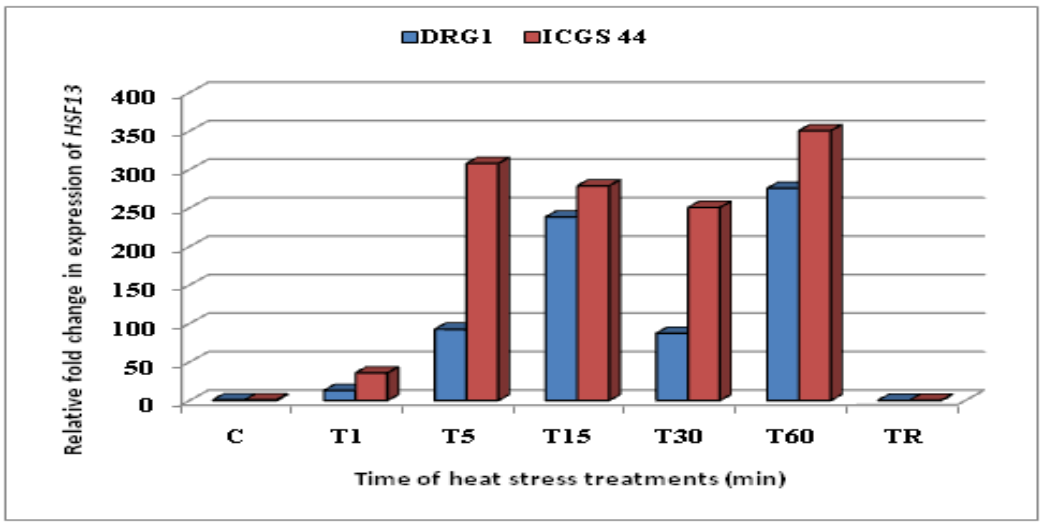
4. The reduction in pod yield was higher in Virginia (~17%) compared to Spanish (~10%) under high temperature stress.
5. High temperature affected negatively oil content and positively protein content and the effect were more prominent in Virginia.
6. The O/L ratio was negatively affected by high temperature stress during pod filling.

Possible role of Heat Shock Transcription Factor 13 (*HSF13*) in groundnut under HS

Heat Shock Transcription Factors (HSFs) play a crucial role in plants response to several abiotic stresses especially heat stress (HS) by regulating the expression of stress-responsive genes, such as heat shock proteins (HSPs). In our earlier study we have reported that imposition of short-term high temperature stress results in the higher induction of small heat-shock proteins (HSPs), particularly HSP-17 which is suggested to be an indicator of heat stress sensitivity of groundnut genotypes.

The role of plant *HSFs* in abiotic stresses, especially in HS, has been recently brought to light. In a recent study, Wang et al (2017) identified 16 and 17 *Hsf* genes from *Arachis duranensis* and *A. ipaensis*, respectively andstudied their temporal and spatial expression under heat stress (42^{0}C). From the study, it was observed that *AhHsf4, 5, 6, 10, 11*, and *13* could response rapidly to high temperature, and up-regulated after 1 h treatment. The expression of *AhHsf4, 5, 6, 10*, and *11* was continuously increased during 1–6 h of 42°C treatment. However, the expression of *AhHsf13* was increased substantially (more than 500 fold) within 1 hr and decreased at 6 h after HS treatment. We hypothesize the role of HSF13 as a master regulator for heat stress signaling in groundnut.

In the present study, two genotypes (identified in our earlier experiments), ICGS44 (tolerant) and DRG1 (susceptible) were grown in controlled conditions in P-II glass house with mean day-night temperature 35/25 ^{0}C and mean relative humidity 40/60 %. The 7 days old plants were exposed to high temperature stress i.e. 42 ^{0}C in a seed germinator with light and humidity control. The leave tissues were collected after different time intervals (1, 5, 15, 30 and 60 min) for RNA isolation to study the kinetics of HSF13 gene. Sample harvestedunstressed plant was used as control (C). Further to study the recovery after HS, tissues were collected from plants exposed to 2 hr HS and kept at 25 ^{0}C overnight.



Gene expression analysis showed that *HSF13* induced within 1 min after HS treatment and its expression continued to increase upto 5 min. Then there was a slight decrease in its relative expression which again reached to the peak at 1 hr after HS treatment. The tolerant genotype, ICGS44 maintained a higher induction of *HSF13* at any point of time than that of the susceptible genotype, DRG1 suggesting its possible role in HS tolerance in groundnut. In future further characterization of *HSF13* and expression analysis of the downstream genes need to carried out to confirm its role in HS tolerance in groundnut.

Evaluation of nutritional and bioactive compounds of groundnut

Mahatma MK , Bishi SK, Rathnakumar AL and Singh AL

Evaluation of nutritional quality traits of groundnut cultivars

Nutritional quality traits of 31 groundnut cultivars were analysed. Oil content was observed in the range of 43.8-54.7% with an average of 48.75%. Highest oil content was observed in GG22 (54.7%) while lowest in TG51(43.8%). Highest protein content (36%) was observed in TG51 and lowest in Gg22 (20.9). Thus oil and protein content have negative correlation. Soluble sugars were analysed by Ion chromatograph for sugar profiles. Cultivar TG51 had highest soluble sugars (6.96 mg/g) while JL776 had lowest (3.60 mg/g). Total 7 sugars i.e. myo-Inositol, mannitol, trehalose, glucose, sucrose, raffinose and stachyose were detected by Ion chromatograph. Sucrose, stachyose and myo-inositol are predominant sugars. Highest RFOs were present in Girnar2 (0.87mg/g) while lowest (0.22 mg/g) in GPBD4. Fatty acid profiles using gas chromatograph revealed that oleic, linoleic and palmitic acid contributed about 82% of total fatty acids. While, remaining 18% of fatty acid consisted stearic (2.98%), behenic (2.58%), arachidic (1.32 %), lignoceris (1.04%), gadolic (0.91%), linolenic (0.48%) and palmitoleic acid (0.031%). GG20 had highest oleic acid (62.75%), followed by GG18 (61.77%) and GG18 (61.20%). Only 5 cultivars had more than 2.0 O/L ratios, among that GG20, GG18 and GG22 had 2.9 O/L ratio while TPG 41 had 2.4 and BAU13 had 2.04 O/L ratio. Smallest seed size (100 seed weight) cultivar was found to be Girnar3 with 32 gm while largest seed (95 gm) was found in BAU13. Blanching per cent was also recorded for all 31 cultivars, TAG24 had highest blanching quality (94%) , followed by Girnar2 (93%),TKG19A (92%), TLG5 (89%) and GPBD4 (87%), while Kadiri7 had lowest (29%).

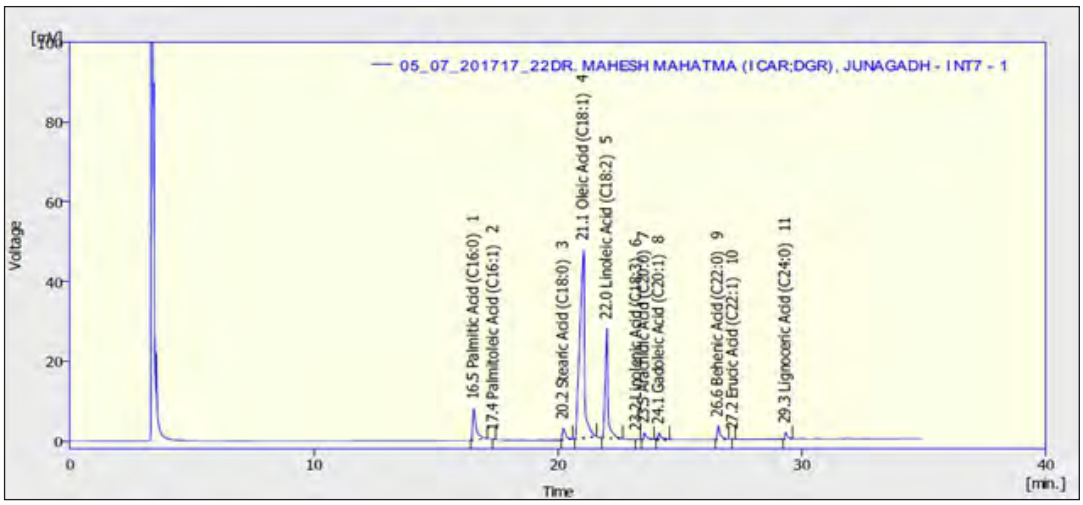


Fig : Chromatogram of fatty acid profile of GJG18

Evaluation of bioactive compounds of groundnut cultivars

Total phenol content, phenolic profile and antioxidant activity were also analysed from 31 cultivars. Total phenol content was varied from 1.49 (JL501) to 3.61(Kadiri7) mg/g kernel with a mean content of 2.28 mg/g kernel. Antioxidant activity was strongly correlated with phenol content. Maximum antioxidant activity was observed in Kadiri7 (19.05 Trolox equivalents (TE)/g) while lowest in JL501 (8.58 TE/g) with average value of 43.86 µM TE/g kernel. Total 16 phenolics viz., caffeic acid, catechol, chlorogenic acid, cinnamic acid, coumaric acid, ferulic acid, gallic acid, syringic acid, salicylic acid, vanillic acid, catechin, epicatechin, epigallocatechin, kaempferol, resveratrol and quercetin were identified in groundnut kernel using LC-MS/MS. These phenolics were identified based on retention time and mass value of standard phenolics. Coumaric and cinnamic acid are predominant phenolics in groundnut kernels followed by kaempferol, syringic acid and salicylic acid. All the genotypes had resveratrolin the range of200-650ng/g.

Services:

Oil, protein and moisture content of 4500 groundnut samples from different section of DGR and AICRP-G centers were measured by NIR spectroscopy.

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

(Dey R, Pal KK and Thirumalaisamy PP)

Development of liquid formulation of DAPG-producing fluorescent pseudomonads

Formulations of DAPG-producing *Pseudomonas putida* DAPG4 and *Pseudomonas putida* FP86 which have 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 formulations were inoculated with the concentrated culture suspension of 1.5 X 10^{12}cfu/ml and population built-up and shelf-life was monitored at 0h, 3d, 5d, 15d, 30d, 45d, 60d, 90d, 120d, 150d, 180d, 210d, 240d, and 270days after inoculation in eight different combinations. While formulation 8 maintained the population of 6.15X10^{10} cfu/ml after 270 days of inoculation at RT, the same formulation also helped *Pseudomonas putida* FP86 to maintain a population of 3.85X10^{10}cfu/ml after 210 days of inoculation at RT. The formulations will be evaluated upto 360 days at RT for studying the shelf-life.

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

Twelve efficient and competitive strains of groundnut rhizobia, including a standard culture TAL1000, were evaluated in a field trial with cultivar TG37A during the *kharif*season, to assess the effects of their inoculation on the growth and yield of groundnut. Seed inoculation with eight of the rhizobial cultures resulted in significant enhancement of pod yield (15–36%), while four treatments were at par with the uninoculated control. Four of these efficient strains of rhizobia also resulted in significant enhancement of haulm yield. In general, inoculation with these efficient strains resulted in increase in nodulation, plant biomass measurement and hundred kernel mass.

Studying the diversity of groundnut rhizobia in the Saurashtra region of Gujarat

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

Characterisation of epiphytic bacteria and their selection

Phyllosphere or epiphytic bacteria can be used as potential biological control agents for air-borne fungal pathogens. Forty-eight morphologically different isolates of epiphytic bacteria were selected for studying their antifungal activities against two

major foliar pathogens of groundnut, i.e *Alternaria* and LLS pathogen. Though 19 cultures showed antifungal activities against *Alternaria* (3-18 mm inhibition zone after 96 h of incubation), six isolates were promising in showing high degree of antifungal activity against *Alternaria* (>10 mm inhibition zone). Nine epiphytes showed antifungal activities against LLS pathogen, the inhibition zones ranging from 6 to 12 mm.

Characterization of Zn and K solubilizing microorganisms and quantitative estimations

The PGPR cultures BHU-1, FP82, BM6, FP93 and *Bacillus megaterium* have been identified as efficient Zn solubilizers. Sixteen PGPR cultures showed clear zones of K solubilization under in vitro conditions, using potassium aluminosilicate as insoluble source of K. Consortium of compatible strains of Zn and K solubilizers will be developed and tested for enhancing Zn and K solubilisation and uptake in groundnut, besides quantification of the quantum of Zn and K solubilisation.

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

(Pal KK, Dey R, Meena HN, Mahatma MK, Harish G and Ajay BC)

Isolation, characterisation and identification of endophytes and rhizobia from germplasm accessions and released cultivars by imposing drought stress

A total of 379 new putative endophytes and 47 putative rhizobia were isolated from germplasm accessions (drought tolerant; Junagadh) and advanced breeding lines and released cultivars (Kadiri 6, Kadiri 9 and Narayani) at Anantapur District of AP. Out of these endophytes, 71 isolates could grow at -2.2 MPa and 148 could grow at -1.7 Mpa.

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

To ascertain whether substantial irrigation water can be saved by application of endophytic bacteria in summer groundnut, it was found that average pod yield with endophytes (*Pseudomonas pseudoalcaligenes* SEN29, and *Bacillus firmus* J22) obtained with the application of four irrigations (1932 kg/ha) was at par that obtained with 10 irrigations without inoculation (1990 kg/ha) with cultivar TG37A (Table 1).

In a separate experiment, five endophytes (*Bacillus firmus* J22, *Bacillus subtilis* R51, *Pseudomonas pseudoalcaligenes* SEN29, *Acinetobacter junii* J20 and *Pseudoxanthomonas maxicana* R47) were evaluated during summer 2017 with cultivar TG37A and with five different level of irrigations (one, two, three, four and 10 irrigations after emergence). Results indicated that application of endophytes and 4 irrigations can provide as much pod yield (average 1873 kg/ha) that can be obtained with 10 supplementary irrigations after emergence (1766 kg/ha). Inoculation of endophytes improved the pod and haulm yield of groundnut at all level of irrigations. Maximum benefit was received by *Bacillus firmus* J22, followed by *Pseudomonas pseudoalcaligenes* SEN29 (Table 2).

Thus, it would be feasible to reduce quantity (30-50%) and frequency of irrigations (3-4 irrigations) substantially for raising summer groundnut with endophytes and there is possibility of horizontal spread in areas with the application of endophytes with the available quantity of irrigation water.

The modulation of C3-CAM transition was also studied and it was found that there was enhanced level of production of key enzymes of carboxylation and de-carboxylation modules of C3-CAM pathways due to inoculation of groundnut with reduction in frequency of irrigation.

Table 1: Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut (Summer 2017; TG37A)

Treatments	No of supplementary irrigations				Mean
	2	3	4	10	
Control	1097	1327	1707	1990	**1530**
J22	1325	1592	1918	2265	**1771**
SEN15	1194	1450	1810	2086	**1635**
SEN29	1307	1618	1948	2318	**1802**
Mean	**1231**	**1497**	**1846**	**2165**	**1684**
	LSD (0.05)				
Treatment	**40**				
Irrigation	**31**				
Treatment X Irrigation	**63**				

Table 2. Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut, TG37A, Summer 2017

Treatments	No of supplementary irrigations after emergence					Mean
	1	2	3	4	10	
Control	470	1130	1383	1560	1767	**1262**
REN47	577	1362	1583	1860	2033	**1483**
SEN29	613	1300	1523	1900	2127	**1493**
J20	560	1417	1583	1903	2093	**1511**
R51	543	1353	1470	1895	2047	**1462**
J22	623	1350	1660	1810	2067	**1502**
Mean	**564**	**1319**	**1534**	**1821**	**2022**	**1452**
	LSD (0.05)					
Treatment	35					
Irrigation	29					
Treatment X Irrigation	70					

Evaluation of endophytes for alleviation of salinity stress in groundnut and mechanisms of alleviation

Five endophytes (*Bacillus firmus* J22, *Bacillus subtilis* R51, *Pseudomonas pseudoalcaligenes* SEN29, *Acinetobacter junii* J20 and *Pseudoxanthomonas maxicana* R47) were evaluated during summer 2017 with cultivar TG37A (known as susceptible cultivar) for alleviation of salinity stress, if any and with salinity level of around 5.2 at harvest. Results indicated that though there was drastic reduction in yield of groundnut with the application of saline water and at 5.2 EC of soil salinity at harvest, there was reduction in yield by 60-65%. Application of endophytes like *Bacillus firmus* J22, *Pseudomonas pseudoalcaligenes* SEN29 and *Bacillus subtilis* REN51 prevented the reduction in yield losses by improving the yield by 28%, 20%, and 18%, respectively (749 kg/ha in control and 886-963 kg/ha with these endophytes) at soil EC of around 5.2 at harvest.

A separate experiment was undertaken with TG37A and four of its C3-CAM transited and drought tolerant variants with soil salinity level of around 5.2, at harvest, to understand the phenomenon further. It was found that while imposition of salinity at around 5.2 of soil EC reduced the biomass production in the susceptible cultivar TG37A by almost 60% (8037 kg/ha in normal soil condition to 3293 kg/ha in around 5.2 soil EC in TG37A), the over-expressive C3-CAM transited variants of TG37A (which are otherwise drought tolerant) like DGRMB5 minimized the biomass reduction (5233 kg/ha) and maintained at 35% level of reduction (Table 3).

Evaluation of the role of endophyte (*Bacillus firmus* J22) in alleviation of salinity stress in groundnut at Bhuj (farmers field in collaboration with Dr. Devidayal, HOD, RRS-CAZRI, Bhuj)

Field demonstration on 30 farmers fields of villages; Kotda, Tharawda, Varli, Reldi, and Vesal Par-Nakhatarana of Kachchh district, Gujarat were organized during Kharif 2017 to show the beneficial effect of bacterial endophyte, *Bacillus firmus* in improving productivity of groundnut. Groundnut seeds (cv GG 2) were treated with *B. firmus* just before sowing, shade dried and sown in the field. The soils of the farmers' fields were saline and the final EC of soil at the time of harvest ranged from 4.5-6.2.

The pod yield in control plot ranged from 1000 to 3800 kg/ha with a mean of 2058 kg/ha whereas in treated plot, it ranged from 1250 to 4400 kg/ha with a mean value of 2427 kg/ha. The average increase in pod yield due to seed treatment with bacteria over the control was 17.89%. The haulm yield increased by 5.65% due to seed treatment over the control. The pod yield increase was mainly due to increased number and weight of pods per plant under the treated plot as compared to the control. The bacterial seed treatment was economically beneficial as a net return of Rs 79,320/ha along with BCR of 2.37 was recorded under treated plot as against Rs 63,895/ha with BCR of 2.15 in control. An average increase in Net returns due to seed treatment was 10% over the control.

Yield evaluation and multiplication of C3-CAM transited variants for supply to AICRP-G trials (Summer and Kharif 2017)

The C3-CAM variants obtained from TG37A were evaluated and multiplied under rainfed conditions only for evaluation of yield and for supplying the multiplied materials to AICRP-G trials in IVT. DGRMB3, DGRMB5, DGRMB19, DGRMB24, DGRMB31 and DGRMB32 gave significantly higher yield as compared to TG37A. Similar trend was also obtained while evaluating the same materials during summer season of 2017 with two, three and four supplementary irrigations after emergence.

Table 3. Biomass production under salinity stress (average soil EC at harvest: 5.2 in salinity treatment)

Treatments	PY (kg/ha)	HY (kg/ha)	% reduction in biomass
TG37A	2100	5937	-
TG37A+Salt	736	2557	59.03
DGRMB17+ Salt	980	3050	49.86
DGRMB19 + Salt	1093	3237	46.12
DGRMB31 + Salt	918	3007	51.16
DGRMB5 + Salt	1197	4036	34.89
CD (5%)	**123**	**204**	**-**

Table 4. Yield potential of C3-CAM transited variants of TG37A under rainfed conditions (kharif 2017)

Variants/ WT	PY (kg/ha)	SOT (%)	HKM (g)
TG37A	2873	69.30	41.87
DGRMB1	2610	71.13	43.40
DGRMB3	3360	70.63	44.10
DGRMB5	3477	72.23	47.87
DGRMB13	2863	70.00	44.37
DGRMB17	3090	69.57	43.33
DGRMB19	3140	70.23	42.97
DGRMB20	2873	72.00	44.77
DGRMB24	3337	68.23	45.43
DGRMB29	2930	68.20	42.73
DGRMB31	3423	69.33	42.80
DGRMB32	3567	70.47	42.50
DGRMB41	2993	68.73	41.70
CD (0.05)	**257**	**1.84**	**1.63**

5 Socio-economic Research and Extension for Groundnut in Developments

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

Narayanan G and Jat RA

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

There is a gap in yield or additional increase in output per unit input from the existing production level of groundnut. To bridge the gap or to improve the productivity we have to find out ways to increase output per unit input. This will lead to attainment of desirable transfer of factors of production among small and marginal farmers for high output for unit input. Hence, this study assessment of farm managerial abilities and of small and marginal farmers was undertaken among Gir-Somnath and Rajkot districts farmers primarily to identify the determinants of output growth in groundnut cultivation. For this 120 farmers from both districts were interviewed with structured interview schedule. From Gir-Somnath,Kodinar and Talala Talukas and in Rajkot district, Dhoraji and Jam Kandorna talukas were chosen.

Table.1: Cost and returns from groundnut cultivation of small and marginal farmers (Resource Use Efficiency in value terms)(n=120)

Cost of cultivation	Mean	Minimum	Maximum	% share
Ploughing (ha)	1372.08	375.00	5000.00	2.53
Land clearing (ha)	999.17	350.00	2500.00	1.84
Levelling (ha)	2709.35	812.00	6250.00	4.99
Seed (ha) (Rs.)	5490.67	4800.00	6000.00	10.11
Seed treatment (ha)	915.00	400.00	1800.00	1.68
Sowing (ha)	1976.04	937.50	2750.00	3.64
Weeding/ Hoeing/Inter-culture operations (ha)	2962.08	625.00	6250.00	5.45
Irrigation and electricity charges (ha)	1373.33	750.00	3000.00	2.53
FYM (ha)	4335.59	1000.00	6250.00	7.98
Fertilizers& micro-nutrients (ha)	2964.58	1000.00	6250.00	5.46
Plant protection chemicals (Insecticide, fungicide and weedicide) (ha)	4240.83	1000.00	7500.00	7.81
Harvesting, drying, threshing, cleaning, gleaning cost (ha)	11983.33	7500.00	15625.00	22.06
Transportation and marketing (Rs./kg)	1391.15	575.00	2356.25	2.56
Rental value of land (ha)	11675.00	7000.00	22500.00	21.49
Total cost of cultivation (ha)	54315.95	44675.00	65212.50	100.00
Gross value of product (ha)	84115.63	52500.00	112500.00	
Net income (ha)	29799.67	-2000.00	60225.00	

Rental value of land and post harvesting practices having equal share in cost of cultivation. This speaks that needed of much more mechanization in post-harvest practices, along with that change of APMC act may reduce the transportation cost. Alternatively in order to have efficiency in production system contract farming approach may be promoted. Rental value of land (21.5%) is very high with respect to other investment. For marginal farmers, with given expenditure recorded, groundnut cultivation is no longer remunerative crop.

Allocative efficiency is concerned; the allocation for seed seems to be same and constant. The change may have to be effected in plant protection chemicals, harvesting, drying, threshing, cleaning, gleaning etc. of post-harvest handlings. The BC ratio, range is very narrow i.e. 1:1.6 to 1:1.7. Regarding minimum category it was 1:1.2 hence farmers who have less resource are continue to go for groundnut to get the by product. They depend only on monsoon and not on market price and expressed that as main economics constraints.

Technical efficiency of small and marginal farmers (Frontier production function model)

Majority of marginal farmers (50 per cent) operating with 75.69 per cent of technical efficiency. About 38 per cent farmers operating with 85.18 technical efficiency. Only 7 per cent of farmers operating with more than 90 per cent of technical efficiency. This reveals that among small and marginal farmers with the same investment, about 21 per cent yield improvement can be achieved. This speaks about the yield gap exists in groundnut and need to build the capacity of small and marginal farmers on better allocative efficiency.

Table.2: Technical efficiency of small and marginal farmers (Frontier production function model)

TE range	Farmers (%)	Average TE	% of output lose due to inefficiency
< 70%	05	62.43	37.57
70-80%	50	75.69	24.31
80-90%	38	85.81	14.19
>90%	7	94.98	5.02

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

The study was carried out assessing the extent of farm managerial abilities of small and marginal farmers. It was found that majority of the small (80%) and marginal farmers (90%) found to have medium farm managerial abilities. Among small farmers, only about 20% of farmers found to have high farm managerial abilities.

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

Table.3. Assessing the extent of farm-managerial abilities of groundnut growers

Extent of farm-managerial abilities	Marginal Farmers (60)		Small Farmers (60)	
	No. of Farmers	Percentage	No. of Farmers	Percentage
High >77	6	10	12	20
Medium ≤77	54	90	48	80

Table.4: Component wise presentation of farm-managerial abilities of groundnut growers

Sr.No.	Managerial Abilities	Marginal farmers (60)		Small farmers 60)	
		Medium%	High %	Medium %	High %
1	Knowledge of scientific practices	100	-	90	-
2	Planning in groundnut cultivation	30	67	23	77
3	Organizing the activities	27	63	35	57
4	Supervision in cultivation of groundnut	3	97	17	83
5	Budgeting	20	80	30	70
6	Coordination the activities	17	83	30	70
7	Communication	40	57	43	40
8	Controlling	30	67	45	50
9	Decision making	23	77	17	80

Constraints faced by the farmers in groundnut cultivation

On the constraints study carried out among small and marginal farmers it was revealed that risk of revenue lose/low yield, non-remunerative price, high cost of inputs and non-availability of cash found to be top three severe constraints among marginal farmers. The top three severe constraints among small farmers also found to be the same economic constraints among them.

Apart from top three other severe constraints are non-availability of improved varieties and labour expressed by marginal farmers and non-availability of labours and low adoption of neighbouring farmers found to be severe constraints by small farmers. Thus for achieving high profit, investment in high cost machineries and better skilled labours may be need of the hour.

Visit of farmers

This year (2017-18), altogether 1443 visitors from various states viz.Gujarat, Madhya Pradesh, Karnataka, Odisha, New Delhi, Maharashtra, andRajasthan visited this Directorate. It includes a total of 735 farmers from 7different states, 685 students from four universities and 23 staff belonging todifferent agriculture universities and state departments. These visits weresponsored by State Department of Agriculture or State Agricultural universities concerned. All visiting groups were taken to the demonstration fields, provided with Hindi, Gujarati and English literatures; shown fieldexperiments, Technology Park, laboratories, museum, library etc. andi-nteraction meetings with the scientists were also arranged.

Development activities for tribal and hill regions: Reaching the unreached

The tribal lives mostly in hilly areas where the source of irrigation (about 80%) is open wells. Groundnut, the major

high valued oilseed crop with latest variety and technology will helpful to get higher and better quality yield among them and ultimately resulting in to improving the economic condition of the tribal, which indirectly helpful for improving the education level and nutritional security of their children as well as family as a whole. Further, popularization of groundnut across tribal belts will also helpful to improve the groundnut production in the country. Thus, during 2017-18 to conduct the On-Farm Demonstration on groundnut with latest varieties and technologies about Rs.20 lakhs was sanctioned to five KVKs viz.,1. KVK, Kodinar (Gir Somnath), 2. KVK, Khedbrama (Sabarkantha), 3. KVK, Deesa (Banaskantha), 4. KVK, Vyara (Tapi), 5. KVK, Dediapada (Narmada) of tribal dominated districts of Gujarat and covered about 264 tribal farm families.

Table 5: Constraints faced by the farmers in groundnut cultivation

Sr. No.	Constraints	Marginal farmers (60)		Small farmers (60	
		No. of Farmers	Rank	No. of Farmers	Rank
1.	**General constraints**				
(a)	Non-availability of labours	10	6	20	5
(b)	Non-availability of improved varieties	18	5	10	8
(c)	Non-availability of irrigation waters	2	9	10	8
2.	**Technical constraints**				
(a)	Lack of awareness	22	4	12	7
(b)	Lack of timely guidance	8	7	4	9
3.	**Social constraints**				
(a)	Low adoption of neighbouring farmers	2	8	14	6
(b)	Lack of participation in meetings and discussions	2	8	2	10
(c)	Lack of education	10	6	10	8
4.	**Economic constraints**				
(a)	Non-remunerative price	38	2	34	1
(b)	High cost of inputs	36	3	32	2
(c)	Risk of revenue loss/low yield	46	1	24	3
(d)	High cost of machineries	22	4	24	3
(e)	Non-availability of cash	36	3	22	4

6 Highlights of AICRP on Groundnut: 2017-18

I. Crop Improvement

1. Maintenance, multiplication and characterisationof groundnut germplasm

- Four thousand one hundred and forty-six(4146) germplasm accessions have been multiplied and maintained at 11 centres during *kharif* 2017. This included 60 wild accessions; 19 interspecific derivatives; exotic collection; 2834 Spanish bunch accessions; 53 Valencia accessions; 810 Virginia Bunch accessions; 374 Virginia Runner accessions; and four other germplasm accessions.
- During *rabi*-summer 2016-17, a total of 1328 accessions, 492 accessions at ICAR-DGR Junagadh; 514 accessions at TNAU-Vridhachalam and 322 accessions at ANGARU-Kadiri have been multiplied and characterized.

2. Identification of promising germplasm/advance breeding lines

Promising genotypes/ germplasm have been identified for different target traits at eight centres for important traits like drought (NRCG 14346, RGR-155, ICGV 99195, ICGV 00298, TVG 0856); foliar fungal diseases (NRCG8115, NRCG8171, NRCG 13282, NRCG 3, NRCG13271); tolerance to PBND (R2001-2, R2001-3); multiple disease resistance (RTNG-173, RTNG-174, RTNG-175, RTNG-176); and early maturity (RTNG 86, RHRG 1344, TG 37A).

3. Maintenance of wild *Arachis* species and interspecichy- bridisation

- Sixty accessions belonging to twenty-four wild species of six sections of *Arachis* are being maintained at RRS, Vridhachalam (TNAU).Wild *Arachis* genetic resources developed earlier, Allotriploids, autotetraploids, amphidiploids, auto hexaploids were field maintained at RRS Vriddhachalam for use in wide hybridisation

4. Interspecific hybridisation programme at RRS-Vridhachalam (TNAU)

- In *kharif* at Vridhachalam eighteen interspecific crosses were effected with three foliar and fungal diseases susceptible ovule parents (VRI 2, VRI 3 and JL 24) and three resistant auto tetraploids (A. villosa, A. duranensis, and A. stenosperma) and three resistant diploid species (viz., A. helodes, A. diogoi and A. cardenasii) during this kharif 2017 season. Pod setting in these crosses ranged from 15.5% (JL 24 X A. *helodes*)to 1.9% (VRI 2 X A. *diogoi*). True F1s will be identified in next season for further selection and advancement.
- In *Rabi*-summer at same centre, sixteen interspecific crosses made between four cultivated groundnut varieties (TMV 2, TMV 7, VRI 3, VRI 4) and four wild *Arachis*species viz. *Arachiscardenasii, A. villosa, A. duranensis,* and *A. stenosperma*were made. In all sixteen crosses, the pod setting (%) was less than 10% or just over 10.0% (A. hypogaea L. Cv. VRI 3 X A. stenosperma)
- Due to the production of unreduced gametes 18 tetraploids were obtained from seven triploid populations naturally which will be further evaluated for the disease reaction and cross-compatibility to further use in crop improvement. From eleven interspecific crosses which were advanced to F_2 during *kharif* 2017, 35 tetraploid derivatives were obtained.

5. Hybridization programme

- For developing high-yielding groundnut cultivars possessing resistance to various biotic and biotic stresses which limit yield in season, 151 single-crosses were made was undertaken at 13 AICRP-G centers during kharif and 167 crosses at 10 centres during *rabi*-summer.
- During *kharif* 2017 Segregating generations of objective specific inter varietal and intra varietal crosses effected at 13 AICRP-G centers earlier, were advanced to their respective next filial generations. During *kharif* season, progenies of 608 crosses were advanced to their

respective next filial generation from which very large number of (19035) selections were made. The selections comprised more (17104) of single plants and 1931 progeny bulks. Of the total crosses, which were advanced to different filial generations 298 crosses were in early generations (F1- F3) and 608 crosses in advanced generations (F4 onwards).

- **During *rabi*-summer**,

  progenies of 312 crosses were advanced to their respective next filial generation from which a very large number (14525) of selections were made at 9 AICRP-G centres. The selections comprised mostly of single plants rest (1297) were progeny bulks. Of the total crosses, which were advanced to different filial generations, 136 crosses were in early generations (F_1- F_3) and 312 crosses in advanced generations (F_4 onwards)

6. Varietal evaluation at multi-location

- A three tier system of evaluation of groundnut entries under the nomenclature of Initial Varietal Trial, Stage I (IVT I); Initial Varietal Trial, Stage II (IVT II) and Advanced Varietal Trial (AVT) was adopted and the trials were allotted to 22 centers located in five agro-ecological zones of groundnut both in kharif and rabi-summer
- During *kharif*, 13 entries of Spanish Bunch; 8 entries of Virginia; and 6 entries in Large Seeded types in IVT-I; 13 SB entries, 8 genotypes of Virginia and seven large seeded genotypes in IVT-II were tested across the five zoneswith appropriate checks. Entries of IVT-I will be evaluated for one more year and in IVT-II.
- In IVT-II, during kharif two genotypes GNH 804 (Proposed by HAU, Bawal) promoted to AVT In Zone IV (Odisha, West Bengal; Jharkhand; Manipur) and Dh 256 (Proposed by UAS Dharawd) in Zone V (TN, AP, Telengana, Karnataka) significantly out yielded the best check for pod and higher kernel yield are promoted to AVT
- **In AVT during *kharif***, one Spanish Bunch entry, JL 1085-of MPKV Jalgaon, was evaluated in Zone V(TN AP, Kar, Telengana and south Maharashtra) and found superior over the checksacross different stages of evaluation; Increase in pod yield of JL 1085 was 40.9% over GPBD 4; 23.3% over VG 9816; and 10.9 and 11.9% over the best checks of this zone namely R 2001-2 and R 2001-3 respectively. Whereas increase in kernel yield of this genotype over these check varieties was 42.5% over GPBD 4; 24.5% over VG 9816; and 12.8% and 12.0% over the best checks of this zone namely R 2001-2 and R 2001-3 respectively.
- **In *rabi*-summer 2016-17**, two entries (K 1609, TCGS 894) were evaluated at AVT in Zone IIIb (AP, Telengana, TN). The entry TCGS 894 was found superior over checks over different stages of evaluation and the increase in pod yield of TCGS 894 was 21.8% over the zonal check, R 8808; 13.5% over TAG 24 (ZC); and 5.3% over ICGV 00350 (ZC). Whereas increase in kernel yield of this genotype over these check varieties was 28.7% over R 8808 (ZC); 19.9% over TAG 24 (ZC); and 14.3% over ICGV 00350.

  Both these genotypes are proposed for identification

7. Special Varietal trial on 'High Oil and High oleic Acid' (HOVT)

- A special trial on High Oil and High oleic Acid Varietal Trial (HOVT) has been constituted with 19 elite genotypes developed on a DAC-GOI funded project mode by ICRISAT and the national collaborators namely, TNAU-Coimbatore; ANGRAU-Tirupati, JAU-Junagadh and ICAR-DGR, Junagadh and evaluated at six locations: Junagadh, Durgapura, Dharwad, Palem, Tirupati and Tindivanam
- The oil content was in the range

of 50% to 54% in the test genotypes and checks. Oil content was 54% in 8 genotypes; 53% in 8 genotypes; 52% in 5 genotypes; and 50% in one genotype.

- As regards oleic content, 14 genotypes expressed around 80%; 79% in 1 genotype; 75% in 2 genotype; <75% in 2 genotypes; ~62% in two genotypesand <60% in 2 genotypes.
- Oleic acid content was stable across the locations except for Durgapura where the expression of this trait has been found altered. It may either be due to environment or due to sampling error either of more over matured or immature kernels in the samples.
- As such the trial has to be repeated for one more year, no decision needs to be taken regarding promotion/ identification of these varieties.

8. Breeder Seed Production

- During *kharif* 2017, DAC indents to the tune of 10168.41q of breeder seeds were received for 49 groundnut varieties. Based on the availability of nucleus/ breeder seed stage I, a production target of 10198.90q was assigned for 45 groundnut varieties to 20 centres. During *kharif* 2017, a total quantity of 4865.36q breeder seed could be produced. To mitigate the short fall, a compensatory programme was undertaken during *rabi*-summer 2017-18 and the anticipated production is 7648.00q. Thus, the total production of groundnut breeder seeds during 2017-18 would be 12513.36q

A special trial on High Oil and High oleic Acid Varietal Trial (HOVT) has been constituted with 19 elite genotypes developed on a DAC-GOI funded project mode by ICRISAT and the national collaborators namely, TNAU-Coimbatore; ANGRAU-Tirupati, JAU-Junagadh and ICAR-DGR, Junagadh for over a period of ten years along with check varieties

II. Crop Production (*Kharif-2017)*

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

The experiment was conducted at Bhubaneswar, Shirgaon, Vriddhachalam and all the three centres have completed the study for three consecutive seasons of *kharif* 2015, 2016, and 2017. Significantly higher pod yield was reported during *kharif* 2017 by Bhubaneswar and Shirgaoncentres with application of paclobutrazol @ 100 ppm but no significant improvement in pod yield was found due to spray of paclobutrazol at Vriddha-chalamrather higher doses of paclobutrazol significantly reduced pod yield over control. Regarding timing of spray, significantly higher pod yield was reported with one spray at 30 DAE at Bhubaneswar, and two sprays at 30 and 50 DAE, being at par with one spray at 30 DAE, at Shirgaon.

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

The experiment was conducted at Bikaner, Puducherry, Raigarh, Tindivanam, Tirupaticentres during kharif 2017. At Bikaner no significant effect was observed on pod and haulm yield and disease infestation percentage. At Pudducherry, significantly higher pod yield was found with FP 86 which was at par with DAPG 4. While at Raigadh the pod yield was significantly higher with DAPG1 which was at par with DAPG 2 and Trichoderma sp. Pod yield was reported significantly higher with DAPG at Tindivanam. Similarly, at Tirupati pod yield was significantly increased with the application of DAPG 4 which was at par with DAPG 1 and FP 98. The incidence of collar rot and dry root rot was also significantly lower with DAPG 4 at Tirupati. Puducherry, Raigarh, Tindivanamcentres

have not reported data on disease incidence while none reported data on nutrient use efficiency.

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

The experiment was conducted at Mohanpur, Puducherry, Tindivanam, and Tirupati centres during kharif 2017. At Mohanpur, application of tank mix imazethpyr (60%) + quizalofop ethyl (40%) at 20-30 DAS gave significantly higher pod yield. At Pudducherry and Tindivanam, pre-emergence application of pendimethalin @1.5 kg a.i./ha (PE) followed by tank mix application of imazethpyr (50%)+ quizalofop ethyl (50%) at 20- 30 DAS produced significantly higher pod yield. At Tirupati, pendimethalin (PE) followed by imazethpyr @ 75 g a.i./ha at 20-30 DAS produced significantly higher pod yield.

4. Economizing phosphorus use in groundnut production by exploiting phosphorus build-up in soil.

The experiment was conducted at Akola, Bhubaneswar, Bikaner, Dharwad, Durgapura, Jalgaon, Junagadh, Kadiri, Mohanpur, Shirgaon, Tindivanam, Tirupati, Vridhachalamcentres during kharif 2017 while Jagtialcentre did not report data. A perusal of data revealed that at Akola, Bikaner, Mohanpur, and Shirgaon application of FYM 5t/ha+ 100%P+ DGRC 1 produced significantly higher pod yield. While at Jalgaon, Pudducherry, and Vriddhachalam application of FYM 5t/ha+100% P+ DGRC 2 gave significantly higher pod yield. At Bhubaneswar and Kadiri application of FYM 5t/ha+ 50% P+ DGRC 1 and at Tirupati application of FYM 5t/ha+ 50% P+ DGRC 2 was found to give significantly higher pod yield. At Dharwad, Durgapura, and Tindivanam significantly higher pod yield was obtained with the application of FYM 5t/ha+ 100% P but application of either of DGRC 1 or DGRC 2 failed to improve pod yield further significantly. At Junagadh, no significant effect was found on pod yield due to different phosphorus management practices.

5. Identification of rain fed groundnut + millet intercropping system for red soils of Karnataka.

The trial was vitiated at Dharwad because of poor emergence of millets and groundnut due to insufficient moisture in the seed zone. At Hiriyur, significnatly higher pod yield and GPEY was ontained with sole groundnut but higher net returns were obtained with Groundnut + finger millet (5:2).

6. Response of *kharif* groundnut to plant geometry and fertility levels in light soils.

The experiment was conducted at Bawal, Gwalior and Raigadh during kharif 2017. Significantly higher pod yield was reported with sowing at 25 x 10 cm spacing at Bawal while pod yield was significantly higher with sowing at 30 x10 cm spacing at Gwalior and Raigadh. Pod yield was found significantly higher with application of 125% RDF at Bawal (18.75-62.5-31.25 kg/ha NPK), Gwalior (25-75-25 kg/ha NPK) and Raigadh (37.5-75-37.5 kg/ha NPK).

7. Alleviation of moisture-deficit stress in groundnut by application of endophytic bacteria.

The experiment was conducted at Akola, Durgapura, Hiryur, Kadiri, Tirupati centres while trial was viriated at Hiriyur due to poor monsoon rainfalls. At Akola, significantly higher pod yield was obtained with DGREB 4 which was at par with DGREB 1, DGREB 2, DGREB 3, and DGREB 5. However, no significant differences were observed in pod yield due to application of different endophytic bacteria at Durgapura, Kadiri, and Tirupati centres.

8. Standardization of sowing depths of groundnut crop in light soils of hyper arid regions.

The experiment was conducted

during kharif 2017 at Bikaner centre and results revealed that sowing of groundnut at depth of 7cm, followed by 9 cm depth, in sandy soils of hyper arid zone of Bikaner gave significantly higher pod yield over sowing at depth of 5 cm and 11 cm.

9. Optimization of seed rate for groundnut cultivars having differential seed sizes during *kharif* season.

The experiment was conducted at Bhubaneswar, Durgapura, Jalgaon, and Junagadh centres during kharif 2017. At Bhubaneswar variety Kadiri 6 (HKW 65 g) performed well, while at Durgapura variety RG 510 (HKW 40-50 g), at Jalgaon variety JL 776 (HKW 50 g), and at Junagadh variety GJG 55 (HKW 50 g) and KDG 128 (HKW 42 g) gave significantly higher pod yield. With respect to spacing, significantly higher pod yield was obtained with spacing 30 x 10 cm at Bhubaneswar, Durgapura, and Junagadh centres while sowing at 45 x 20 cm spacing gave significantly higher pod yield at Jalgaon. The experiment was vitiated at Bikaner center while Jagtial center has not reported data.

10. Assessment of compatibility of post-emergence herbicides with insecticides in kharif groundnut.

The experiment was conducted at Tirupati center during kharif 2017. Significantly highest pod yield was obtained with farmers' practice i.e. separate application of herbicides and insecticides which was at par with tank mix application of imazethapyr 10% S.L. @ 75 g a.i./ha + imidachloprid @ 150ml/ha at 15 - 20 DAS and tank mix application of imazethapyr 10% S.L. @ 75 g a.i./ha+ monocrotophos 36% S.L.@ 800ml/ha at 5-20 DAS.

11. Identification of remunerative groundnut based cropping system under rain fed situation.

The experiment was initiated at Dharwad, Jalagaon, Junagadh and Vridhachalamcentres during kharif 2017. Since *rabi* crops were in the field, reports are awaited and will be included in the next year annual report.

12. Application of bio-formulations in kharif groundnut production.

The experiment was conducted at Dharwad, Durgapura, Gwalior, Jalgaon, Junagadh, Kadiri, Mohanpur, Shirgaon, Tirupaticentres during kharif 2017. Application of 100 % RDF was found to significantly improve pod yield at Dharwad, Gwalior, Jalgaon, Mohanpur, Shirgaon, Tirupaticentres while application of 75% RDF being at par with 100% RDF significantly gave pod yield at Durgapura, Junagadh, and Kadiri. While in case of bio-formulations, application of Bio-grow and NPK liquid bioformulation + zinc solubulizing bacteria being at par significantly improved pod yield at all the locations. Mohanpurcentre has not reported any data.

13. Agronomic management of AVT.

One AVT was conducted at Dharwad for groundnut entry JL 1085 with recommended package practices. JL 1085 gave significantly higher dry pod yield(2697 kg ha-1) over local check GPBD-4 (2451 kg ha-1). Under rainfed situation, paired row planting with recommended plant population performed better than normal planting. Further, groundnut entry JL 1085 responded to application of organics under both the planting patterns. Application of vermicompost resulted in better yield over farm yard manure application.

Crop Production (Rabi-summer 2016-17)

1. Response of summer groundnut to fertilizer doses and plant population under drip-fertigation and check basin methods

The experiment was conducted at Jagtial center during rabi-summer 2016-17. Drip irrigation recorded significantly superior pod yield 2579 kg ha^{-1} and haulm yield 4082 kg ha^{-1} as compared to check basin

method 1524 and 2918 kg ha^{-1}. Significantly higher pod and haulm yield was recorded under plant population @ 4.0 lakh ha^{-}. Application of 100% RDF recorded highest pod yield 2330 kg ha^{-1}and haulm yield @ 3830 kg ha-1 was on par to 75% RDF with pod yield@2097 kg ha^{-1} and haulm yield@ 3143 kg ha^{-1}.

2. Evaluation of DAPG producing *Fluoroscent pseudomonads* for enhancing nutrient use efficiency, bio-control of soil borne disease and yield of groundnut

The experiment was started during Rabi-Summer 2014-015 in order to test the effect of DAPG producing fluorescent pseudomonas for enhancing nutrient use efficiency, bio control and groundnut productivity. During Rabi-Summer 2016-17 trials were conducted at Bhubaneswar, Dharwad, Jalgaon, Junagadh, Kadiri, Mohanpur, Rahuri, Shirgaon, Tirupati, Tindivanam and Virddhachalam. The significantly higher pod yield was reported with PF-98 at Jalgaon, Rahuri, DAPG-2 at Dharwad, Kadiri, Mohanpur, Shirgaon, Tirupati DAPG-4 at Bhubaneswar, Junagadh, Tindivanam, and at Virddhachalam non-significant difference was observed.

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

The experiment was started during Rabi-Summer 2015-16 and during next year it was conducted only at Rahuri with the objective to standardize the level and time of application of potassium through drip irrigation in summer groundnut. Significantly higher pod yield was recorded with application of 30 kg K_2O per ha and fertigation of potash uniformly in equal splits at weekly interval up to 75 DAS (10 Splits).

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

This experiment was allotted to Mohanpur center for rabi-simmer 2016-17 but data has not been reported by the center.

5. Economizing phosphorus use in groundnut production by exploiting phosphorus build-up in soil

The experiment was started during Rabi-Summer 2015-16 in order to exploit the native soil phosphorus for groundnut nutrition and in next year 2016-17 it was conducted at Bhubaneswar, Dharwad, Jalgaon, Junagadh, Kadiri, Mohanpur, Rahuri, Shirgaon, Tirupati, Tindivanam and Virddhachalam. The significantly higher groundnut productivity was observed with application of FYM@ 5t/ha + 100% P + DGRC-1/DGRC-2 all all the centersas compared to other treatments.

6. Studies on tank mix application of early post emergence herbicides for efficient weed control in groundnut

The experiment was started at Tindivanam during 2015-16 and during 2016-17. The application of pendimethalin @ 1.5 kg a.i./ha (PE) + tank mix imazethpyr (50%) + quizalopfop ethyl 50 (50%) at 20-30 DAS resulted in higher groundnut pod yield.

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

The experiment was initiated at Deesa and Mohanpur during 2016-17. At Deesa TAG 24 performed significantly higher pod yield, kernel yield and harvest index which was at par with DH 86. Highest haulm yield and shelling % were recorded under DH 86. However, highest pod yield and kernel yield were observed under 100% RDF which was statistically at par with 75% RDF. At Mohanpur Highest pod yield was recorded with the variety TG 51 which was statistically at par with TAG 24 but significantly superior to TG 37A and AK-12-24. Further highest pod yield was recorded under without

inorganic fertilizer which was statistically at par with RDF25% but significantly superior to rest of the treatments.

8. Irrigation management in summer groundnut under potato-groundnut system in light soils

The experiment was initiated at Deesa during 2016-17. The results revealed that irrigation methods did not significantly influenceall the yield and yield attributing characters. Further, significantly higher pod yield and net returns were recorded under 1.2 ETcbut it was at par with 0.8 ETc of irrigation level.

9. Efficacy of herbicides on weed control in groundnut under rice- groundnut system

The experiment was initiated during Rabi-Summer 2016-17 in order to test the efficacyof herbicide on weed control under rice-groundnut system. It was conducted at Akola, Bhubaneswar, Dharwad, Mohanpur, Tindivanam and Virddhachalam. application of Two hand weeding (At 20 and 40 DAS) gave highest yield at Akola, Bhubaneswar; Pendimethalin 30% E.C. @ 1.5 kg a.i./ha + One hand weeding at 25 DAS gave highest yield at Dharwad; Pendimethalin 30% E.C.@ 1.5 kg a.i /ha + Imazethapyr 10% S.L. @ 75 g a,i/ha at 20-30 DAS (At 2-5 leaf stage weeds) gave highest yield at Mohanpur , Tindivanam and Pendimethalin 30% EC @ 1.5 kg a.i/ha (PE) + One hand weeding at 25 DAS gave highest yield at Virddhachalam in groundnut.

10. Agronomic management of *rabi*-summer groundnut under rice-groundnut system

The experiment was initiated during Rabi-Summer 2016-17. It was conducted at Dharwad, Shirgaon, Tindivanam and Virddhachalam. Groundnut varieties namely Dh-101 and Dh-86 performed equally under rice groundnut system. However, groundnut variety Dh-101 recorded higher dry pod yield. Combined application of RDF + Rhizobium (Seed treatment) produced the higher pod yield than application of RDF alone. The interaction effect was found not significantat Dharwad. Under South Konkan Coastal condition, promising groundnut variety, TKG Bold fertilized with application of 125% RDF+ Rhizobium recorded increased pod yield over groundnut cultivar, Konkan Gaurav grown with same fertilizer dose at Shirgaon. The higher pod yield was observed in TMV 13 under rice fallow groundnut system. In nutrient management treatment i.e 100 % RDF along with Rhizobium seed treatment recorded the highest pod yield at Tidivanam. The higher pod yield was observed in VRI 8 and the combined application of 125 % RDF (25:50:75 NPK kg/ha) along with seed treatment recorded the higher pod yield and economics than the application of inorganic fertilizers alone at Virddhachalam

11. Agronomic management of AVT

The advanced genetic material was tested with local check at Dharwad, Shirgaon and Virddhachalam. The AVT entry ICGV 07240 and local check Dh-86 performed statistically at par with each other. Further, significantly highest dry pod yield was observed at 30 cm X 10 cm spacing with application of FYM @ 7.5 t ha^{-1} + 150 % RDNPK at Dharwad. Under South Konkan Coastal condition, promising groundnut entry, RTNG-29 sown with 30X10 cm plant spacing (plant population of 3,33,333 plants ha^{-1}) and fertilized with 30:70:00 NPK kg ha^{-1} recorded increased pod yield over groundnut cultivar, Konkan Gaurav grown with same plant spacing and fertilizer dose. But in terms of economics groundnut entry RTNG-29 sown with 30X10 cm plant spacing and fertilized with 25:50:00 NPK kg ha^{-1} gives more benefit to cost ratio as that of groundnut entry RTNG-29 sown with 30X10 cm plant spacing and fertilized with 30:70:00 NPK

kgha^{-1}at Shirgaon. Agronomic trials on AVT entries revealed that the pod yield was not significant between the entry TCGS-894 and VRI 8 whereas differs significantly with VRI 2 for pod yield, no. of matured pods/plant and DMP (at 30 DAS). Between the spacing, the yield and net returns were highest with 30 x 15 cm spacing. Increased levels of fertilizers recorded significantly higher growth parameters, yield parameters and yield.

III. Crop Protection

Altogether 23 trials, 11 during *rabi*-summer 2016-17, 12 during *kharif* 2017 from pathology and entomology were conducted. The highlights of the research from selective trials are presented:

Pathology (*Rabi* / Summer)

❖ Diseases situation:

Monitoring of major diseases at farmers' field and research stations was reported. Maximum late leaf spot was reported from Vridhachalam (9 scale) followed by Aliyarnagar (8 scale), Jalgaon and Bhubaneswar (7). Early leaf spot was high at Tirupathi (7 scale) and Aliyarnagar(5). Rust was maximum at Aliyarnagar (8 scale) followed by Dharwad, Tirupathi and Vridhachalam (6-7). Maximum *Alternaria* leaf blight was reported from Junagadh (6 scale), Bhubaneswar and Dharwad (5). Collar rot from Junagadh (0-10%) and Vridhachalam (4-10%). Dharwad reported stem rot with incidence of 2-13%. Maximum PBND was reported from Raichur and Tirupathi (26%), and then Pavagada (13%), Kadiri (15%). Dry root rot was recorded high at Raichur (20) and Kadiri (16%).

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

Among genotypes screened, INS-I-2016-13 was reported to be resistant for rust and late leaf spot at Aliyarnagar, for collar rot at Jalgaon and Junagadh, for stem rot at Jalgaon, for dry root rot at Kadiri and for LLS at Raichur. INS-I-2016-16 was resistant to rust and late leaf spot from Aliyarnagar; for collar rot at Junagadh and for dry root rot at Kadiri. INS-I-2016-15 was resistant for LLS at Aliyarnagar, Dharwad, and Vridhachalam, for rust at Dharwad. INS-II-2015-2, 4, 8 were reported resistance for LLS at Aliyarnagar, Raichur and Vridhachalam and for rust at Aliyarnagar. INS-I-2015-3 reported resistance for LLS at Dharwad and for dry root rot at Kadiri. INS-I-2015-9 was resistant to dry root rot and PBND at Kadiri. INS-I-2015-4, 5, 7, 11 were found resistant to LLS at Dharwad, dry root rot at Kadiri. RSWUE-I-2016-5, 6 were resistant to ELS, LLS, rust and stem rot at Dharwad, for PBND at Kadiri. INS-I-2016- 3 was resistant to stem rot at Dharwad and Jalgaon. AVT-I-2016-1 was found to be resistant to LLS and rust at Aliyarnagar, for collar rot and stem rot at Jalgaon. AVT-I-2016-8 was resistant to stem rot and collar rot at Jalgaon. AVT-II-15 reported to be resistant against ELS, PSND and PBND at Tirupati. INS-2013-13, AVT-I-2016-8, RSWUE-2016-3 reported to be resistant against dry root rot, Alternaria blight, stem rot and collar rot at Jalgaon. RHRG-1108, 1137; JL-578, 7186 showed resistance against collar rot and stem rot at Jalgaon. ISK-I 3110 was resistant to ELS, rust, PBND and PSND at Tirupati.

❖ Management of major foliar diseases:

Treatment T_4 was reported to be the best amongst all the treatments with the lowest incidence of foliar diseases ELS, LLS and rust in Bhubaneswar, Dharwad, Raichur and Vridhachalam and supporting higher pod and haulm yield. Treatment T_2 was reported to be the best at Aliyarnagar and Jalgaon. T_3 was reported to be the next best to T_4 was reported at Raichur and Vridhachalam. Dharwad reported that T_2, T_3 and T_4 were at par in the management of foliar diseases. {*T_4: Tebuconazole 50% + Trifloxystobin 25% WG @ 1.32 g/L (0.035%) at*

*40 and 65 DAS, T_2: Tebuconazole @ 1 mL/L (0.0259%) at 40 and 65 DAS, **T_3:** Pyraclostrobin 5% + Metiram 55% WG @ 2 g/L (0.12%) at 40 and 65 DAS}*

❖ Management of PBND through integration of different modules:

The damage of thrips and PBND was reported to be lowest, with highest pod and haulm yield from **module 2** at Kadiri, Pavagada, Raichur and Tirupati. {***Module 2**: Border crop with bajra (4 rows) + Seed treatment with Gaucho 600 FS @1 mL/Kg seeds + Foliar sprays using Thiocloprid 480 SC @ 0.3 mL/L at 20-25 DAS followed by Fipronil 5SC @ 1 mL/L @ 40DAS and Acetamaprid 20 SP @ 0.2 g/L at 60 DAS}*.

Pathology (*Kharif*)

❖ Monitoring of major diseases of groundnut:

MaximumEarly leaf spot was reported from Kadiri (8 scale), followed by at Pavagada (6), Junagadh (5), Bhubaneswar and Vizianagaram. Maximumlate leaf spot was from Dharwad (9scale)and Vridhachalam, 8 scale from Bhubaneswar and Aliyarnagar, 7 from Pavagada and 6 from Latur, Junagadh. Rust was less severe (4 scale) in all the centers except at Aliyarnagar (8 scale) and Dharwad (7 scale). *Alternaria* disease was less severe and maximum scale of 5 was recorded at Vridhachalam. The incidence of collar rot was maximum at Pavagada (21%), Vridhachalam (16%), Bikaner (15%) and about 7% was recorded at Junagadh, Kadiri and Bhubaneswar. Dry root rot was high at Kadiri (15%) followed by Vridhachalam (9%) and Bhubaneswar (6%). Incidence of stem rot was high in Dharwad (27%), Pavagada (19%), Vridhachalam (17%) and Aliyarnagar (16%). High incidence of PBND (21%) was recorded at Pavagada and in remaining places less than 5% was recorded.

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

diseases: Among the genotypes screened resistance against stem rot and collar rot was recorded by ISK-I-2017-19 at Jalgaon and Kadiri, ISK-I-2017-12 and IVK-I2017-18 at Jalgaon and Junagadh. ISK-I-2017 14 found resistant against collar rot and stem rot at Jalgaon, LLS and rust at Latur. ISK-I-2017-2, 36 was resistant against collar rot at Junagadh and Kadiri. LSVT-I-2017-3, 8, 9 found to be resistant for collar rot and stem rot at Jalgaon and Junagadh and for PSND at Kadiri.ISK-I-2017-6, 10 was resistant against collar rot and stem rot at Junagadh and for LLS and rust at Dharwad.

❖ Development of technologies for management of soil borne diseases:

Treatment T_4 was reported to be the best amongst all the treatments with the lowest incidence of collar rot, stem rot and dry root rot and supporting higher pod and haulm yield at Aliyarnagar, Bhubaneswar, Bikaner, Dharwad, Jalgaon, Junagadh, Kadiri, Tirupati, Vizianagaram and Vridhachalam with ICBR (3.7-9.83) at the above mentioned centres. {T4: Deep summer ploughing with mould board plough + Soil application of Trichoderma @ 4 kg/ ha enriched in 250 kg FYM/ha+Seed treatment with Tebuconazole 2DS @ 1.5 g/ kg of seeds followed by seed treatment with PGPR @625g/ for per ha of seeds + Soil application of Trichoderma @ 4 kg/ ha enriched in 250 kg FYM/ha at 35 and 70 DAS}.

❖ Proposed recommendation:

Based on three years (2015, 2016, 2017) pooled data received from centres "Deep summer ploughing with mouldboard plough, then soil application of Trichoderma sp. @ 4 kg/ha enriched in 250 kg FYM/ha as basal application, then seed treatment with Tebuconazole 1.5 g/kg seed followed by PGPR @ 625 g/per ha of seed, then again soil application of Trichoderma sp. @ 4 kg/ha enriched in FYM @ 250 kg/ha at 35 and 70 DAS, has effectively

reduced incidence of soil borne diseases with higher ICBR, over popular farmers' practice in four centres/ states viz. Aliyarnagar (Tamilnadu), Kadiri (Andhra Pradesh), Raichur (Raichur) and Jalgaon (Maharashtra).

❖ Management of major foliar diseases:

Treatment T_4 was reported to be best at Dharwad, Junagadh, Pavagada, Tirupati, Vizianagaram and Vridhachalam with minimum incidences of foliar diseases, supporting high pod and haulm yield. Whereas, T2 provided the best result at Jalgaon and Kadiri{**T4:** Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seeds+ Tebuconazole 50% + Trifloxystobin 25% WG @ 1.32 g/L (0.035%) at 40 and 65 DAS; T2: Foliar spray of Tebuconazole 25.9 % EC @ 1ml/l at 40 and 65 DAS}.

❖ Evaluation of different IPM modules for management of major insect-pest and diseases in groundnut:

The module I & II were found most promising for lowest damage of diseases and pest supporting high pod and haulm yield. Early leaf spots 12-45 PDI at Jalgaon, Junagadh, Kadiri and Pavagada. Late leaf spots 14-39 PDI at Dharwad, Jalgaon, Junagadh, Pavagada and Vridhachalam. Rust from 2-26 PDI at Dharwad, Jalgaon, Kadiri and Pavagada. Collar rot from (1-9%) at Jalgaon, Junagadh, Kadiri, Pavagada and Vridhachalam. Stem rot (1-14%) at Dharwad, Jalgaon, Junagadh, and Kadiri. Pavagada and Vridhachalam. Dry root rot (1-7%) from Junagadh, Kadiri and Vridhachalam. Thrips (2-19%) at Jalgaon, Kadiri, Pavagada and Vridhachalam. *Spodoptera sp.*(2-23%) at Jalgaon, Junagadh, Kadiri and Vridhachalam. Leaf hopper (2-9%) for Jalgaon, Kadiri, Pavagada and Vridhachalam. Leaf Miner (4%) at Kadiri and (14%) at Vridhachalam. Pod yield ranged from 1300-2805 kg/ha and haulm yield from 2747-3857 kg/ha. {**Module 1**: Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg seed + Border crop with bajra (3 or 4 rows) + Need based spray of Thiodicarb 75 WP @ 1 g/L for defoliator 50-70 DAS + Need based spray of Hexaconazole 5 EC @ 1 mL/L 50-70DAS; **Module 2**: Seed treatment with Trichoderma @ 4 g/kg seed + Need based spray of Imidacloprid 17.8 SL @ 0.3 mL/L + Need based spray of Novaluron 10 EC @ 1 mL/L for defoliator 50-70 DAS + Need based spray of Tebuconazole 25.9 EC @ 1.5 mL/L 50-70 DAS}.

Entomology: (*Rabi* / Summer)

❖ Insect–pests' situation:

Moderate to high incidence of *Spodoptera*sp. was recorded at Raichur (0-25%) and at Jagtial (0-15 %). Leaf miner was high at Raichur (2-30%). Thrips leaf damage was high (5-25%) at Raichur and moderate (0-18%) at Junagadh. Damage by Leaf hopper was high (0-40%) from Jagtial followed by Pavagada (0-28%). *Helicoverpa* leaf damage (0-31%) from Junagadh, (0-24%) from Dharwad. Aphid infestation was high at Pavagada (1-36) followed by Jagtial (0-16%). *Spilataria* (0-5%) from Dharwad.

❖ Occurrenceof natural enemies:

Natural enemies like *Coccinellids*, Spider at Jagtial, Kadiri, Dharwad, Raichur and Vridhachalam, spiders at Dharwad, Jagtial, Kadiri and Vridhachalam, green lace wings at Kadiri and Raichur. *Apantales* sp., *CampoletisChloridae*, NPV, Muscardine at Kadiri. Syrphid flies at Jagtial. Braconids from Vridhachalam were observed with 2% natural incidence. *Chelonis*sp. were observed at Raichur. In Junagadh no natural enemies were observed.

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

The highest *Spodoptera* was recorded (100/5 trap) at 5th standard week in Raichur, and (61.8/5) trap at 11th

standard weed in Jagtial. At Kadiri, *Helicoverpa* was observed (4.80/5 trap) at 5th and 8th standard week. The peak incidence of leaf hopper was recorded (190/trap) at 50th standard week, thrips (101.6/trap) at 49th standard week, Leaf miner (25.6/trap) at 12th standard week at Kadiri.

❖ Screening for resistance to insect pests:

Groundnut entries like INS-I-2016-7 at Dharwad, Jalgaon and Kadiri, INS-I-2016-2,3,5,7,28,29 and AIS-I-2016-6 at Jagtial, Jalgaon, Junagadh and Kadiri, AIS-I-2016-9 Dharwad, Kadiri and Jalgaon showed minimum damage of thrips. INS-I-2016-12, 23, RSWUE-I-2016-8 showed minimum damage of Leaf hopper at Jagtial and Kadiri. INS-I-2016-8, 21, 23, 27, 28, 29, AIS-I-2016-8, 9, 10 showed minimum damage of *Spodoptera* spp. at Jagtial and Kadiri. INS-I-2016-20, 21, 23, 25, AIS-I-2016-8, 9, 10 showed less damage of Leaf miner. INS-I-2016-20 recorded less damage of Aphid at Vridhachalam. INS-I-2016-12 showed minimum damage of thrips Dharwad, Jalgaon Jagtial and Kadiri. INS-I-2016-8, 21, 28, 29 showed minimum resistance to Thrips, *Spodoptera* sp. and Leaf miner at Dharwad, Jalgaon Jagtial, Junagadh and Kadiri. AIS-I-2016-8, 9, 10 showed minimum resistances to Thrips, *Spodoptera* sp. and Leaf miner at Jagtial, Jalgaon and Kadiri.

❖ Management of groundnut defoliator pests using botanicals:

Treatment T_6 was observed good at Jagtial, Kadiri, Raichur and Vridhachalam. At Jagtial pest infestation was least (3%), pod yield (2640 kg/ha), haulm yield (4750 kg/ha). At Kadiri, *Spodoptera* infestation was minimum (20%), leaf miner (17%) pod yield (1342 kg/ha), haulm yield (1642 kg/ha) with ICBR of 1:2.32. At Raichur, *Spodoptera* infestation was minimum (9%), leaf miner (1%), pod yield (2336 kg/ha), haulm yield (3066 kg/ha), and ICBR was 1:7.26. However, at Vridhachalam, pest infestation was least (3%) with yield (1000 kg/ha), haulm yield (3900 kg/ha) and ICBR (1:5.6) for treatment Ponneem.

Entomology (*Kharif)*

❖ Insect-pests' situation:

Moderate to high incidence of *Spodoptera*sp. was recorded at Dharwad (6-28%) and at Jagtial (1-17 %). Leaf miner was moderate at Jalgaon (0-6%) and marginal at Vridhachalam (1-5%). Thrips leaf damage (5-35%) at Jagtial and (5-23%) at Latur. Leaf hopper (0-73%) from Jagtial followed by Latur (5-25%). *Helicoverpa* leaf damage (3-47%) from Junagadh followed by (0-10%) from Latur.

❖ Occurrence of natural enemies:

Natural enemies like *Coccinellids* at Dharwad, Jagtial, Jalgaon, Junagadh, Latur, Raichur and Vridhachalam;, Syrphid fly at Jagtial; Spider at Dharwad, Jagtial, Latur, Raichur and Vridhachalam; GLW at Dharwad, Latur and Raichur; *Campoletischloridae* at Dharwad, *Apantales* sp. at Dharwad and Jalgaon; Fungi at Dharwad was highest (2-19%).

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

The maximum incidence of *Spodoptera* was observed at Jagtail (235.4/5 trap) at 31st standard week followed by (170/5 trap) at 32ndstandard week at Dharwad. Thrips were observed (68/trap) at 36rd standard week at Jalgaon, (17/trap) at 39th standard week at Junagadh. *Helicoverpa* was observed (80/5trap) at 45th standard week at Raichur; leaf hopper was observed at Jagtial with 25/trap at 35th standard week followed by 20/trap at 40th standard week at Junagadh. Aphid was observed (66/trap) at 28th standard week at Jagtial.

❖ Screening for resistance to insect pests:

Groundnut entries like ISK-2017-1, 5, 6, 10, 14, 15, 18, 19, 20, 22 showed less (1-2) incidence of thripsat Jagtial

and Raichur. ISK-I-2017-1 less incidence of thrips at Jagtial, Jalgaon and Raichur. ISK-I-2017-10 at Jagtial, Jalgaon and Raichur, LSVT-2017-11 and DTWUE-2017-8 at Jalgaon, Raichur and Vridhachalam showed fewer incidences to Leaf hopper. LSVT-I-2017-7, 8 showed less incidence of Spodoptera at Jagtial and Dharwad. LSVT-I-2017-7 showed fewer incidences to leaf miner and *Spodoptera*sp. at Dharwad, Jagtial, Raichur and Vridhachalam. ISK-I-2017-22 showed fewer (1-2) incidences to thrips, and leafhopper at Jagtial and Raichur and for Helicoverpa at Junagadh. ISK-I-2017-10,20 reported less incidence for leaf hopper at Jagtial and Raichur and for Thrips at Jalgaon and Raichur. Most of the entries showed <10% incidence of sucking pests and defoliators at most of the centres.

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

Seed treatment with imida-chloprid 600 FS@2mL/kg was found effective at Junagadh with 9% white grub, pod yield (2209 kg/ha), haulm yield (3601 kg/ha) and ICBR of 1: 2.49.

AICRP-G FLD

Kharif- 2017

❖ During Kharif-2017 FLDs were allotted in 9 states having 21 groundnut research FLDs centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Rajasthan, Maharashtra, Karnataka, Manipur, Tamil Nadu, and West Bengal. The FIDs were allotted on Whole Package (WP). Among the 400 FLDs allotted, results were received for 293 FLDs from 1 6 centers, which indicated 73 per cent of implementation.

❖ There were 23 new varieties production potential and profitability were compared with14 old ruling varieties which are cultivated with farmers traditional cultivation practices

❖ The average pod yield achieved was 2170kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The Old varieties performance observed was 1717kg/ha with farmer's traditional practices. The yield increase observed was 28 per cent. The minimum yield difference observed was 11 percent and the maximum was 73 per cent.

❖ The average cost of cultivation with improved practice was Rs.44717 kg/ha in comparison with 41429 kg/ha with farmer's practice. The maximum observed was 83225kg/ha in improved practice and 81225 kg/ha with farmer's traditional practice.

❖ The average Gross Marginal Returns with improved practice was Rs.102510/ha and Rs.80817/ha with respect to traditional practices. Net returns observed was Rs. 57322/ha and Rs. 39186/ha for improved practice and farmer's practices respectively. The average B:C ratio was 1:2.3 and 1:2.0 for improved practice and farmer's practices respectively.

Rabi-Summer 2016-17

❖ The Rabi-Summer 2016-17 FLDs were allotted in 9 states having 18 groundnut research FLD centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. The FLDs were allotted on different aspects such as Improved Varity (IV), Whole Package (WP), Integrated Nutrient Management (INM), Integrated Pest and Disease Management (IPDM), Integrated Weed Management (IWM), and Plant Growth. Promoting Rhizobacteria (PGPR). The 265 FLDs allotted, from 16 centers results were received for 204 FLDs, which indicated 77 per cent of implementation.

❖ There were 11 new varieties' production potential and profitability were compared with 12 old ruling varieties which are cultivated with farmers' traditional cultivation practices.

❖ The average pod yield achieved was 2324 kg/ha under improved whole package of

practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 1869 kg/ha with farmer's traditional practices. The yield increase observed was 25 per cent. The minimum yield difference observed was 13 percent and the maximum was 42 per cent.

- The average cost of cultivation with improved practice was Rs .44774 kg/ha in comparison with 42585kg/ha with farmer's practice. The maximum observed was 67905kajha in improved practice and 61592kg/ha with farmer's traditional practice.
- The average Gross Marginal Returns with improved practice was Rs.111643/ha and Rs. 88869/ha with respect to traditional practices. Net returns observed was Rs.65939/ha and Rs.45471/ha for improved practice and farmer's practices respectively. The average B:C ratio was 1:2.5 and 1:2.1 for improved practice and farmer's practices respectively.

7 Externally funded projects

1. All India network project on soil biodiversity-biofertilizers
(PI: K.K. PAL, CO-PI: R. DEY)

Funding agency: ICAR

Duration:
01.04.2017-31.03.2020
Fund: Rs. 11.00 lakh

Objectives:

- Identification of drought- and salinity- tolerant rhizobia for enhancing BNF and yield of groundnut
- Microbial diversity in groundnut based cropping systems
- Development of formulation of bioinoculants

Achievements:

- Formulations of DAPG-producing *Pseudomonas putida* DAPG4 and *Pseudomonas putida* FP86, which have 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. Liquid formulations developed for both the cultures have shelf-life of more than one year at room temperature and maintained a population of 3.85-6.15X10^{10}cfu/ml.
- Sequenced fresh lot 61 rhizobial isolates of groundnut and majority of them belonging to the genus *Sinorhizobium*, *Mesorhizobium* and *Bradyrhizobium*.

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

(PI: K.K. PAL, CO-PI: R. DEY)

Funding agency:

ICAR through AMAAS project

Duration:
01.04.2017-31.03.2020
Fund: Rs. 31.64 lakh

Objectives:

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

Significant Achievements:

Validated in real time, the mechanism of osmotolerance (survival and multiplication) in extreme haloarchaeon 3A1-DGR linked to alternate carbon gain as readily available carbon is negligible in growth medium. Over-expression of biocarbonate transporter (21 folds), phospho-enolpyruvate orthophosphate dikinase (PPDK) (11.5 folds), phosphoenolpyruvate carboxylase (15.3 folds) and malate dehydrogenase (18 folds) linked to uptake of biocarbonate as carbon source and its subsequent modifications into malate was found when 3A1-DGR was grown at 30% of NaCl concentration as compared to when it was grown at 10% NaCl. Also validated the over-expression of Na/H pump in excluding the Na from the incoming solute into the cells.

Table 1. Over-expression of genes of the enzymes and transporter linked to osmotolerance and alternate carbon gain

Treatment	Genes/transporters of				
	PPDK	PEPC	MDH	Bic transporter	Na/Hantiporter
3A1-DGR (10% NaCl)	1.00c	1.00c	1.00c	1.00c	1.00c
TG37A 3A1-DGR(20% NaCl)	6.00b	10.56b	15.27b	14.47b	11.65b
3A1-DGR (30% NaCl)	11.32a	15.26a	18.08ab	20.74a	26.24a

- Concomitantly, there was also overexpression of the genes of Serine hydroxymethyl transferase, phosphoserine phosphatase, serine-glyoxylate aminotransferase, methylmalony l CoA-mutase, ethyl malonyl-CoA mutase, etc. in 3A1-DGR in imparting salinity tolerance and alternate route of carbon gain.

3. Modelling insect pests and diseases under climate change and development of digital tools for pest management (2017-2020) under the thematic area Pest Dynamics in Relation to Climate Change in the National Innovation on Climate Resilient Agriculture (NICRA)

(PI: P. P. Thirumalaisamy, Co-PI: Harish G)

The project was implemented to develop and document data base for assessment of field level impact of climate change on insect pests and diseases through implementation of ICT based pest surveillance in addition to prediction of pest scenarios for future climate change. The activities *viz.,* quantification of effect of climate change insect pests and diseases using RTPD data base, development/ refinement of pest forecast models and their validation and development of ICT/ digital tools for delivery of pest management advisories are to be focused from 2017-2020. Fixed Fields at Research Station: In the research station, two experimental fields, each with an area of near to one acre, was planted with popular cultivar TG 37A in summer and GG 20 in *kharif* and one of the fields has to be kept unprotected without any plant protection measures for any of the pests on the crop (designated as fixed1). In the other field, designated as protected (fixed 2) pest management practices on need basis as per recommendations was followed. Selection of fixed fields in villages: Selected ten groundnut growing villages representing the agro ecology of the identified region in the same district or nearby districts. In each village, two farmer fields (Fixed 1 and fixed 2) of near to one acre were selected assigning fields of farmers as fixed1 and fixed2 during the first observation and the same was maintained till the end of season. The latitude and longitude were entered using GPS units and pest and disease dynamics were recorded as per the guidelines and uploaded in the software at NICRA-NCIPM website.

4. Synthesis, Validation and popularization of Integrated Pest management Technology for Groundnut Crop

CCPIs: Harish G

Stem rot and early leaf spot incidence was more in farmers practice compared to IPDM model. IPDM module harbored lower number of thrips and leafhoppers as compared to Farmers practice. The highest pod yield during *Rabi*-summer season was obtained in IPDM module (1057 kg ha^{-1}) and lowest in FP (1010.5 kg ha^{-1}). Similarly in *Kharif* also the pod yield was highest in IPDM module (1040 kg ha^{-1}) and lowest in FP (1000 kg ha^{-1}).

Summary

IPDM module recorded lowest disease and insect pest incidence and higher pod yield of 1057 kg ha^{-1}(*Rabi*-summer) and 1040 kg ha^{-1} (*Kharif*) which was significantly higher than farmers practice.

5. ICAR Seed Project on Seed Production in Agricultural Crops

Nodal Officer :
Dr. Narendra Kumar

Co-PI : Mr. Ghous Ali, Scientist, Agronomy, Arid Regional Campus (ARC)-ICAR-CSWRI, Bichhwal Industrial Area, Bikaner (Associated from 09th May 2016)

Funding Agency : ICAR-Indian Institute of Seed Science, Mau-275103, Uttar Pradesh

Duration : 2017 - 2020

Fund outlay : 9.25 Lakhs/year

Breeder Seed Production Achievement:

A. Summer-2017:

Compensatory breeder seed production programme of Girnar-3 was taken up in 1.5 ha. area in summer 2017. Due to unexpected rains at the time of harvesting, pods were infected with fungus resulting discoloration of pod. This material was disposed-off as general produce with the approval of the Director.

B. *Kharif*-2017:

The BSP-I indent for breeder seed of Girnar-2 and Girnar-3 was 100.0q and 70.0q respectively for *kharif*-2018 which was produced in *kharif*-17. Against the BSP-I indent, breeder seed production of Girnar-2 variety was taken up in 5.9 ha. at DGR-RRC, Bikaner and Girnar-3 in 11.5 ha. (Seeds unit: 4.0ha. and Farm section: 7.5ha.) of land at DGR, unit produced 26.7q breeder seed and 4.2q nucleus seed and 0.12q quality seed of Girnar-3 variety. Now we have enough nucleus seed of Girnar-2 and Girnar-3 to meet out DAC indent of breeder seed of Girnar-2(4.0q) and Girnar-3 (117.68q) for the*kharif*-2019, which will be produce in kharif-2018.

Distribution of seed/planting material

During 2017-18, we have supplied a total 154.1q breeder seed and 22.15q quality seed of Girnar-2, Girnar-3 and GG-20 varieties to the 15 different indentor, of which121.4q breeder seed and 83kg quality seed of Girnar-2;32.7q breeder seed and 12kg quality seed of Girnar-3 and 21.2q quality seed of GG-20 variety (Table-2).

Table 2: Details of seed materials supplied during 2017-18

SN	Variety	No. of indentor	Breeder/Nucleus seed (q)	quality seed (q)	Resource generation (Rs.)
1	**Girnar-2**	07	121.40	0.83	22,34,000.00
2	**Girnar-3**	06	32.7	0.12	
3	**GG-20**	02	0.00	21.2	
		15	**154.1**	**22.15**	

Resource generation

During 2017-18, we have generated revenue of Rs. 22,34,000/- by supply of total a total 154.1q breeder seed and 22.15q TFL seed of Girnar-2, Girnar-3 and GG-20 varieties to the 15 different indentors. Annual budget of Rs. 9.25 lakhs received under this project from the ICAR-Indian Institute of Seed Science, Mau during the period under report (01.04.2017-31.3.2018) (Table-2).

Capacity building and technology dissemination

During the 2017-18, under HRD programme of ICAR seed project organized a Pre-*kharif* campaign on management of white grub and bruchid beetle in groundnut on 3rd March, 17 at ICAR-DGR, Junagadh. About 150 farmers from 15 villages from Junagadh district participated in this kisanghosti and 10 exhibitions were done by the different dealers of insecticides and pesticides, seed companies to demonstrate their technology to the farmers. The aim of training programme was to demonstrate improved technology of groundnut cultivation.

Table 3: Details of HRD programme organized during 2017-18

SN	Programme name	Date	No of farmers	Place of farmers
1.	Pre-*kharif* campaign on management of Junagadh district of white grub and bruchid beetle in groundnut	3rd March 2018	150	15 village

HRD programmes and field visits

Kisan Gosthi organized on 3rd March 2018at ICAR-DGR, Junagadh

Breeder seed monitoring at DGR, Junagadh

Summary

- During 2017-18, breeder seed production of Girnar-3 variety was taken in 4.0 ha at at DGR, Junagadh.
- Total seed production of Girnar-3 was 31.02q during 2017-18.
- During 2017-18 supplied a total 154.1q breeder seed and 22.15q TFL seed of Girnar-2, Girnar-3 and GG-20 varieties to the 15 different indentor.
- During 2017-18, generated a revenue of Rs. 22,34,000.00 from selling of the groundnut breeder seed and groundnut fodder.
- Groundnut fodder of 6.0 ha. area of Girnar-2 was handed over to ICAR-CSWRI-ARC, Bikaner.
- One Kisan Ghosti was organized for 150 farmers of Junagadh district on 3rd March 2018 at DGR Junagadh.

6. Augmentation of Groundnut seed production in Rajasthan and Eastern India to enhance productivity and seed replacement ratio

Principal Investigator :
Dr. Narendra Kumar

Funding Agency : National Mission on Oilseeds and Oil Palm (NMOOP), Ministry of Agriculture and Farmers Welfare, Government of India.

Duration: 2017-2018

Fund outlay:Rs. 37.80 Lakhs

Breeder Seed Production Achievements:

A. Rajasthan:

The ICAR-DGR has been operating Regional Research Centre at Arid Region Campus of ICAR-CSWRI Bikaner, Rajasthan in 10 ha area.To start this project we have used Girnar-2 variety, a high yielding Virginia bunch medium bold seeded variety recommended for Rajasthan in *kharif* season. A total 10q nucleus seed of Girnar-2 variety was used to take breeder seed production programme in 5.9 ha. area at DGR-RRC, Bikaner. A total 63.97q seed of Girnar-2 variety was produced during project period (47.50q breeder seed, 15.6 q nucleus seed and 0.87q quality seed).Under this project one tube well was dig out with the help of Department of Groundnut Water, Govt. of Rajasthan and purchase of sprinkler irrigation system. One YP-I was recruited for looking day to day field activities of seed production.

B. Eastern India:

To operate this project in eastern India, DGR also has a Regional Station at Medinipur, West Bengal. We have been provided with 25 acre land by the state government. This allotted land does not have irrigation facility and fencing which is essentially required for seed production. To achieve target of seed production for Eastern India, DGR had own variety Girnar-3, a high yielding Spanish bunch variety recommended for West Bengal, Odisha and NEH region for *kharif* season. DGR had taken breeder seed production programme in 7.5ha. area using 10.0q nucleus seed of Girnar-3 variety at DGR, Junagadh farm. We had produced a total 47.7q breeder seed of Girnar-3 variety.

The total breeder seed production of both the varieties was 95.2q during *kharif*-2017, of which Girnar-2 was 63.97q (47.50q breeder seed, 15.6 q nucleus seed and 0.87q TFL seed), and Girnar-3 was 47.7 q breeder seed (Table 1).

Seed of different classes and varieties produced in *kharif*- 2017

Variety	Indent (q)		Plot	Area	Total	Seed production q)		
	DAC	BSP-I	no.	(ha.)	Production(q)	Breeder Seed	Nucleus Seed	TFL Seed
Girnar-2	64.01	00.0	ARC,	5.90	63.97	47.50	15.60	0.87
Girnar-3	28.03	70.0	I-9	1.0	47.70	47.70	–	--
			H-8&9	3.5				
			I-7&8	3.0				
Total				**7.5**	**111.67**	**95.20**	**15.60**	**0.87**

Monitoring of seed production programmeat Bikaner and DGR, Junagadh

BSP monitoring team of Girnar-2 at DGR-RRC, Bikaner

BSP monitoring team of Girnar-3 at DGR-Junagadh

Summary

- During 2017-18, breeder seed production of Girnar-2 variety was taken in 5.9 ha at DGR-RRS, Bikaner and Girnar-3 in 7.5 ha at DGR, Junagadh.
- Total seed production of Girnar-2 and Girnar-3 was 111.67q during 2017-18.

8 Publications

Research Articles

- Ajay B.C., Meena H.N., Singh A.L., Bera S.K., Dagla M.C., Kumar N. and Makwana A.D. (2017) Response of different peanut genotypes to reduced phosphorous availability, *Indian journal of Genetics and Plant Breeding* 77(1): 105-111.
- Ajay BC, Kambiranda, D., Bera, S.K., Kumar, N., Gangadhar, K., Abdul F.R., and Ramya, K.T. (2018) low phytic acid peanut: a potential tool to overcome mineral malnutrition in humans. *Current Science*, 114 (6):1165-1166
- Bera S. K., Rathnakumar A. L. and Radhakrishnan T. (2018) NRCGCS 281 (INGR16019): a fresh Spanish Bunch HPS Groundnut genotype with extra-large kernel size, *Indian J. Plant Genet. Resour*., 31 (1): 116-117.
- Bhaduri D, Mandal A, Chakraborty K, Chatterjee, D and Dey R (2017). Interlinked chemical-biological processes in anoxic waterlogged soil – A review. *Indian Journal of Agricultural Sciences,* 87(12): 1587-1599.
- Chakraborty, K., Bishi, S. K., Singh, A. L., Zala, P. V., Mahatma, M. K., Kalariya, K. A. and Jat, R. A. 2017. Rapid induction of small heat shock proteins improves physiological adaptation to high temperature stress in peanut. J Agro Crop Sci. 2018;1–13 DOI: 10.1111/jac. 12260.
- Chakraborty, K., Bishi, S.K., Singh, A.L., Zala, P.V., Mahatma, M.K., Kalariya, K.A., Jat R.A., 2018 Rapid induction of small heat shock proteins improves physiological adaptation to high temperature stress in peanut. *Journal of Agronomy and Crop Science* DOI: 10.1111/jac.12260
- Darvhankar M.S., Kamdar JH., Kasundra S.V., Jasani M.D., Kulkarni and Bera SK (2017) Assesment of yield and yield related traits in recombinant inbred lines of groundnut (*Arachis hypogeae* L) using principal component and cluster analysis, *The Bioscan* 11(3): 2025-2030.
- Diwedi, A. and Jat, R.A. 2017. Response of Summer Groundnut to Nutrient Sources and olubilizers in Black Calcareous Soil. *Indian Journal of Fertilisers* 13 (10): 42-45.
- Diwedi, A., Jat, R.A. and Reddy K.K. 2018. Organic manures and nutrient solubilizers for organic cultivation of summer groundnut *(Arachis hypogaea)* in black calcareous soil. *Indian Journal of Agronomy* (Accepted).
- Gangadhara K. and Nadaf, H.L, 2018, Genetic analysis of oleic acid and linoleic acid content in relation to oil quality in groundnut, *Electronic Journal of Plant Breeding*, 9 (1): 283 – 294.
- Gangadhara, K, Nadaf, H.L. and Ashish J, 2017, Diversity analysis of groundnut advanced backcross lines based agronomic and nutritional traits, *The Bioscan*, 10:93-102.
- Gurjar MS, Aggarwal R, Jogawat A, Sharma S, Kulshreshtha D, Gupta A, Gogoi R, Thirumalaisamy PP, Saini A. 2017. Development of real time PCR assay for detection and quantification of teliospores of Tilletiaindica in soil. I*ndian Journal of Experimental Biology,* 55: 549-554.
- Harish, G., Naganagoud A., Sreenivas, A. G., Somashekar, Sharangouda Hiregoudar and Kisan. B., 2018. Diversity and distribution of stored grain insect pests of pulses and their natural enemies *Indian Journal of Agricultural Research* (Accepted A-4957)
- Jadon KS, Thirumalaisamy PP, Koradia VG, Padavi RD. 2018 Management of peanut (Arachis hypogaea L.) diseases through nutrient supplements. *Legume Research*, DOI10. 18805/ LR-3835.
- Jadon KS, Thirumalaisamy PP, Vinod Kumar, 2017. Integrated Management of Major Foliar and Soil-Borne Diseases of Peanut (*Arachis hypogae*a L.) with Fungicides, Trichoderma and Castor Cake. International *Journal of Current Microbiology and Applied Sciences,* 6 (12): 1884-1899.
- Jain, N.K., Jat, R.S., Meena, H.N., Chakraborty, K. 2018. .Productivity, Nutrient, and

Soil Enzymes Influenced with Conservation Agriculture Practices in Peanut. *Agronomy Journal*. doi:10.2134/ agronj 2017.08.0467

- Jasani, M.D., Maurya A.K., Dash P., Kamdar J.H., Sunkad G., Mahatma M.K., Bera S.K., 2018. Identification of peanut interspecific pre-breeding lines resistance to peanut bud necrosis disease (PBND): field screening, morphological and biochemical parameter *International Journal of Current Microbiology and Applied Science* 7(2): 1928-1939
- Kalariya K.A., Deepti Mehta, Nisha Goswami, A.L. Singh, K. Chakraborty, MK Mahatma, P.V. Zala, and C.B. Patel (2017). Stomatal clustering pattern in *Arachis hypogaea* L. under water deficit stress. *Indian Journal of Experimental Biology* 55: 880-883.
- Kalariya, KA, A.L. Singh, K. Chakraborty, B.C. Ajay, P.V. Zala, C.B. Patel, R.N. Nakar, Nisha Goswami and Deepti Mehta, 2017. SCMR: A more pertinent trait than SLA in peanut genotypes under transient water deficit stress during summer. *Proc Natl Acad of Sci, India Sec B: Biol Sci*. 87 (2):579-589.
- Kumar,N. Ajay,B.C., Dagla, M.C., Rathanakumar, A.L.Lal, C., Radhakrishnan T, Samdur, M.Y., Mathur, R.K.Manivel, P., Makwana,A.D. and Chikani, B.M. (2018). Evaluation of spanish bunch advanced breeding lines for fresh seed dormancy in groundnut (*Arachis hypogaea* L.). *Frontiers in Crop Improvement*, 6(1): 9-12.
- Kumar,N. Ajay, B.C., Dagla, M.C., Rathanakumar, A.L. Lal, C., Radhakrishnan T, Samdur, M.Y., Mathur, R.K.Manivel,P., Makwana, A.D. and Chikani, B.M. (2018). Identification of Spanish bunch advanced breeding lines having fresh seed dormancy in groundnut (*Arachis hypogaea* L.). *Progressive Research*, 13 (1):19-23.
- Kumar,N., Rathnakumar AL, Ajay BC, Radhakrishnan T, Chunilal, Samdur MY, Mathur RK, Manivel P and Chikani BM. 2017. Genetic variability for fresh seed dormancy in Spanish bunch advanced breeding lines of groundnut (*Arachis hypogaea* L.). *Journal of Oil seeds Research* 34(2): 119-124.
- Mahatma MK, Thawait LK, Jadon KS, Thirumalaisamy PP, Bishi SK, 2018. Metabolic profiles of groundnut (*Arachis hypogaea* L.) genotypes differing in *Sclerotium rolfsii* reaction. *European Journal of Plant Pathology*, 151:463-474.
- Mann,A., Singh, A.L, Oza, S., Goswami, N., Mehta, D. and Chaudhari, V. (2017). Effects of iron sources on lime induced iron deficiency chlorosis in groundnut. *Legume Research* 40 (2): 241-249.
- Meena, H.N. and Yadav, R.S. 2018. Effects of Reusing Peanut Seeds Grown in Saline Irrigation Water on Yield Attributes and Quality Traits. *Journal of Irrigation and Drainage Engineering*, Vol. 144, Issue 3 (March 2018).
- Meena, H.N., Yadav, R.S. and Bhaduri, D. 2018. Effects of potassium application on growth of peanut (Arachishypogaea) and ionic alteration under saline irrigation. *Indian Journal of Agronomy* 63(1): 95-103.
- Nautiyal, P.C. Rathnakumar, A.L., Kulkarni, G. and Sheshshayee. M.S. (2017). Evaluation of wild Arachis species for cultivation under semiarid tropics as a fodder crop. *Photosynthetica* 55 (1): 41-49, DOI: 10.1007/s 11099-016-0642-7
- Patel, K.G., Radhakrishnan, T., Mishra, G. P., Mandaliya, V.B., Kumar, A., and Dobaria, JR, 2017. Transgenic Peanut (*Arachis hypogaea* L.) Over expressing *mtlD* Gene Showed Improved Photosynthetic, Physio-Biochemical, and Yield-Parameters under Soil-Moisture Deficit Stress in Lysimeter System. *Front Plant Sci*. 8: 1881
- Rajyaguru RH, Thirumalaisamy PP, Patel KG, Thumar JT, 2017. Biochemical basis of genotypic and bio-agent induced stem rot r*esistance in groundnut*. Legume Research, 40(04): 929-939.
- Raval, S.S., Mahatma, M.K., Chakraborty, K., Bishi, S.K., Singh, A.L., Rathod, K.J.,

Jadav, J.K., Sanghani, J.M., Mandavia, M.K., Gajera, H.P., Golakiya, B.A.,2018.

- Metabolomics of groundnut (*Arachis hypogaea* L.) genotypes under varying temperature regimes. *Plant Growth Regulation* 84: 493–505
- Shekhar, M., Singh, N., Dutta, R., Kumar, S., Mahajan, V. (2017). Comparative study of qualitative and quantitative methods to determine toxicity level of Aspergillus flavus isolates in maize, *PLoS ONE* 12(12
- Singh A.L., S.K. Bishi, M.K. Mahatama, V. Chaudhari L.K. Thawait and Sushmita 2017. High zinc density crop genotypes are a solution in alleviating zinc malnutrition in India. *Indian Journal of Agricultural Biochemistry 30 (2):107-114*.
- Singh, A.L., Jat,R.S., Zala, A., Bariya, H., Kumar, S., Ramakrishna, Y.S., Rangaraju, G. Masih, M. Rani, Bhanusali, T.B., Vijaykumar, S., Somasundaram, E. and Singh, I.M. (2017). Scaling-up of boron sources for yield and quality of large seeded peanut cultivars under varied agro-ecological conditions in India. *Journal of Plant Nutrition* 40 (19): 2756-2767
- Singh, LS and Dutta, R. (2017). *In-vitro* efficacy of native bio-control agents from maize regime against *Exserohilumturcicum* in response to botanicals and fungicides, *Bioscan* 12(2): 775-779
- Singh,P.B., Bharti,B., Kumar,A., Singh, R., Kumar, N. and Rathnakumar A.L. (2017). Genetic characterization, character association for yield and yield component traits in groundnut (*Arachis hypogaea* L). *Electronic Journal of Plant Breeding*, 8(4): 1229-1235.
- Sushmita and Pravin Prakash, 2017. Seed priming with salicylic acid and hydrogen peroxide alleviates water deficit in wheat (*Triticum aestivum*L.) at seedling stage. *Current Advances in Agricultural Sciences* 9(1): 76-80.
- Tiwari,S., Tripathi,M. K., Kumar,N.,Tomar,R. S., Joshi,E.,Tiwari,R., Gupta, R. and Singh,A. K. (2017). Improvement of Groundnut for Fatty Acids using Marker Assisted Breeding Approaches. *International Journal of Pureand Applied Bioscience* 5 (6): 59-63.
- Yadav R.S., Jain N.K., Meena H.N., Bhaduri D., Bhalodia P.K., Bhadarka M., Desai D. 2018. Dynamics of soil phosphorus under different management practices for groundnut cultivation in calcareous Vertisols. *Journal of Soil and Water Conservation.* 16(2): 160-165.

Technical /Popular articles

- AL Rathnakumar, SK Bera, Gangadhara K and Narendra Kumar (2017). Botany, systematics, characterization and utilization of groundnut germplasm. A Training manual on Hybridization Techniques in Groundnut. ICAR-Directorate of Groundnut Research, Junagadh-362 001. pp: 6-15.
- Gangadhara K, AL Ratnakumar and Narendra Kumar (2017). Breeding for Early Maturity and Quality Traits in Groundnut. A Training manual on Hybridization Techniques in Groundnut. ICAR-Directorate of Groundnut Research, Junagadh- 362 001. pp: 44-50.
- Jat, R.A., Nataraja M.V. and R. Solanki. Conservation Agriculture improves Earthworm Population in Soil. ICAR-DGR Newsletter, Vol. XVI No. 1-2, Jan-Jun, 2017
- Kiran Reddy. Calcareous soils and their management. ICAR-DGR Newsletter, Vol. XVI No. 1-2, Jan-Jun, 2017
- Narendra Kumar, AL Rathnakumar, Ajay BC and Gangadhara K. (2017). Breeding for foliar disease resistance in groundnut. A Training manual on Hybridization Techniques in Groundnut. ICAR-Directorate of Groundnut Research, Junagadh - 362001. pp: 33-43.
- हरनारायण मीना, महेश कुमार महात्मा एवं राधाकृष्णन टी. 2017. पोषण से भरपूर मूँगफली की उन्नत किस्में. **खेती,** अक्टूबर, 2017.
- मुरलीधर मीना, हरनारायण मीना एवं सुरेन्द्र सिंह. 2017 प्रधानमंत्री फसल बीमा योजना-किसानों का रक्षाकवच. **पूसा सुरभि**, 10:107-112.

Book chapters/Technical bulletins/ manual

- Dey R., Pal K.K., Thomas M., Sherathia D.N., Mandaliya V.B., Bhadania R.A., Patel M.B., Maida P., Mehta D.H., Nawade B.D. and Patel S.V. (2018) Endophytic microorganisms: Future tools for climate resilient agriculture. In: Kashyap PL, Srivastava AK, Tiwari SP and Kumar S (Ed.) Microbes for Climate Resilient Agriculture, pp. 235-253. John Wiley & Sons
- Jat, R. A., Singh G. and Radhakrishnan T., 2017. Climate smart agricultural practices for resilient groundnut-based cropping systems. ICAR- Directorate of Groundnut Research, Junagadh 362 001 Gujarat. pp. 26.
- Kumar Narendra and Rathnakumar AL (2017) Hybridization Techniques in Groundnut. Training manual. ICAR-Directorate of Groundnut Research, Junagadh-362 001. Page: 50.
- Mahatma M. K. (2017). Basic and application of metabolomics in crop improvement. In: Tomar R.S. Parakhia M.V., Bhatt S.B. and Golakiya B.A. (Eds). 2017. Genomic, proteomic and metabolomic application in crop improvement, My Research Publication, India. pp67-76. (ISBN:978-93-86546-79-1)
- MahatmaM. K., SrivashtavV. S., JhaS. (2017).Genetic diversity analysis of date palm using random amplified polymorphic DNA (RAPD) and inter-simple sequence repeat (ISSR). In: Al-Khayri J., Jain S., Johnson D. (Eds) Date Palm Biotechnology Protocols Volume II. Methods in Molecular Biology, vol 1638. Humana Press, New York, NY.pp 105-112.
- Thomas M, Pal K.K. and Dey R. (2018). Archaeal community structure: Resilience to climate change. In: Kashyap PL, Srivastava AK, Tiwari SP and Kumar S (Ed.) Microbes for Climate Resilient Agriculture, pp. 191-203. John Wiley & Sons
- Yadav RS, Mahatma MK, Thirumalaisamy PP, Meena HN, Bhaduri D, Sanjay Arora, and Panwar J. 2017. Arbuscular Mycorrhizal Fungi (AMF) for Sustainable Soil and Plant Health in Salt-Affected Soils. *In:* Bioremediation of Salt Affected Soils: An Indian Perspective. Sanjay Arora, Atul K Singh, Singh YP (Eds). Springer International Publishing, 479p.
- नरेन्द्र कुमार एवं हरीश जी. 2017. मूँगफली में सफेद लट का समन्वित प्रबंधन विषय पर पत्रक.

Papers Presented in Conferences/ Symposia/Seminars

Singh A.L.

- Singh, A.L., Sushmita, Bishi S.K. and Patel C.B. 2017. Zinc content in groundnut is influenced by their seed size and fertilizers. In: Abstract book, National Conference of Plant Physiology "Emerging Role of Plant Physiology for Food Security and Climate Resilient Agriculture" Nov 23-25 2017, IGKV Raipur, Chhattisgarh. p 19 (SS 37)

Thirumalaisamy PP

- Sudini H, Thirumalaisamy PP, Naik MK, Vemana K, Sundravadana S, Mangala UN, Vijay Krishna Kumar K. 2017. Investigation on prevalence of aflatoxin contamination in major groundnut growing states of India, influencing soil characteristics and farmers level of awareness. Inter Droubht –V, ICRISAT, Hyderabad, 21-25 February, 2017. P-008.
- Rathna Kumar AL, Thirumalaisamy PP, Narendrakumar, Lalwani HB, Nadaf HL, Nagaraju P, Basavaraj Yenagi, Sudam Patil, Jitendra Suryawanshi, Deshmukh MP, Kumbhar CT, Kathmale DK, Naik KSS, Prasanna Rajesh, Vemana K, Premalatha N, Sundaravadana S, Murali T Variath, Manish K Pandey, Rajeev K Varshney, Janila P. 2017. Molecular breeding tools improved drought tolerant groundnut variety for resistance to foliar fungal diseases. InterDroubht –V, ICRISAT, Hyderabad, 21-25 February, 2017. Page-108

Participation in Conference/ Workshop/ Seminar/ Symposia / Meetings /Training and Capacity Building

Dr. Radhakrishnan

- As expert in Institute Bio-safety Committee Saurashtra University on 07.05.2017
- Meeting on finalization of report on oilseed – production to meet demand and reduce import under doubling of farmers' income, at IIOR, Hyderabad on 29.05.2017
- ICAR Review Committee interaction meeting, IARI, New Delhi on 29.04.2017
- Annual Groundnut Workshop at UAS, Dharwad on 25-27 April 2017
- Strategy Workshop on Vegetable Oil Economy and Production Problems in India held at NAAS, New Delhi on 03.07.2017
- The meeting to discuss the policy issues for land acquisition to establish Regional Research Centre on Cotton at Junagadh, convened by DG, ICAR, New Delhi on 13.07.2017
- The Directors Conference, NASC Complex, New Delhi on 15-16 July 2017
- Attended the Golden Jubilee Logo and Foundation Day of ICAR-IIOR held at IIOR, Hyderabad on 01.082017
- Attended the meeting related to collaborative project with IOPEPC convened by the DG, ICAR on 09.08.2017
- Vistit to the AICRP centre at Bikaner and Breeder seed monitoring on 6-8 Oct. 2017
- Attended the meeting on EFC/SFC called by DG, ICAR at Krishi Bhavan, New Delhi on 14.09.2017
- Attended and acted as a panelist in the Brain Storming Session-cum-Workshop on "Strategies for area expansion and productivity enhancement of oilseeds &Oilpalm and inclusion of coconut under NMOOP" held at IIOR, Hyderabad on 26.09.2017
- Attended the Rabi Summer 27th ZREAC meeting of Junagadh Agricultural University held at JAU, Junagadh on 04.10.2017
- Attended the Groundnut Farmers' Fair cum Exhibition organised by ICAR-DGR at ARC, Bikaner on 07.10.2017
- Attended the meeting of Chairman/Member Secretaries of the State Level Coordination Committees convened by DG, ICAR at Krishi Bhavan, New Delhi on 10.10.2017
- Attended reconciliation meeting with ALC, Rajkot on 24.10.2017
- Attended meeting of the Committee for preparation of action plan doubling of farmers income at JAU, Junagadh on 30.10.2017
- Attended the meeting of Chariman/Conveners of the State Level Coordination Committees for Doubling Farmers' Income under the Charimanship of Prof. MS Swaminathan at NASC Complex, New Delhi on 03.11.2017
- Visited RRS-DGR atmedinipur to explore the possibilities of initiation of seed production during ensuing summer 2018 on 21.11.2017
- Attended the conference on NEXT GENERATION GENOMICS & INTEGRATED BREEDING FOR CROP IMPROVEMENT: PRESENT & FUTURE, being held at ICRISAT on 6-8 Dec. 2017
- Attended the meeting of the committee for IT policy of Junagadh Agricultural University, Junagadh on 13.12. 2017
- Attended 28th ZREAC meeting of Junagadh Agricultural University at JAU, Junagadh on 16.01.2018
- Attended the meeting to set up the comprehensive agenda on pulses seed production and distribution held at IIPR, Kanpur on 19.01.2018
- Attended 79th meeting of Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops convened by DDG(CS) at IARI, New Delhi on 20.01.2018
- Attended hearing in the application filed by Smt. Muktaben Maganbhai Makwana, ex-employee of DGR at ALC, Rajkot on 24.01.2018

- Attended the 1st meeting of QRT (2012-16) of ICAR-DGR, Junagadh at NASC Complex, New Delhi on 03.02.2018
- Attended the meeting on DNAF at NBPGR, New Delhi on 12.02.2018
- Visited the RRS-DGR at Bikaner on 13.02.2018
- Attend the Director's Conference held at NASC Complex, New Delhi on 08-09 March 2018
- Given an invited presentation on AICRP-Groundnut during the OFID work plan meeting at ICRISAT, Hyderabad on 29.03.2018
- Given an invited presentation on Breeding priorities of groundnut in India at the Groundnut Network Group-Asia (GNG-A) meeting held at ICRISAT, Hyderabad on 30.03.2018

Bishi S. K.

- Attended a seminar on "Recent trends and techniques in genomics and proteomics for agriculture" on 12th Oct, 2017 at Department of Biotechnology, Junagadh Agricultural University, Junagadh.

Chandramohan Sangh

- State Level Biosafety Capacity Building Workshop at Anand on 13-Jul-2017 and presented on the topic "Research Initiatives in transgenic groundnut at ICAR-Directorate of Groundnut Research"
- Fifth Annual South Asia Biosafety Conference from 11th to 13th sept 2017 at Bengaluru

Dey R.

- Attended 18th IMC Meeting of ICAR-DGR on 13th June 2017
- Participated in a *"Rajbhasha Karyashala"* on 6 January 2018 at ICAR-DGR, Junagadh

Gangadhara K.

- Participated in XII Annual Review Meeting of ICAR Seed Project from 29-30 July 2017 at MPKV, Rahuri, Maharashtra

Kumar Narendra

- Attended AICRP-G Annual groundnut workshop from 25-27th April 2017 at UAS, Dharwad.
- Attended XIIth Annual Review Meeting of ICAR Seed Project-"Seed Production in Agricultural Crops" held on 29-30 July, 2017 at MPKV, Rahuri.
- Attended monitoring of breeder seed production and AICRP-G trials in the zone-V (Raichur and Dharwad) from 12-17.09.17. Monitoring of breeder seed production programme of JAU, Junagadh from 25-27 September 2017.
- Attended Seed Review Meeting of R& D project on "Augmentation of Groundnut seed production in Rajasthan and Eastern India to enhance productivity and seed replacement ratio" under National Mission on Oilseeds and Oil Palm (NMOOP) on 19.01.2018 at IIOPR, Pedavegi, AP.
- Attended Groundnut Network Group-Asia (GNG-A) Workshop from on 30-31st March 2018 at ICRISAT, Patancheru, Telangana.
- Attended seven days training programme on "Analysis of experimental data" from 19-24 Feb 2018 at NAARM, Hyderabad.

Singh A. L.

- Dr A. L. Singh attendedthe National Conference of Plant Physiology "Emerging Role of Plant Physiology for Food Security and Climate Resilient Agriculture" during Nov 23-25 2017, IGKV Raipur, Chhattisgarh and delivered a lecture and also chaired a session. As Vice president of the ISPP he also co-chaired the GBM on 23rd Nov at Raipur.

HN Meena

- Participate in the AICRP-Groundnut Workshop at JAU, Junagadh during April 2017.
- Brainstorming session on "Seaweed Farming and its Utilization in Gujarat"

KK Reddy

- Invited as speaker in 2-day workshop entitled "Emerging applications of space technology in Agriculture and

Allied sectors" held at SAC, Ahmedabad from June 28-29, 2017

Pal K.K.

- Attended the 12th IMC Meeting of ICAR-NBAIM, Mau held on 26-4-2017, as member of Institute Management Committee
- Participated in the meeting with IFD, ICAR, at Krishi Bhavan on 09-06-2017 along with Director DGR for finalizing EFC of ICAR-DGR, Junagadh for the period 2017-2020.
- Attended 19th IMC meeting of ICAR-DGR, Junagadh on 20-12-2017.
- Attended the Special Symposium of Indian Phytopathological Society on "Microbial Antagonists and Their Role in Biological Control of Plant Diseases" during October 5-7, 2017 at Anand Agricultural University, Anand, organized by Department of Plant Pathology, BACA, AAU, Anand and Indian Phytopathological Society, New Delhi and delivered a lecture on "Endophytes for management and or alleviation of biotic and abiotic stresses of crops" on 05-10-2017.
- Attended the National Conference on "Innovative Farming for Food and Livelihood Security in Changing Climate" jointly organized by Innovative Farming, Society for Advancement of Agricultural Innovations (SAAI) and AICRP on Soil Test Crop Response Correlation, Directorate of research, BCKV, West Bengal, held from 12-13th January 2018 at BCKV, Kalyani, W.B and delivered invited lecture on 'Endophytes for alleviation of abiotic stresses in crops: retrospects and prospects' on 13-1-2018.
- Attended a DPC meeting for promotion of Scientists, from Scientist to Senior Scale Scientist of ICAR-NBAIM, Mau on 02-02-2018.
- Organized and participated in the 1st meeting of QRT (2012-16) of ICAR-DGR held at NASC complex, N. Delhi on 03-02-2018.
- Attended QRT meeting of AMAAS project on 29-1-2018 at TNAU, Coimbatore
- Attended the QRT of AINP-biofertilizer project held at AAU, Anand on 5-6 Feb. 2018.

Ram Dutta

- MDP on Science, Technology and Society, at National Institute of Advanced Studies, IISc, Bengaluru during 11 – 22 December 2017 sponsored by DST.

Thirumalaisamy PP

- Participated AICRP workshop at UAS Dharwad from 22 to 26th April, 2017
- Participated NICRA workshop at NCIPM New, Delhi on 13.10.2017
- Delivered presentation on 'management of post-harvest aflatoxin contamination in food industries' at ICAR-DGR industrial interface meeting, 2017 at DGR, Junagadh on 31.1.2017.

Narayanan G

- Attended AICRP-G Annual groundnut workshop from 25-27th April 2017 at UAS, Dharwad.

Training and Capacity Building

Ajay BC

- Attended training on "Multivariate Data Analysis" from 14-20th Dec 2017 at ICAR-NAARM, Hyderabad

Bishi S. K.

- Attended 21 days(25th Oct- 15th Nov, 2017) Summer school training on "Phenotyping of drought adaptable physiological traits in different crops" sponsored by ICAR at GKVK, Banglore

Chandramohan Sangh

- Using Statistical Methods for Agricultural Research through SAS Programme at DGR Junagadh from 14th to 16th September 2017

Dey R.

- Attended a 3 day training program 'Using statistical methods for agricultural research through SAS programme' held at DGR from 14-16 September 2017

Gangadhara K.

- Undergone training programme on "Using Statistical Methods for Agricultural Research through SAS Programme" from 14-16 September 2017 at ICAR-DGR.

Kumar Narendra

- Coordinated a three-day farmers training programme on "Orientation-cum-training programme on Hybridization techniques in groundnut" for AICRP-G centres from August 17-19, 2017 at ICAR-DGR, Junagadh.

KK Reddy

- Participated in training program on Using statistical methods for agricultural research through SAS programme held at ICAR-DGR from 14-16 September 2017

Thirumalaisamy PP

- Four days training on 'Aflatoxin contamination in peanut and its management' from 26th Feb. to 1st Mar., 2018 at ICAR-DGR (coordinator)

Lecture delivered in training programme

Gangadhara K.

- Delivered a lecture on Breeding for early maturity & quality traits in groundnut-In a three-day orientation-cum-training programme on "Hybridization techniques in groundnut" for AICRP-G centres from August 17-19, 2017 at ICAR-DGR, Junagadh.
- Delivered training lecture on "Quality seed production practices in groundnut on 16.05.2017 in a farmers training programme on "Technologies for Improved production production in Maharashtra" from 15-16.05.2017 at ICAR-DGR, Junagadh.

Kumar Narendra

- Invited as speaker and presented seed production achievements of 2016-17 at DGR, Junagadh in XIIth Annual Review Meeting of ICAR Seed Project-"Seed Production in Agricultural Crops" held on 29-30th July at MPKV, Rahuri.
- Invited as speaker and presented status of seed production during 2017-18 at DGR, Junagadh in the Seed Review Meeting of R& D project on "Augmentation of Groundnut seed production in Rajasthan and Eastern India to enhance productivity and seed replacement ratio" under National Mission on Oilseeds and Oil Palm (NMOOP) from on 19.01.2018 at IIOPR, Pedavegi, AP.

Mahatma M.K.

- Delivered invited lecture on "Basic and application of metabolomics in crop improvement" on 11-9-2017 in the ICAR sponsored winter school on "Genomic, proteomic and metabolomic application in crop improvement' held at Dept. of Biotechnology, JAU, Junagadh during 4th to 24th September 2017.

Pal K.K.

- Delivered invited lecture on "Exploiting Prokaryotic and Archaebacterial Complete Genome Sequence Data: Strategy for Developing Cultivars Tolerant to Salinity and Drought" on 05-9-2017 in the ICAR sponsored winter school on "Genomic, proteomic and metabolomic application in crop improvement' held at Dept. of Biotechnology, JAU, Junagadh during 4th to 24th September 2017.

Thirumalaisamy PP

- Delivered lecture on Major diseases and their management in groundnut and aflatoxin management in groundnut at a two days training 13-14 March, 2018 at ICAR-DGR, Junagadh organized to Godrej agrovet let, Mumbai.

National Assignments

Thirumalaisamy PP

- Member in the inspection team of APEDA with IOPEPC for issuing certificates for the export oriented peanut processing units (M/S Khedut feeds & foods, Gondal, M/S Kirti traders, Amreli, M/S H. Bheda& Co, Rajkot

Meetings

Groundnut Farmers Mela cum Exhibition

ICAR-Directorate of Groundnut Research, Junagadh with the support of NMOOP organized a Groundnut Farmer Fair cum Exhibition on 07th October 2017 at Arid Region Campus of CSWRI at Bikaner. On this occasion Dr. RS Paroda, Honorable Ex-Director General, ICAR and Secretary DARE was the Chief-Guest and Dr. BR Chhipa, Honorable VC, SKRAU was the special guest of this function. Dr. RS Paroda released a leaflet on "Integrated management of white grub in groundnut". He emphasized on the importance of availability of quality seed and farmer adoption of new technology for the better productivity and management of white grub in groundnut. He further appreciated the efforts of Director, and his team for organizing kisan mela at Bikaner. With more than 600 farmers from 20 villages, demonstration of 20 exhibits by nearby ICAR institutes, SAUs, dealers and companies of seed, insecticides and pesticides, made the the mela a grand success.

XX Meeting of Research Advisory Committee

The 20th meeting of the Research Advisory Committee was held at ICAR-DGR, Junagadh from 27-28 March, 2018. The meeting was chaired by Dr. Padma Raju, Ex VC, ANGRAU, Hyderabad, Dr. SN Nigam, Ex. Principal Groundnut Breeder in ICRISAT, Hyderabad, Dr. IU Dhruj, Associate Director of Research, JAU, Junagadh, Dr. KP Patel, Dean Faculty of Agriculture, Anand Agricultural University, Anand, Radhakrishnan T. Director, ICAR-DGR, Junagadh and Dr. SK Bera, Principal Scientist, DGR was the member secretary of 20th RAC meeting. Works done report of the ongoing projects were delivered before the committee, extensively discussed and the future work plan was tweaked as per the suggestions of the research advisory committee.

Work Plan 2017-18

Programme 1: Genetic improvement of groundnut

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

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

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

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

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

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

Enhancement of oleic acid content (~80%) in two mega groundnut varieties of Gujarat
Bera SK, Gangadhara K, And Chandramohan S

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

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

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

Studies on white grub and bruchid beetle and their management in groundnut
Harish G, Ram Dutta and Yadav RS

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

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

Work Plan 2017-18

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

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

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

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

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

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

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

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

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

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

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

Staff List 2017-18

S. No.	Name of employees	Designation
1	Dr. Radhakrishnan T.	Director
2	Dr. A.L. Singh	Principal Scientist, Plant Physiology
3	Dr. A.L. Rathnakumar	Principal Scientist , Plant Breeding
4	Dr. S.K. Bera	Principal Scientist, Cytogenetics
5	Dr. K.K. Pal	Principal Scientist, Microbiology
6	Dr. RinkuDey	Principal Scientist, Microbiology
7	Dr. Ram Dutta	Principal Scientist , Plant Pathology
8	Dr. R.S. Yadav	Senior Scientist , Soil Science Transferred on 07.07.17
9	Dr. R.A. Jat	Senior Scientist , Agronomy
10	Dr. M.K. Mahatma	Senior Scientist , Plant Biochemistry
11	Dr. H.N. Meena	Senior Scientist, Agronomy
12	Dr. Abhay Kumar	Scientist (Senior Scale), Plant Biotechnology Transferred on 07.07.17
13	Dr. S.K. Bishi	Scientist (Senior Scale), Plant Biochemistry
14	Dr. P.P. Thirumalaisamy	Scientist (Senior Scale) , Plant Pathology
15	Dr. Harish G.	Scientist (Senior Scale), Entomology
16	Dr. Narendra Kumar	Scientist (Senior Scale), Plant Breeding
17	Dr. Ajay B.C.	Scientist (Senior Scale), Plant Breeding
18	Sh. M.V. Nataraja	Scientist (Senior Scale), Entomology
19	Dr. G. Narayan	Scientist (Senior Scale), Extension Education
20	Sh. Murlidhar Meena	Scientist, Agricultural Economics Transferred on 07.07.17
21	Dr. K. Gangadhara	Scientist, Plant Breeding
22	Dr. Sangh Chandramohan	Scientist, Plant Biotechnology
23	Sh. Kiran Kumar Reddy	Scientist, Soil Science
24	Dr. Sushmita	Scientist, Plant Physiology
25	Dr. Kona Praveen	Scientist, Plant Breeding
26	Dr. D.L. Parmar	Chief Technical Officer
27	Sh. D.M. Bhatt	Chief Technical Officer
28	Sh. P.R. Naik	Assistant Chief Technical Officer

S. No.	Name of employees	Designation
29	Sh. N.R. Ghetia	Chief Technical Officer
30	Sh. P.K. Bhalodia	Chief Technical Officer
31	Sh. P.V. Zala	Chief Technical Officer
32	Sh. H.B. Lalwani	Chief Technical Officer
33	Dr. H.K. Gor	Chief Technical Officer
34	Sh. H.M. Hingrajia	Assistant Chief Technical Officer
35	Dr. J.R. Dobaria	Assistant Chief Technical Officer
36	Dr. M.V. Gedia	Assistant Chief Technical Officer
37	Sh. Ranvir Singh	Assistant Chief Technical Officer
38	Dr. S.D. Savaliya	Assistant Chief Technical Officer
39	Mrs. V.S. Chaudhari	Assistant Chief Technical Officer
40	Sh. B.M. Chikani	Assistant Chief Technical Officer
41	Sh. D.R. Bhatt	Assistant Chief Technical Officer
42	Sh. R.D. Padvi	Technical Officer
43	Sh. H.V. Patel	Technical Officer
44	Sh. K.H. Koradia	Technical Officer (Driver)
45	Sh. A.M. Vakhariya	Technical Officer (Photographer)
46	Sh. C.B. Patel	Technical Officer
47	Sh. P.B. Garchar	Tech. Officer (Electrician)
48	Sh. N.M. Safi	Tech. Officer (Driver)
49	Sh. A.D. Makwana	Technical Assistant
50	Sh. G.G. Bhalani	Sr.Technical Assistant (Driver)
51	Sh. B.M. Solanki	Sr.Technical Assistant (Tractor Driver)
52	Sh. Anil K Maurya	Sr.Technical Assistant
53	Sh. Lokesh Kumar	Sr,Technical Assistant
54	Sh. Pitabas Das	Technical Assistant
55	Sh. Indra Raj Meena	Administrative Officer
56	Sh. Amit Kumar	Finance & Account Officer
57	Sh. R.T. Thakar	Assistant Administrative Officer

S. No.	Name of employees	Designation
58	Mrs. Rosamma Joseph	Personal Secretary
59	Sh. Y.S. Kariya	Personal Assistant
60	Sh. L.V. Tilwani	Personal Assistant
61	Mrs. SanthaVenugolan	Assistant
62	Mrs. M.N. Vaghasia	Assistant
63	Sh. M.B. Kher	Security Supervisor
64	Sh. C.G. Makawan	Upper Division Clerk
65	Sh. H.S. Mistry	Upper Division Clerk
66	Sh. P.N. Solanki	Lower Division Clerk
67	Sh. N.M. Pandya	Skilled Support Staff
68	Sh. R.B. Chawada	Skilled Support Staff
69	Sh. D.M. Sachaniya	Skilled Support Staff
70	Sh. M.B. Shaikh	Skilled Support Staff
71	Sh. J.G. Agrawat	Skilled Support Staff
72	Sh. K.T. Kapadia	Skilled Support Staff
73	Sh. V.N. Kodiatar	Skilled Support Staff
74	Sh. R.P. Sondarwa	Skilled Support Staff
75	Sh. V.M. Chawada	Skilled Support Staff
76	Sh. G.S. Mori	Skilled Support Staff
77	Mrs. D.S. Sarvaiya	Skilled Support Staff
78	Sh. P.M. Solanki	Skilled Support Staff
79	Sh. N.G. Vadher	Skilled Support Staff
80	Sh. B.J. Dabhi	Skilled Support Staff
81	Sh. C.G. Moradia	Skilled Support Staff
82	Sh. D.A. Makwana	Skilled Support Staff
83	Sh. Jay R. Purohit	Skilled Support Staff

General Information

Staff Strength

Category of staff	Sanctioned	Filled	General	SC	ST	BC
Scientific	39 + 1RMP	21 + 1RMP	10+ 1RMP	03	02	06
Technical	39	29	17	01	05	06
Admin.	17	12	07	01	01	03
SSS	19	16	04	03	02	07
Total	**114 + 1RMP**	**78 + 1RMP**	**38 + 1RMP**	**08**	**10**	**22**

Discipline and grade wise sanction of scientific positions

Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
Agricultural Biotechnology	02	01	0	03
Agricultural Economics	01	0	0	01
Agricultural Entomology	02	01	0	03
Agricultural Extension	01	0	0	01
Agricultural Microbiology	01	01	0	02
Agricultural Statistics	0	01	0	01
Agronomy	01	01	01	03
Genetics & Plant Breeding	07	03	01	11
Nematology	01	0	0	01
Plant Biochemistry	01	01	0	02
Plant Pathology	02	02	01	05
Plant Physiology	02	01	0	03
Seed Science & Technology	0	01	0	01
Soil Science	01	01	0	02
Total	**22**	**14**	**03**	**39**

DPC/Promotion/probation/MACP

- Dr.H.N.Meena, promoted to the next higher RGP Rs.8000 as Senior Scientist, DPC held on 19.05.2017.
- Three Scientists of our Directorate viz. Dr.Gangadhar, Dr.Sangh and Sushmita got Probation Clearance through DPC held on 06.11.2017.
- Two Technical Staff viz. H.B.Lalwani, Dr.H.K.Gor promoted to the post of CTO from ACTO through DPC Held on 01.07.2017.
- One Administrative Staff got MACP viz. Smt.S.Venugopalan, through DPC held on 07.11.2017.

Retirement

- Sh. H.S.Mistry,UDC retired on superannuation w.e.f. 31.05.2017
- Sh. D.M.Bhatt, Chief Technical Officer retired on superannuation w.e.f. 31.07.2017
- Sh. A.M.Vakharia, Technical Officer retired on superannuation w.e.f. 30.11.2017.
- Sh. N.M.Pandia,SSS retired on superannuation w.e.f. 31.01.2018.
- Sh. K.H.Koradia,Technical Officer (Driver), retired on superannuation w.e.f. 28.02.2018.
- Sh.H.B.Lalwani, CTO, retired on superannuation w.e.f. 31.03.2018.

Transfer

- Dr. R.S.Yadav,Sr. Scientist (Soil Science) was transferred to ICAR-CAZRI,Jodhpur on 07.07.2017.
- Dr. Abhay kumar, Scientist was transferred to ICAR-NRC for Litchi Muzaffarpur on 07.07.2017.
- Dr. Murlidhar Meena, Scientist was transferred to ICAR-NRC on Seed Spices, Ajmer on 07.07.2017.

Institute Joint Staff Council

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

Members: Staff side

1. **Shri A.M. Vakharia**, Technical Officer
2. **Shri A.D. Makwana**, Technical Assistant, Secretary IJSC
3. **Mrs. M.N. Vaghasia**, Assistant
4. **Shri Y.S. Karia**, PA, Member CJSC
5. **Shri B.J. Dabhi**, SSS
6. **Shri C.G. Moradia**, SSS

Members:- Office side

1. **Dr. R. Day**, Principal Scientist
2. **Dr. D.L. Parmar**, CTO
3. **Smt. V.S. Chaudhri**, ACTO
4. Finance & Accounts Officer, ICAR-DGR, Junagadh
5. Administrative Officer, ICAR-DGR, Junagadh

Institute Management Committee

Director ICAR-DGR, Junagadh, Chairman

Assistant Director General (OP), ICAR, KB, New Delhi, Member

Dr. S.K. Yadav, Principal Scientist, Biochemistry, CRIDA, Santoshnagar, Hyderabad-500 059, Member

Dr. Geetha K.S., Principal Scientist, DMAPR, Anand Gujarat, Member

Dr. K.K. Pal, Principal Scientist (Microbiology), ICAR-DGR, Junagadh, Member

Dr. I.P. Singh, Principal Scientist, ICAR-Central Citrus Research Institute, Post Box No. 464, Shankar Nagar, PO Nagpur-440 010, Member

Finance & Accounts Officer, ICAR-CSWRI, Avikanagar, Rajasthan, Member

Administrative Officer, ICAR-DGR, Junagadh, Member Secretary

Finance and Accounts

Budget DGR Main Unit (Rs. in lakhs)

Budget Head	Allocation	Total Expenditure
Establishment charges	818.80	817.89
Wages	62.00	58.79
Administrative Expenses	208.50	188.43
Pension	225.13	225.13
T.A.	22.00	21.80
Research and Operational Expenses	175.00	156.59
HRD	3.0	2.80
Works	35.00	35.00
Equipment	62.00	61.92
Furniture	0.0	0.0
IT	15.00	14.97
Books	0.0	0.0
Vehicles	0.0	0.0
Miscellaneous	17.50	17.29
TSP	0.0	0.0
TOTAL(Rs. in lakhs)	**1643.93**	**1600.61**

AICRP-G (Rs. in Lakhs)

Budget Head	Allocation	Total Expenditure
Pay & Allowance	810.00	625.56
TA	9.97	6.15
Recurring Contingency & Need Based Research	104.03	106.81
TSP	20.0	19.96
TOTAL(Rs. in lakhs)	**944.00**	**758.48**

भाकृअनुप
ICAR

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

Agrisearch with a human touch