



वार्षिक प्रतिवेदन ANNUAL REPORT 2019



भाकृअनुप-मूँगफली अनुसंधान निदेशालय

(आई.एस.ओ 9001 : 2015 प्रमाणित संस्थान)

इवनगर रोड, पोस्ट बॉक्स नं. 5, जूनागढ़ 362 001, गुजरात, भारत

ICAR-Directorate of Groundnut Research

(An ISO 9001 : 2015 Certified Institute)

Ivnagar Road, PO Box No. 5, Junagadh-362 001, Gujarat, India

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Preface



It is a matter of immense pleasure and great satisfaction to present the annual report (2019-2020) of ICAR- Directorate of Groundnut Research, Junagadh. As an organization we strive our best to serve the multitude stakeholders from farmers to industries through research accomplishment and technological competence of the institute. Groundnut was introduced for cultivation in late 60's and in a span of 5 decades, the crop has become an economically important oilseed crop of India. At present the crop is grown on more than 4 million hectare area with a production of nearly 7 million tones. The contribution of groundnut to total oilseeds and edible oil produced in the country is about 24%. Peanuts are treated as functional food as it is source of fats, proteins, minerals, vitamins, antioxidants and health improving bioactive compounds such as resveratrol, tocopherol, arginine etc. There is an increasing demand for peanut and peanut-based products in the international market, especially for confectionary types.

The lower productivity is one of the major challenges in front of peanut researchers. High temperature and drought stress at critical growth stages, devastating environmental changes with simultaneous concurrence of number of diseases and insects have a large impact on productivity. Scientists at DGR, are making all efforts to overcome these problems and continue to strive for increasing productivity in the face of climate change. The major strategies include development of improved lines, production and protection technologies to overcome the problem of drought, infestation by diseases and insect pests and breeding for quality improvement. The present annual report of the institute highlights the significant achievements made under different research, extension and training programs.

During the year some promising advanced breeding lines namely, PBS29079B (highest hundred kernel weight >72 g), PBS-12190, PBS-22131, PBS-22132 and PBS-22133 (resistance to *Alternaria* blight), PBS-22092 (resistance to collar rot) and PBS14060, 14068, 16044, 11077, 11092, 15027, 15028, 16023 and 16038 (15 days fresh seed dormancy); interspecific derivatives NRCGCS 133 (high yielder under drought), NRCGCS-176, NRCGCS-180, NRCGCS-196 and NRCGCS-298 (resistance to *Alternaria* leaf blight) were identified. Advanced breeding line PBS 15044 (IVT-II) was multiplied for seed supply for AICRP-G trials during kharif 2019. Relay sowing of groundnut + pigeonpea in 3:1 ratio gave higher groundnut pod equivalent yield. Application of paclobutrazol @100 ppm spray at 30 DAS and 35 DAS and increasing level of N doses (40 kg N/ha) significantly increased pod yield. Further, application of urea along with DGRC1 (PSB) gave significantly higher pod yield. It would be feasible to reduce quantity (30-50%) and frequency of irrigations (3-4 irrigations) substantially for raising summer groundnut with application of endophytes without compromising yield. Seed inoculation with competitive strains of groundnut rhizobia (DGR 24, DGR 25, DGR 35, DGR 10) resulted in significant enhancement of pod yield. Spraying of epiphytic bacteria *Bacillus amyloliquefaciens* 9S2 reduced *Alternaria* leaf blight severity along with enhancement of pod yield by 11%. During the year, a total of 8809.23 quintals of breeder seed comprising of 46 varieties was produced. ICAR-DGR also organized a number of outreach programs that includes farmers' fair-cum-exhibition, front line demonstrations, Mera Gaon Mera Gaurav, Swachh Bharat Mission and farmer's training programmes.

ICAR-DGR Annual report-2019 would give a panoramic scenario of research and extension activities undertaken by institute. I am thankful to chairman and members of RAC for giving valuable suggestions and direction to our research activities. I gratefully acknowledge the whole-hearted support and co-operation of all the scientific, technical, administrative, account and supporting staff of the directorate. I wish to express my thanks to the editorial committee for their sincere efforts in compiling and editing this report.



Radhakrishnan T.
Director

Executive summary



Crop Improvement

- Twelve thermo tolerant (low and high temperature) promising varieties (DH 86, GJG 9, LGN 1, ICGV 00350, JL220, JGN 3, TAG 24, KISAN, OG 52-1, KOPERGAON-3, ALR 3) are identified after two years of field evaluation.
- Three accessions viz. NRCGS 14324, 14367, and 14480 and one susceptible variety GPBD 4 were multiplied for further large scale evaluation and identification of traits associated with thermo tolerance.
- A total of 161 accessions from South American collection were multiplied in summer 2019.
- Preliminary yield evaluation trial identified NRCGCS 133 to be high yielder than superior check at Anantpur.
- Around 120 most promising advanced breeding lines identified from different drought screening trials for yield under rainfed conditions of Anantpur were multiplied at Junagadh
- Total 238 probable F_1 s were identified from eight crosses for quality traits improvement viz., seed size, oil and protein content based on male parent characters.
- In pooled data analysis of Kharif, 2018 and Kharif, 2019 the genotype PBS29079B recorded highest 100KW (>72 g) and found superior over checks at Junagadh.
- In Bikaner, PBS29079B genotype recorded 121.97 g of hundred kernel weight with highest pod weight per plant (43.06 g).
- Identified two advanced breeding lines PBS-12217 and PBS-12218 which had 20% and 36% higher kernel yield over the best check variety TG37A during summer 2018-2019.
- Identified an advanced breeding line PBS-12223 which had 15% higher kernel yield over the best check variety TG37A during kharif 2018-2019.
- Based on three summer season (2017, 2018, 2019) screening results identified three cultivars viz., Kaidiri 9, Kadiri Haritendra, ICGV-00348; four advanced breeding lines viz., PBS-12190, PBS-22131, PBS-22132 and PBS-22133 and four interspecific derivatives viz., NRCGCS-176, NRCGCS-180, NRCGCS-196 and NRCGCS-298 found resistance to Alternaria leaf blight (score 3 on 1-9 scale).
- An advanced breeding line PBS-22092 recorded less than 15% collar rot incidence in

five consecutive kharif season (2015-2019) at DGR-RRS, Bikaner. Hence genotype has been identified as novel genetic stock for resistant to collar rot.

- Three advanced breeding lines viz., PBS-18038, PBS-18064, PBS-22089 recorded low plant mortality as compared to resistant genotype J-11(18.5%) during *kharif* 2018 and 2019 at DGR-RRS, Bikaner.
- Evaluation of 48 germplasm accessions for two years during summer, genotypes viz., NRCG 14507, NRCG CS 254, NRCG CS 313 and Girnar 1 showed early flowering initiation and NRCG 10620 and TG 39 exhibited higher pod yield over two years.
- Three consecutive years evaluation of 97 germplasm collections of different habit groups from 2017 to 2019 identified promising germplasm accessions for productive and maturity duration are Virginia bunch (NRCG 14477, TG 39, ICGS 76, GG 20, TGLPS 3, NRCG 14463, Kadiri 3, LGN 2, Girnar 2), Virginia runner (Sun oleic 95 R, GJG 17, M 13, Kaushal, Somnath, NRCG 14475, GG 12), Spanish bunch (Girnar 3, TG 37 A, Girnar 1, TLG 45, JL 501, TAG 24, DH 86, TG 38, SG 99, GG 7, NRCG 10620, TG 26, VRI 2, GG 2, Kadiri 6, GJG 09, Kadiri 9) and Valencia (NRCG 6780, NRCG 17277, NRCG 14507, Gangapuri, NRCG 14345,

NRCG 14379, NRCG 14435).

- Advanced breeding lines PBS 14060, 14068, 16044, 11077, 11092, 15027, 15028, 16023 and 16038 exhibited 15 days fresh seed dormancy. Accessions NRCG 1439 and breeding line PBS 11085 had tolerant reaction to LLS during 2017 and 2018.

Basic Sciences

- 4 groundnut cultivars with low phytic acid and high Zn in seeds were identified
- Zn solubilizing microbes enhanced Zn, Mn and K content in rhizosphere and uptake in seeds
- Commercial zinc sources enhanced Zn content in seeds with chelated form yielding best results
- Yields losses and aflatoxin contamination are decided by Pod zone moisture
- Cultivars with wide elasticity for various drought situations identified
- Growth regulators enhances seed size in groundnut
- Average sugar content was higher in the cultivars grown at Junagadh (5.34 mg/g kernel) compared to their released location (4.95 mg/g kernel).
- High oleic containing genotypes had higher average oil content (53.7%) as compared to released cultivars (48.7%),
- Protein content was observed less (25.2%) in high oleic

containing genotypes than that of released cultivars (30%).

- High oleic acid containing genotypes had higher average sugar content (7.4%) than that of released cultivars (5.5%).
- Seed inoculation with four new competitive strains of groundnut rhizobia (DGR 24, DGR 25, DGR 35, DGR 10) resulted in significant enhancement of pod yield (27–32%) of groundnut, cultivar TG37A.
- Twenty-four new zinc-solubilising bacterial isolates were found to be different species of the genus *Enterobacter*, *Pseudomonas*, *Acinetobacter* and *Microbacterium*.
- Twelve new K-solubilising bacterial isolates from groundnut rhizosphere were identified and majority of the isolates were found to be belonging to the genera *Enterobacter*, *Pseudomonas* and *Acinetobacter*.
- The severity of alternaria leaf blight reduced from a score of 7.0 (in a scale of 1-9) in uninoculated control to 4.0 when sprayed with leaf epiphytic bacteria *Bacillus amyloliquefaciens* 9S2, along with enhancement of pod yield by 11%.
- Application of endophytes and 5 irrigations can provide as much pod yield (average 2414 kg/ha) that can be obtained with 10 supplementary irrigations after emergence

(2445 kg/ha) without endophytes.

- It would be feasible to reduce quantity (30-50%) and frequency of irrigations (3-4 irrigations) substantially for raising summer groundnut with endophytes
- Application of endophytes like *Acinetobacter junii* J20N, *Bacillus firmus* J22N, and *Pseudomonas pseudocaligenes* SEN29N and prevented the reduction in yield losses by improving the yield by 31.1%, 25.3%, and 26.2%, respectively (942 kg/ha in control and 1180-1235 kg/ha with these endophytes) at soil EC of around 4.53 at harvest
- Modulation of pathways leading to expression of CAM has been found to be the major factor in alleviation of drought and salinity stress in groundnut by endophytes.
- Yield evaluation of C3-CAM variants of TG37A shows that reduction of biomass was around 45% in TG37A with two supplementary irrigations, C3-CAM transited variants showed biomass reduction from 27-35% in similar conditions. Least reduction in biomass was obtained with DGRMB19.
- Over-expressive C3-CAM transited variants of TG37A (which are otherwise drought tolerant) like DGRMB19 minimized the biomass reduction (7514 kg/ha on

normal condition to 4862 kg/ha) and maintained at 35% level of reduction at 4.87 soil EC.

- Application of *Bacillus firmus* J22 were found to alleviate salinity stress in cotton, til, bajra, guar, and mungbean and gave significantly higher yield.
- CAM transited variant of TG37A (DGRMB24) outperformed TG37A and local check (Kadiri 6) at 65 days of drought after sowing at farmers field.

Crop Production

- Pigeonpea grain yield and groundnut pod equivalent yield (GPEY) was found higher with 3:1 ratio in groundnut+pigeonpea relay cropping system in both Spanish and Virginia bunch varieties. Pigeonpea grain yield and GPEY was found significantly higher with relay sowing of pigeonpea at 30 days after sowing of groundnut in both the varieties.
- Groundnut pod and haulm yield was found higher with 3:1 ratio in groundnut+pigeonpea relay cropping system in both Spanish bunch and Virginia bunch varieties. Pod yield of groundnut was recorded higher when pigeonpea was relay sown at 50 and 40 days after sowing in Virginia bunch and Spanish bunch varieties, respectively.
- Groundnut pod yield and

haulm yield was found higher with rota-tillage and zero tillage, respectively. Application of crop residues did not affect crop yields significantly. Groundnut+pigeonpea cropping system was found to give higher groundnut pod yield, haulm yield over groundnut+cotton intercropping system.

- Application of paclobutrazol @100 ppm spray at 30 DAS and 35 DAS gave higher pod yield and haulm yield, respectively.
- Pod yield increased with increasing level of N doses and highest significant yield was found at 40 kg N/ha (3150 kg/ha) and 30 kg N/ha (2501 kg/ha) in TG37A and GG 22, respectively. While, significantly higher haulm yield was found at 50 kg N/ha in both the varieties.
- Significantly higher pod yield (2651 kg/ha) was obtained with the application of ammonium sulphate in addition to FYM and DGRC1. DGRC1 alone improved pod yield by over 200 kg/ha compared to control.
- Application of PSB (DGRC 1) + 75% RDP improved 2-fold pod yield (1886 kg/ha) compared control (985 kg/ha).
- Application of organic acid mix (Citric acid: malic acid: oxalic acid 4:2:1) @ 60 kg/ha + DGRC1 culture without addition of any P to soil

reported significantly higher pod yield (1818 kg/ha)

Crop Protection

- Module-M17A i.e. Deep summer ploughing with mould board plough + seed of variety TG 37A+ seed treatment with tebuconazole @ 1.5 g/ kg of seed + soil application of Trichoderma harzianum S1 @ 4 kg/ ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS, was effective in inhibition of stem rot and collar rot as well as supporting yield in refinement.
- Trichoderma isolate T-354 was recorded with highest chitinase activity as well as supporting higher pod and fodder yield.
- Module- M4A & M17A were effective in inhibition of soil borne diseases and supporting yield while validation.
- Total of 77 isolates of *Alternaria* sp. associated with leaf blight disease of groundnut were collected from different agro-climatic regions of India could not be differentiated based on colony morphology, mycelial growth rate, and spore characters. However, differences in pathogenicity of *Alternaria* sp. isolates were recorded. Existence of genetic diversity among isolates of *Alternaria* sp. was observed using RAPD and URP markers.

- Fungicides namely pyraclostrobin + metiram and tebuconazole were found to be effective to reduce the *Alternaria* disease severity.
- Epidemiological factors - crop age of 70-110 days, relative humidity below 60% and temperature above 37 degree C, favoured occurrence of *Alternaria* leaf blight up-to 7 rating scale (max. 60% severity) of 1-9 scale. Water stress for 4 weeks or above, deficiencies of nitrogen, iron and zinc, damage of peanut by jassids and thrips, and peanut grown in the saline soil at 4 dsm⁻¹ or above were favoured the *Alternaria* leaf blight.
- Up to 96 per cent control of white grub in Junagadh district was achieved who followed timely integrated pest control measures compared to previous year.
- HDPE bag of 160 micron was cost effective and improve the storability of groundnut compared to gunny bags when stored under natural condition.
- Pod damage by bruchid beetles was less in Girnar 3 due to smaller seed size and higher content of total phenols compared to Girnar 2 were damage was significantly higher due to large seed size and low total phenol content, but after three months of storage more than 50 per cent pod damage was recorded in

Girnar 3 due to reduction in total phenol content from 0.32 in first month to 0.26 after three months of storage.

- Thrips and leafhopper population was found throughout the year, but we observed two significant peaks of thrips population during 6th and 38th Standard week and leafhopper population had three peaks at 7th, 43rd and 45th Standard week.
- Three nematodes groups viz., Plant parasitic, Free living and Predatory nematodes were isolated

Social Science

- The study on farm-managerial abilities, resource-use efficiency and technical efficiencies among small and marginal farmers revealed that small and marginal farmers invest about 35% of cost in seed and post harvesting practices.
- Majority of marginal farmers (72.0 per cent) operating with 62.50 per cent of technical efficiency.
- Among small and marginal farmers, with the same investment, about 34.5 per cent yield improvement can be achieved.
- It was found that majority of the small (51.60%) and marginal farmers (40%) found to have medium (30-36%) farm managerial abilities.

कार्यकारी सारांश



फसल सुधार

- बारह उष्मा सहनशील (कम तथा अधिक तापमान) आशाजनक किस्मों (डीएच 86, जीजजी 9, एलजीएन 1, आईसीजीवी 00350, जेएल 220, जेजीएन 3, टीएजी 24, किसान, ओजी-52-1, कोपरगॉव-3, एएलआर 3) की पहचान दो वर्षों तक प्रक्षेत्र मूल्यांकन के पश्चात किया गया।
- तीन प्रविष्टियों अर्थात एनआरसीजीएस 14324, 14367 एवं 14480 तथा एक संवेदनशील किस्म जीपीबीडी-4 का गुणन बड़े पैमाने पर मूल्यांकन तथा उष्मा सहनशीलता से जुड़े गुणों की पहचान हेतु किया गया।
- कुल 161 दक्षिण अमेरिकी संग्रह की प्रविष्टियों का गुणन ग्रीष्म 2019 में किया गया। अनंतपुर की बारानी अवस्था में प्राथमिक उपज मूल्यांकन परीक्षण में एनआरसीजीसीएस-133 को उत्कृष्ट नियंत्रण की तुलना में अधिक उपज लाइन के रूप में पहचाना गया।
- अनंतपुर की बारानी अवस्था में प्राथमिक उपज मूल्यांकन परीक्षण में एनआरसीजी सीएस-133 को उत्कृष्ट नियंत्रण की तुलना में अधिक उपज प्रदान करने वाली लाइनें रूप में पहचाना गया।
- अनंतपुर की बारानी अवस्था में उपज हेतु शुष्कता के विरुद्ध किये गये विभिन्न परिक्षणों में से पहचानी गई आशाजनक अग्रवर्ती प्रजनन लाइनों में से लगभग 120 को बीज गुणन के लिए जूनागढ़ में उगाया गया।
- नर जनकों में गुणवत्ता गुणधर्मों अर्थात: बीज आकार, तेल तथा प्रोटीन की मात्रा में सुधार के आधार पर संकरनों में से कुल 238 संभावित एफ₁ की पहचान की गई।
- खरीफ 2018 तथा खरीफ 2019 के संग्रहित आंकड़ा विश्लेषण में जीन प्रकार पीबीएस 29079बी ने अधिकतम 100 के डब्ल्यू (>72ग्राम) दर्ज किया तथा इसे जूनागढ़ में उत्कृष्ट नियंत्रणों की तुलना में उत्कृष्ट पाया गया।
- बीकानेर में पीबीएस 29079बी जीनोटाइप द्वारा 121.97 प्रति सौ बीज भार तथा अधिकतम प्रति पौध फली भार (43.06 ग्राम) दर्ज किया गया।
- ग्रीष्म 2019 (7) तथा खरीफ 2019 (13) के दौरान बीस नई प्रोन्नत अधिक उपज प्रदान करने वाले प्रजनन लाइनों (स्पेनिश जीन स्वभाव के क्रमशः 13 तथा 7) को विकसित किया गया।
- ग्रीष्म 2018-19 के दौरान पहचानी गई दो प्रोन्नत प्रजनन लाइनों पीबीएस-12217 तथा पीबीएस-12218 में उत्कृष्ट नियंत्रण किस्म टीजी37ए की तुलना में क्रमशः 20 प्रतिशत तथा 36 प्रतिशत अधिक बीज उपज दर्ज किया गया।
- खरीफ 2018-19 के दौरान एक प्रोन्नत प्रजनन लाइन पीबीएस-12223 में टीजी37ए की तुलना में 15 प्रतिशत अधिक बीज उपज था।
- तीन ग्रीष्म कालों (2017, 2018, 2019) के दौरान परीक्षण के आधार पर तीन किस्मों अर्थात कादिरी9, कादिरी हरितेन्द्र, आईसीजीवी-00345; चार प्रोन्नत प्रजनन लाइनों अर्थात पीबीएस-12190, पीबीएस-22131, पीबीएस-22132 तथा पीबीएस-22133 एवं चार अंतःविशिष्ट उत्पादों अर्थात एनआरसीजी एस 176, एनआरसीजी एस 180, एनआरसीजी एस 196 तथा एनआरसीजी एस 298 को अल्टरनेरिया पत्ती

- झुलसा के लिए प्रतिरोधी पाया गया (1-9 के पैमाने पर 3 अंक)।
- डीजीआर-आरआरएस, बीकानेर में लगातार पाँच खरीफ कालों (2015-2019) के दौरान एक प्रोन्नत प्रजनन लाईन पीबीएस-22092 में कॉलर सड़न की घटनाओं में 15 प्रतिशत कमी दर्ज की गई। अतः इस जीनोटाइप की कॉलर सड़न के लिए प्रतिरोधिता हेतु एक नवीन आनुवंशिक किस्म के रूप में पहचान की गई।
 - तीन उन्नत प्रजनन लाइनों अर्थात् पीबीएस-18038, पीबीएस-18064, पीबीएस-22089 में खरीफ 2018 तथा 2019 के दौरान डीजीआर-आरआरएस, बीकानेर में प्रतिरोधी किस्मजे-11 की तुलना में कम पौध मृत्यु (18.5 प्रतिशत) दर दर्ज किया।
 - ग्रीष्म के दौरान लगातार दो वर्षों के लिए 48 जनन द्रव्यों के मूल्यांकन में से एनआरसीजी 14507, एनआरसीजी सीएस 254, एनआरसीजी सीएस 313 तथा गिरनार 1 ने अगेती पुष्पन प्रारंभ दर्शाया तथा एनआरसीजी 10620 एवं टीजी 39 से इस दो वर्ष की अवधि में अधिकफली उपज दर्ज की गई।
 - 2017 से 2019 के दौरान विभिन्न स्वभाव समूह के 97 जनन द्रव्य संग्रह का तीन वर्षों तक लगातार परीक्षण के फलस्वरूप उत्पादकता तथा परिपक्वता अवधि के लिए आशाजनक जनन द्रव्यों की पहचान की गई जिसमें वर्जीनिया समूह (एसआरसीजी 14477, टीजी 39, आईसीजीएस 576, जीजी 20, टीजीएल पीएस 3, एनआरसीजी 14463, कदीरी 3, एलजीएन 2, गिरनार 2), वर्जीनिया रनर (सनओलिक 95आर, जीजेजी 17, एम 13, कौशल, सोमनाथ, एनआरसीजी 14475, सीजी 12), स्पेनिश समूह के (गिरनार 3, टीजी 37ए, गिरनार 1, टीएलजी 45, जेएल 501, टीएजी 24, डीएच 86, टीजी 38, एसजी 99, जीजी 7, एनआरसीजी 10620, टीजी 26, वीआरआई 2, जीजी 2, कदीरी 6, जीजेजी 09, कदीरी 9) तथा वेलेंसिया (एनआरसीजी 6780, एनआरसीजी 17277, एनआरसीजी 14507, गंगापुरी, एनआरसीजी 14345, एनआरसीजी 14379 तथा एनआरसीजी 14435) समूह के उपरोक्त सदस्य सम्मिलित हैं।
 - उन्नत प्रजनन लाइनों पीबीएस 14060, 14068, 16044, 11077, 11092, 15027, 15028, 16023 तथा 16038 में ताजा बीजों की प्रसुप्तता अवधि 15 दिन दर्शाई गई। प्रविष्टि एनआरसीजी 1439 तथा प्रजनन लाइन पीबीएस 11085 ने एलएलएस के प्रति वर्ष 2017 तथा 2018 के दौरान सहनशील प्रतिक्रिया दर्शाई।
- ### मूलभूत विज्ञान
- चार मूँगफली किस्मों की पहचान की गई जिसके बीजों में कम फाइटिक अम्ल तथा अधिक जिंक की मात्रा थी।
 - जस्ता विलेयकारी सूक्ष्म जीवों ने जिंक, मैंगनीज तथा पोटैश की मात्रा को जड़ क्षेत्र में तथा बीजों द्वारा उद्ग्रहण में वृद्धि प्रदान की।
 - चिलेटेड रूप में वाणिज्यिक जस्ता स्रोतों ने बीजों में जिंक की मात्रा में वृद्धि की तथा उत्कृष्ट परिणाम प्रदान किया।
 - 114 प्रजनन लाइनों का लौह हरितरोग तथा संबंधित पादपकार्यिकी पैमानों के लिए परीक्षण किया गया।
 - फली क्षेत्र आर्द्रता, उपज में कमी तथा एफलाटाक्सिन संदूषण का निर्धारण करती है।
 - विभिन्न शुष्कता अवस्था के लिए अधिक सहनशील किस्मों की पहचान की गई।
 - पादप विकास नियंत्रक मूँगफली बीजों के आकर में वृद्धि करती है।
 - लवण सहनशीलता क्रियाविधि तथा मूँगफली किस्मों की पहचान की गई।
 - जूनागढ़ में उगाई गई किस्मों में औसत शर्करा की मात्रा (5.34 मिली/ग्रा बीज) इन किस्मों के विमोचन स्थानों पर उगाने की तुलना में अधिक (4.5 मिग्रा/ग्रा. बीज) थी।
 - उच्च ओलिक अम्ल युक्त जीनोटाइप में औसत तेल की मात्रा (53.7 प्रतिशत) विमोचित किस्मों की तुलना में अधिक (48.7 प्रतिशत) थी।
 - विमोचित किस्मों की तुलना में (30 प्रतिशत) अधिक ओलिक अम्ल युक्त जीनोटाइप में प्रोटीन की मात्रा कम (25.2 प्रतिशत) थी।
 - विमोचित किस्मों की तुलना में (5.5 प्रतिशत) अधिक ओलिक अम्ल युक्त जीनोटाइप में औसत शर्करा की मात्रा अधिक (7.4 प्रतिशत) थी।
 - मूँगफली के चार नये प्रतिस्पर्धी राइजोबिया स्ट्रेनों (डीजीआर 24, डीजीआर 25, डीजीआर 35 व डीजीआर 10) के प्रयोग से मूँगफली किस्म टीजी 37ए में फली उपज में सार्थक वृद्धि (27-32 प्रतिशत) दर्ज की गई।
 - चौबीस नये जिंक विलेयकारी जीवाणु पृथक्कृत जीनस इन्ट्रोबेक्टर सूडोमोनास, एसीनीटोबेक्टर तथा माइक्रोबेक्टेरियम की अलग प्रजातियाँ थी।
 - मूँगफली जड़ क्षेत्र से बारह नये पोटेसियम विलेयकारी पृथक्कृतों की पहचान की गई तथा अधिकतर

पृथक्कृतों को एन्टेरोबेक्टर, सूडोमोनास तथा एसीनेटोबेक्टर जेनेरा का सदस्य पाया गया।

- पत्तियों के अधिपादप जीवाणु बेसीलस एमीलोलीकवी फेसीयंस 952 से छिड़काव करने पर बिना छिड़काव वाले नियंत्रण की तुलना में (4.0) अल्टरनेरिया झुलसा रोग की तीव्रता में 7.0 (1-9 के पैमाने पर) पैमाने तक की कमी हुई तथा फली उपज में भी 11 प्रतिशत की वृद्धि हुई।
- बिना अंतःपादप जीवाणु (एंडोफाइट्स) से उपचारित तथा फसल उगाने के पश्चात् दस पूरक सिंचाई के उपयोग की तुलना में (2445 किग्रा/हे) अंतःपादप जीवाणु के उपयोग के साथ केवल पाँच सिंचाई के द्वारा उतनी ही फली उपज (औसत 2414 किग्रा/हे) प्राप्त किया जा सकता है।
- अंतःपादप जीवाणु के साथ ग्रीष्म काल में मूँगफली उगाने के लिए सिंचाई की मात्रा (30-50 प्रतिशत) तथा संख्या में (3-4 सिंचाई) कमी करना अब संभव होगा।
- एसीनोबेक्टर जुनाई जे20एन, बेसिलस फिर्मस जे22एन तथा सूडोमोनास सूडोअलकेलीजीनिस एसइएन29एन के उपयोग द्वारा कटाई के समय 4.53 मृदा विद्युत चालकता पर भी उपज में क्रमशः 31.1 प्रतिशत, 25.39 तथा 26.2 प्रतिशत सुधार के द्वारा उपज हानि को सुरक्षा प्रदान हुई (नियंत्रण में 942 किग्रा/हे तथा अंतःपादप जीवाणु के साथ 1180-1235 किग्रा/हे)।
- जैव रसायनिक मार्गों में उतार-चढ़ाव के कारण सीएएम की अभिव्यक्ति को अंतःपादप के द्वारा मूँगफली में शुष्कता

तथा लवणता प्रतिबल शमन का प्रमुख घटक पाया गया।

- एंडोफाइट्स द्वारा सीएएम की अभिव्यक्ति की क्रियाओं में उतार-चढ़ाव मूँगफली में सूखे और लवणता के तनाव को कम करने में प्रमुख कारक पाया गया है।
- टीजी 37ए के विभिन्न सी3-सीएएम किस्मों का उपज मूल्यांकन दर्शाता है कि टीजी 37ए में दो पूरक सिंचाई के साथ बायोमास में लगभग 45 प्रतिशत की कमी हुई, सी3-सीएएम द्वारा अग्रसरित रूपांतरों ने इसी अवस्था में 27-35 प्रतिशत बायोमास में कमी दर्शाई। न्यूनतम बायोमास में कमी डीजीआरएमबी 19 में दर्ज की गई।
- टीजी 37ए के अति अभिव्यक्त सी3-सीएएम अग्रसरित रूपांतरों, जो कि प्रायः शुष्कता सहनशील है, जैसे: डीजीआरएमबी 19 ने बायोमास में न्यूनतम कमी दर्शाई (सामान्य अवस्था में 7514 किग्रा/हे. से 4862 किग्रा/हे) तथा 4.87 मृदा इसी पर इसे 35 प्रतिशत के स्तर पर बनाये रखा।

फसल उत्पादन

- तूर दाना उपज तथा मूँगफली फली तुल्यांक उपज (जीपीइवाय) को स्पेनिश तथा वर्जीनिया, दोनों किस्मों के 3:1 अनुपात में, मूँगफली + तूर फसल प्रणाली में अधिकपाया गया। अरहर दाना उपज तथा जीपीइवाय का सार्थक उच्च मान मूँगफली की दोनों किस्मों के बुवाई के 30 दिन पश्चात् तूर की अनुपद सस्यन बुवाई में दर्ज की गई।
- मूँगफली की फलियों तथा भूसे की उपज का अधिक मान 3:1 अनुपात में

मूँगफली + अरहर की अनुपद सस्यन विधि युक्त फसल प्रणाली में मूँगफली की स्पेनिश तथा वर्जीनिया दोनों किस्मों में दर्ज की गई। वर्जीनिया समूह तथा स्पेनिश समूह किस्मों के क्रमशः 50 तथा 30 दिन बुवाई पश्चात् अरहर के अनुपद सस्यन में मूँगफली की फलियों की अधिक उपज दर्ज की गई।

- उच्च मूँगफली फली तथा भूसा उपज का अधिकतम मान क्रमशः रोटा जुताई तथा शून्य जुताई में दर्ज किया गया। फसल अवशेष के उपयोग को फसल उपज पर सार्थक प्रभाव डालने में असफल पाया गया। मूँगफली + कपास अंतःसस्यन फसल प्रणाली की तुलना में मूँगफली + अरहर फसल प्रणाली को अधिक मूँगफली फली उपज, भूसा उपज प्रदान करते पाया गया।
- पेक्लोब्युट्राजोल का 100 पीपीएम की दर से क्रमशः 30 दिन बुवाई पश्चात् (डीएएस) तथा 35 डीएएस पर छिड़काव ने क्रमशः अधिक फली उपज तथा भूसा उपज प्रदान किया।
- नत्रजन की मात्रा में वृद्धि से फली उपज में भी वृद्धि हुई, यह सार्थक अधिक उपज 40 किग्रा नत्रजन/हे (350 किग्रा/हे) तथा 30 किग्रा नत्रजन/हे. (2501 किग्रा/हे) की मात्रा पर क्रमशः किस्म टीजी 37ए तथा जीजी 22 में दर्ज की गई। सार्थक अधिक भूसा उपज दोनों किस्मों में 50 किग्रा नत्रजन/हे पर प्राप्त की गई।
- अमोनियम सल्फेट के साथ एफवायएम तथा डीजीआरसी1 के उपयोग से सार्थक अधिक फली उपज (2651 किग्रा/हे) प्राप्त हुई। केवल डीजीआरसी 1 द्वारा ही नियंत्रण की तुलना में 200 किग्रा/हे फली उपज में सुधार हुआ।

- यूरिया + डीजीआरसी1 के उपयोग से सार्थक अधिक फली उपज (2444 किग्रा/हे) अमोनियम सल्फेट + डीजीआरसी 1 (2216 किग्रा/हे) की तुलना में दर्ज की गई।
- पीएसबी (डीजीआरसी 1) + 75 प्रतिशत संस्तुत फास्फोरस की मात्रा (आरडीपी) के उपयोग से दो गुणा फली उपज में वृद्धि (1886 किग्रा/हे) नियंत्रण की तुलना (985 किग्रा/हे) में रिपोर्ट की गई।
- कार्बनिक अम्ल मिश्रण (सिट्रिक अम्ल: मेलिक अम्ल: आक्सेलिक अम्ल, 4:2:1) को 60 किग्रा/हे + डीजीआरसी 1 संवर्ध, (बिना फास्फोरस) के मृदा में उपयोग द्वारा सार्थक अधिक फली उपज (1818 किग्रा/हे.) रिपोर्ट की गई।

फसल संरक्षण

- माड्यूल-एम17ए को तना सड़न तथा कॉलर सड़न की रोकथाम में प्रभावी तथा उपज सुधार के लिए सहायक पाया गया।
- ट्राइकोडर्मा पृथक्कृत टी-354 ने अधिकतम चीटीनेस गतिविधि दर्ज की तथा इसे उच्च फली एवं चारा उपज में सहायक पाया गया।
- माड्यूल-एम4ए तथा एम17ए को मृदा जनित रोगों को कम करने के लिए प्रभावकारी तथा उपज वृद्धि में भी सहायक पाया गया।
- मूँगफली के पत्ती झुलसा रोग से जुड़े अल्टरनेरिया प्रजाति के 77 वियोजकों को भारत के विभिन्न कृषि जलवायु क्षेत्रों से एकत्रित किया गया, जिन्हें वसाहत रचना, कवक जाल विकास दर तथा बीजाणु गुणों के आधार पर अलग नहीं किया जा सका। फिर भी अल्टरनेरिया प्रजाति के वियोजकों में रोगजनक क्षमता में अंतरों को दर्ज किया गया।

अल्टरनेरिया प्रजाति वियोजकों में आनुवंशिक विविधता को आरएपीडी तथा यूआरपी चिन्हों के उपयोग से देखा गया।

- पाइरेक्लोस्ट्रोबिन + मेटीराम तथा टेबूकोनाजोल नामक कवकनाशी पत्ती झुलसारोग की तीव्रता को कम करने में प्रभावशील थे।
- महामारी कारक घटक – 70–110 दिन फसल उम्र, 60 प्रतिशत से कम सापेक्ष आर्द्रता तथा 37 डिग्री सेंटीग्रेड से ऊपर तापमान, अल्टरनेरिया पत्ती झुलसा रोग को 1–9 के पैमाने पर 7 के पैमाने तक बढ़ाने में सहायक होते हैं। 4 सप्ताह से अधिक तक जल की कमी, नत्रजन लौह तथा जस्ते की कमी, जेसिड व थ्रिप्स के द्वारा मूँगफली को नुकसान तथा 4 डेसी सीमन मोल प्रति लीटर⁻¹ तक की अथवा इससे ऊपर की लवणीयता पर लवणीय मृदा में मूँगफली की खेती अल्टरनेरिया पत्ती झुलसा को बढ़ावा देती है।
- जूनागढ़ जिले में सफेद इल्ली की समस्या पर 96 प्रतिशत नियंत्रण उन किसानों द्वारा प्राप्त किया गया जिन्होंने पिछले वर्ष की तुलना में इस वर्ष समय पर एकीकृत कीट नियंत्रण उपायों को अपनाया।
- 160 माइक्रोन मोटाई के एचडीपीई थैलियों को प्राकृतिक अवस्था में मूँगफली के भंडारण के लिए बोरियों की तुलना में अधिक उपयुक्त तथा मूल्य प्रभावी पाया गया।
- गिरनार 3 में छोटे आकार के बीजों तथा कुल फिनाल की अधिक मात्रा के कारण ब्रूचिड संक्रमण से फली हानि गिरनार-2 की तुलना में कम दर्ज की गई। गिरनार-2 में बड़े बीज आकार के कारण

फलीयों की सार्थक अधिक हानि देखी गई तथा कुल फिनाल की मात्रा भी कम थी, परन्तु तीन माह के भंडारण के पश्चात् गिरनार 3 में 50 प्रतिशत तक की फली हानि, कुल फिनाल की मात्रा के प्रथम माह के 0.32 से 3 माह पश्चात् 0.26 तक की घटत के कारण भी दर्ज की गई।

- थ्रिप्स तथा पत्ती फुदका की संख्या पूरे वर्ष दिखाई दी, परन्तु थ्रिप्स संख्या के लिए दो सार्थक शीर्ष अवस्था 6वें तथा 38वें मानक सप्ताह में तथा पत्ती फुदका के लिए तीन सार्थक शीर्ष अवस्था 7वें, 43वें तथा 45वें मानक सप्ताह में दर्ज की गई।
- सूत्रकृमियों के तीन समूह अर्थात् पौध परजीवी, मुक्त निवासी तथा परभक्षी सूत्रकृमियों को अलग किया गया।

सामाजिक विज्ञान

- छोटे एवं सीमांत किसानों में फार्म प्रबंधकीय क्षमताओं, संसाधन उपयोग कुशलता तथा तकनीकी कुशलता पर अध्ययन से ज्ञात होता है कि छोटे सीमांत किसान 35 प्रतिशत तक का खर्च बीज की कीमत तथा सस्योत्तर विधियों पर करते हैं।
- अधिकतर सीमांत किसान (72.0 प्रतिशत) 62.50 प्रतिशत तकनीकी कुशलता से कार्य करते हैं।
- छोटे एवं सीमांत किसानों में उसी खर्च के साथ लगभग 34.5 प्रतिशत उपज में सुधार प्राप्त किया जा सकता है।
- यह ज्ञात हुआ कि अधिकतर छोटे (51.60 प्रतिशत) तथा सीमांत किसानों (40 प्रतिशत) में फार्म प्रबंधकीय कुशलता मध्यम स्तर की थी।

1 Genetic improvement of groundnut



Project 1: Breeding groundnut varieties for drought tolerance to enhance productivity in arid regions

PI:- Ajay BC

Co-PIs: Gangadhar K, Nataraj KC, Malleswari Sadhneni

Hybridization, selection and generation of advancement In segregating generations

Ten fresh crosses were attempted in *kharif* 2019 to enhance yield under drought stress and more than 2000 hybrid pods were harvested with 37.7% crossing success. In summer 19 probable hybrid (F_1 generation) from nine crosses attempted in *kharif* 2018 were raised and F_2 hybrid pods were harvested as single plants. These nine crosses in F_2 generation were raised in Anantapur under rainfed conditions and early generation

selection was performed at the time of harvest on seven crosses. A total of 17 Spanish and 12 Virginia genotypes were selected for further advancement. Segregating generation consisting of 177 breeding lines were advanced from F_4 to F_5 generation and another set of 59 genotypes were advanced from F_3 to F_4 generation.

Multiplication of promising breeding lines

Around 120 most promising advanced breeding lines identified from different drought screening trials for yield under rainfed conditions of Anantapur were multiplied at Junagadh

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. There was significant genotypic differences for pod yield per plant, haulm yield per plant and harvest index. Genotypes NRCG 14431, 11866, 12291, 12326, 12148, 12273, 14472, 12667 and NRCGCS 223 had high pod yield than the superior check Kadiri 6. For haulm yield genotypes NRCG 11866, 12177, 10820, 14327, 10541, 12672, 14328 and 9510 had high haulm yield than superior check Kadiri 6.

Screening of reported drought tolerant genotypes at Anantapur

A set of 27 reported drought tolerant genotypes were

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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 pod yield per plant, haulm yield per plant and harvest index. Cultivars Spanish improved, AK 265, ICGS 1, K134 and Anantha recorded high yield compared to other cultivars.

Preliminary Spanish Initial yield evaluation trial

A set of 20 Spanish genotypes were evaluated along with 2 check varieties (Kadiri 6 and R 2001-2) for their yield performance under drought conditions of Anantapur. Genotypes NRCGCS 133 had high pod yield when compared to superior check R2001-2.

Multiplication of genotypes for Advanced yield evaluation

A set of 19 genotypes consisting both Spanish and Virginia groups identified for Advanced yield evaluation were multiplied.

Establishing Drought Nursery

More than 700 genotypes consisting of advanced breeding lines, interspecific derivatives and germplasm accessions were evaluated under drought conditions of Anantapur from 2016 to 2018 and constituted a pool of 56 genotypes on the

basis of relative water content (RWC), Harvest index and pod yield. These genotypes were multiplied for their maintenance. Pod yield was recorded for these genotypes and genotypes NRCGCS 284, 158, 379, 408, PBS 21116, 24126 and 25104 had very high yield potential.

Project 02: Breeding for *Alternaria* Leaf Blight Resistance in Groundnut

PI: Narendra Kumar

Co-PIs: A. L. Rathnakumar*,
Praveen Kona, R. Dutta and
Chandramohan Sangh)

*Associated till 21st November 2019

1. Hybridization

Eight crosses were effected in *kharif* 2019 to develop improved groundnut varieties resistant of *Alternaria* leaf blight. The number of harvested crossed pods varied from 103 (TPG 41 × CS-298) to 260 (GJG 34 × NRCGCS-298). The mean success rate (%) of the hybridization programme was 35.6, which ranged from 21.4 to 61.2%. In addition to that four crosses for resistance to *Alternaria* leaf blight and four crosses for resistance to stem rot were made by PI of this project, in which average success rate of hybridization was 38.1% and 46.6% respectively.

2. Identification of hybrids

Ten different crosses were raised in summer 2019 to identify F₁'s effected for developing resistant genotypes to *Alternaria* leaf blight. A total 113 single plants have been identified as hybrids in ten crosses, which ranged from 4-20. A maximum number of F₁'s have been identified in the cross TG 37A × NRCGCS 298 (20) followed by TG 37A × PBS 22131 (15).

3. Advancement of different filial generations

Progenies of 25 crosses (F₂:10, F₃:6, F₅:4, F₆:5) of *Alternaria* leaf blight resistance were advanced to next filial generation in summer 2019. Among them 20 crosses in early generations (up to F₄) and 05 in advanced generation. Individual plant progenies of five cross were raised in F₆ generation. Among them seven new advanced high yielding stable breeding lines of Virginia bunch (1) and Spanish bunch (6) identified during summer 2019.

The breeding materials generated earlier were advanced to next filial generation. Progenies of 90 crosses were advanced in *kharif* 2019 to different filial generations (F₂-F₆), among them 69 crosses in early generations (up to F₄) and 21

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Generation advancement of segregating material during summer 2019 (Left) and kharif 2019



Practising selection in segregating generation during Summer 2019 (Left) and *Kharif* 2019 (Right)

in advanced generation. Eight cross were rejected at the time of harvesting due to large proportion of poor recombinants and absence of desirable trait in the recombinants. In F_6 generation, individual plant progenies of 16 crosses were raised to identify high yielding stable genotypes, among these six crosses were rejected and thirteen new advanced high yielding stable breeding lines (SB-7, VB-6) were identified

from the remaining ten crosses and given nomenclature according to the objective and their botanical group.

4. Yield evaluation of advanced breeding lines

Preliminary trial:

A total fifteen Spanish bunch genotypes with six checks (TAG 24, TG-37A, Dh 86 and TPG 41, GJG31, GJG34) were evaluated in RBD with three replications for yield and its component traits during

summer 2019. The results revealed that none of the genotypes found significantly superior over best check variety TG37A for pod (2011 kg/ha) and kernel yield (1207 kg/ha). These genotypes need to be tested one more year for final conclusion.

Advanced trial:

A total five Spanish bunch advanced breeding lines with four checks (TAG 24, TG-37A, Dh 86 and TPG 41) were evaluated in RBD with three

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replications for yield and its component traits during summer 2018 and summer 2019. The results revealed that an advanced breeding line PBS-12218 (pod yield: 2857kg/ha; kernel yield: 2039kg/ha; SOT:72%) was found at par with best check variety TG-37A for pod yield (2444kg/ha) but it was significantly superior over best check variety TG 37A for kernel yield (1500kg/ha) and Dh-86 for SOT (66%) while an advanced breeding line, PBS-12217 (pod yield: 2921kg/ha, kernel yield: 1798kg/ha) was found at par with the best check

12217 and PBS-12218) had 20% and 36% higher kernel yield over the best check variety hence could be proposed for *rabi*-summer testing under AICRP-G trials for yield.

B. Kharif

Spanish bunch (First year):

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

breeding lines need to be tested one more year for final conclusion for testing under AICRP-G trials.

Spanish bunch (Second year):

A total eleven Spanish bunch genotypes including four high yielding checks varieties viz., GG 7, TG-37A, JL-501 and GG 9 were evaluated in five rows of 5m row length for yield and its component traits in a RBD with three replications during *kharif*-2018 and *kharif*-2019. The results revealed that advanced breeding line PBS 12226 (19) was found significantly



Yield evaluation trials in summer 2019 (left) and *Kharif*-2019 (right)

variety TG-37A for pod and kernel yield. An advanced breeding line PBS12219 (21) was significantly superior over the best check variety TG37A for number of pods/plant (18). Based on two year testing in station trials these two advanced breeding lines (PBS-

kharif 2019. The results revealed that one advanced breeding lines viz., PBS-12228 (pod yield: 3362 and kernel yield: 2223kg/ha) found significantly superior over best check variety TG 37A for pod yield and kernel yield (2625; 1506 kg/ha). This

superior over best check variety TG37A (16) for pods/plant. An advanced breeding line PBS 12223 (2307kg/ha; 1584kg/ha) was found at par with best check variety TG37A for pod yield (2206kg/ha) and kernel yield (1380kg/ha). This breeding

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line was found 15% superior in kernel yield than best check variety. Therefore, it can be proposed for multi-location testing under AICRP-G Spanish bunch trials of *kharif* season.

Virginia bunch (First year):

A total fourteen genotypes of Virginia bunch including with four high yielding recommended checks *viz.* GG-20, KDG-123, KDG-128 and GJG-22 were evaluated in five rows of 5m length for yield and its component traits in RBD with three replications for *kharif* 2019. The results revealed that significant difference was observed among the genotypes and one advanced breeding line PBS 22140 (3756 and 2387kg/ha) was found at par with best check variety KDG-128 for pod and kernel yield (3625, 2359kg/ha) respectively. This breeding lines need to be tested one more year for final

conclusion for testing under AICRP-G trials.

Virginia bunch (Second year):

A total fourteen genotypes of Virginia bunch including with four high yielding recommended checks *viz.* GG-20, KDG-123, KDG-128 and GJG 22 were evaluated in five rows of 5m length for yield and its component traits in RBD with three replications for *kharif* 2018 and *kharif* 2019. The results revealed that none of the genotype significantly surpass the best check variety KDG-123 for number of pods/plant (24) pod and kernel yield (3490, 2343kg/ha) and GJG-22 for shelling outturn (70%).

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

I. Development of new advanced breeding lines

During summer2019, a total

seven new advanced high yielding breeding lines were developed from advanced materials, of which one lines belongs to Virginia bunch (PBS-22161) and six lines belongs to Spanish bunch (PBS-12233, PBS-12234, PBS-12235, PBS-12236, PBS-12237, PBS-12238). During *kharif* 2019, thirteen new advanced breeding lines were developed, of which seven line belongs to Spanish Bunch (PBS-12239, PBS-12240, PBS-12241, PBS-12242, PBS-12243, PBS-12244, PBS-12245) and six lines belongs to Virginia bunch habit group (PBS-22162, PBS-22163, PBS-22164, PBS-22165, PBS-22166, PBS-22167).

II. Multiplication and maintenance of breeding materials

A. Summer-2019:

A total 53 advanced breeding



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lines (new and existing), cultivars were mass multiplied during summer-2019 to get sufficient seed for conducting yield and screening trials.

B. Kharif-2019:

A total 358 advanced breeding lines, cultivars, germplasm lines and new advanced breeding lines were mass multiplied during *kharif*-2019 to get sufficient seed for conducting yield and screening trials.

III. Multiplication and status of AICRP-G lines

During *kharif*-2019, seed of two elite breeding lines (PBS-12200 and PBS-12201) were mass multiplied to get sufficient seed required for AICRP-G trials. An elite breeding line PBS 12200 was tested under IVT-II (SB) of AICRP-G trials in *kharif*-2019 and an elite breeding line PBS

12201 was tested under IVT-I (SB) of AICRP-G trials in *kharif*-2019. Elite breeding line PBS 12200 was also found superior in summer therefore it was proposed for testing under IVT-I (SB) of AICRP-G trials for *rabi*-summer 2019-20.

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

The breeding material of 47 different crosses from four segregating (F_2 , F_3 , F_4 and F_5) was selected in *kharif*-2019 and supplied to need based AICRP-G centres to effect location specific selections for different biotic stresses for *kharif*2020.

6. Screening of advanced breeding lines for foliar disease resistance

A. Summer 2019

A total 179 groundnut mini-

core germplasm were screened in the augmented design for resistant to *Alternaria* leaf blight by infector row technique during two consecutive summer-2018 and summer 2019. Artificial Inoculum of pathogen was sprayed after 30 days and there after 15 days interval of crop growth in the evening (06:00PM) on infector as well as test entries for uniform spread of disease in screening trial. Maximum disease incidence was observed in the germplasm NRCG 14385, NRCG 14408 and Girnar-3 (score 7.0 on 1-9 scale). Results of both years revealed that 60 mini-core germplasm (NRCG 14331, NRCG 14347, NRCG 14354, NRCG 14376, NRCG 14378, NRCG 14390, NRCG 14395, NRCG 14396, NRCG 14400, NRCG 14402, NRCG 14406, NRCG 14412, NRCG 14415,



Screening of genotypes for resistance to *Alternaria* leaf blight in summer 2019 (left) screening genotypes for leaf spot and rust in *kharif* 2019 (right)

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NRCG 14416, NRCG 14427, NRCG 14438, NRCG 14441, NRCG 14443, NRCG 14457, NRCG 14464, NRCG 14483, NRCG 14487, NRCG 14495, NRCG 14325, NRCG 14330, NRCG 14339, NRCG 14341, NRCG 14342, NRCG 14352, NRCG 14355, NRCG 14356, NRCG 14357, NRCG 14358, NRCG 14370, NRCG 14372, NRCG 14373, NRCG 14386, NRCG 14413, NRCG 14417, NRCG 14418, NRCG 14432, NRCG 14459, NRCG 14466, NRCG 14478, NRCG 14324, NRCG 14326, NRCG 14336, NRCG 14348, NRCG 14349, NRCG 14350, NRCG 14361, NRCG 14364, NRCG 14422, NRCG 14440, NRCG 14460, NRCG 14452, NRCG 14498, NRCG 14504, NRCG 14506, NRCG 14505) had a score 3 on 1-9 scale. These genotypes need to be screen at least two more season/year to confirm their resistance stability to *Alternaria* leaf blight across the years.

A total 34 groundnut genotypes including advanced breeding lines, cultivars and interspecific derivatives were screened in the replicated design for resistant to *Alternaria* leaf blight by infector row technique for three consecutive year's summer 2017, 2018 and 2019. Maximum disease incidence was observed in the cultivar GJG-31, GG-2 (score 7.0 on 1-

9 scale) in summer 2019. Based on three year data revealed that three cultivars viz., Kaidiri 9, Kadiri Haritendra, ICGV 00348; four advanced breeding lines viz., PBS 12190, PBS 22131, PBS 22132 and PBS 22133; four interspecific derivatives viz., NRCGCS 176, NRCGCS 180, NRCGCS 196 and NRCGCS 298 recorded a disease score 3 on 1-9 scale. These genotypes need to be screen at least one more season/year to confirm their resistance stability for *Alternaria* leaf blight across the years.

B. Kharif 2019

A total 25 genotypes along with resistant check viz., KDG-123 and KDG-128 (high yielding leaf spot and rust resistant variety) were screened in replicated trial under natural condition for resistance of foliar diseases (late spot and rust) during *kharif*, 2018 & *kharif* 2019. The maximum disease pressure for late leaf spot (LLS) and rust was 8.3, 9.0 and 3.7, 7.0 both years respectively on modified 1- 9 point scale. Rust incidence was low in *kharif* 18 while enough in *kharif* 19 therefore high disease incidence data were used to identify genotype. Results showed one advanced breeding lines PBS-12220 had a score 3.0 and 2.0

of LLS and rust score respectively. Genotypes viz., KDG 123 and KDG 128 both showed a LLS score 3 and score 2.0 of rust respectively. A total 12 advanced breeding were also screened in replicated trial under natural condition for resistance of foliar diseases (late spot and rust) during *kharif* 2019. Advanced breeding lines PBS 12228, PBS 12229, PBS 22140, PBS 22144 had LLS and rust score 3 on 1-9 scale.

7. Screening of genotypes for resistance of collar rot

A total 26 genotypes along with two tolerant genotypes OG-52-1 and J-11 were screened in replicated trial for resistance to collar rot at DGR-RRS, Bikaner during *kharif* 2018 and *kharif* 2019. Data were recorded on plant mortality up to 30 DAS. The maximum collar rot incidence was 46% and 38% during studied period *kharif* 2018 and 2019 respectively. Results revealed that four advanced breeding lines viz., PBS-18038, PBS-18064, PBS-22089 and PBS-22092 recorded lower disease incidence than in resistance genotype OG-52-1 and J-11. Advanced breeding line PBS-22092 also recorded less than collar rot incidence as compared to resistant genotype during 2015 (8.5%), 2016 (6.6%), 2017 (10.0%),

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2018 (14.4%) and 2019 (11%). This breeding line could be registered as a novel genetic stock for resistance to collar rot in groundnut.

8. Screening of breeding lines for tolerance of iron chlorosis

A total 78 genotypes

genotypes that breeding lines (PBS 22133, PBS 22040) had a maximum score 2 on 1-5 scale while susceptible genotype GG 6 had a maximum score 5. Hence, breeding line PBS 22040 could be used as novel source of iron tolerance in groundnut.



including advanced breeding lines, interspecific derivatives and cultivars were screened for tolerance of iron chlorosis for summer-2017. The genotypes viz., Narayani, R-2001-2, NRCGCS-124, NRCGCS-574 had 4 visual chlorotic rating (VCR) score while an advanced breeding line PBS-22040 recorded a score 1.0 on 1-5 scale. During summer 2019, a total 36 genotypes screened for iron chlorosis. Results revealed

Project 03: Breeding for Fresh seed dormancy and reducing Maturity duration in groundnut

PI: Gangadhara, K.

Co-PIs: Rathnakumar, A.L**, Ajay B. C., Chandramohan, S., Sushmita and Praveen Kona* (** transferred to IIOR, Hyderabad on 21st November 2019; *Associated from 9th May 2018)

Hybridization and generation advancement

Nine crosses were affected for short duration and fresh seed

dormancy during *kharif* 2019. A total of 1669 pods were harvested from nine crosses. The success rate was highest in cross (KDG 128×VG 13110) ×TAG 24 (64.7 %) followed by TG 37A× Dh 256 (60%), GJG 31×Girnar 3 (50%), (KDG 128×VG 13110)×GG 7(43%),(KDG 123×VRI 3)×Dh 256(37%), KDG 123×Chico (28%), Dh 256×Chico (22%). The lowest success rate was in PBS 11154 ×VRI 3 (18%) and DH 256 × TG 26 (19%) crosses.

F₁s from eight crosses generated during *kharif*-2018, were raised along with their parents during summer-2019 and total of 251 hybrid plants were identified from eight crosses (KDG 128 × VG 13110, KDG 128 × VG 13113, KDG 128 × VRI 3, GJG 31 × VRI 3, GG 20 × DH 86, GG 2 × NRCG 368, TG 37 A × NRCG 14338 and SG 99 × ICGV 06099) and harvested individually for further generation advancement. A total of 30 crosses consists of 16 F₂, 2F₃ and 12F₄ generations were advanced to later generation during *kharif* 2019.

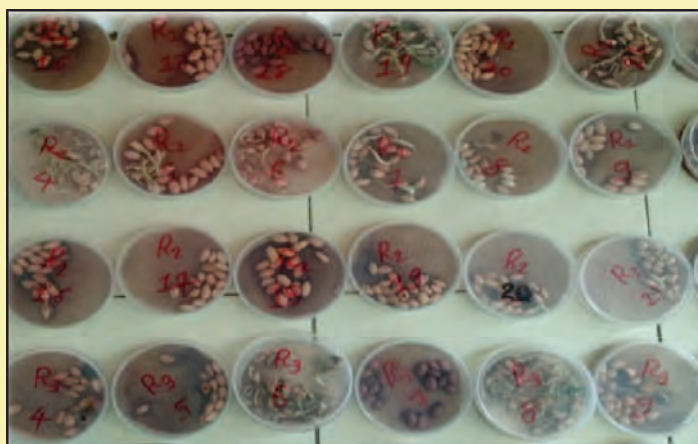
Evaluation of Germplasm collections for productive traits

Forty eight germplasm collections were evaluated for pod yield and its attributes

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Field view of segregating generations during kharif 2019



Screening of advanced breeding lines fresh seed dormancy and seedling characteristics

during summer 2018 and 2019. Genotypes NRCG 14507, NRCG CS 254, NRCG CS 313 and Girnar 1 showed early flowering initiation (35 DAS). The surrogate trait of water use efficiency, SLA was lowest ($150 <$) in genotypes viz., NRCG 17284, SG 99, Gangapuri, ICGS 9114 and VRI 3. Genotypes viz., JGN3, NRCG CS 62, TMV9, ICGS 76, NRCG 8763 showed higher shelling per centage ($>70\%$). Genotypes NRCG 10620 and TG 39 exhibited higher pod yield over two years.

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

Three consecutive years evaluation of 97 germplasm collections of different habit groups from 2017 to 2019 identified promising germplasm accessions for productive and maturity duration are are Virginia bunch (NRCG 14477, TG 39, ICGS 76, GG 20, TGLPS 3, NRCG 14463, Kadir 3, LGN 2, Girnar 2), Virginia runner (Sun oleic 95 R, GJG 17, M 13, Kaushal, Somnath,

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NRCG 14475, GG 12), Spanish bunch (Girnar 3, TG 37 A, Girnar 1, TLG 45, JL 501, TAG 24, DH 86, TG 38, SG 99, GG 7, NRCG 10620, TG 26, VRI 2, GG 2, Kadiri 6, GJG 09, Kadiri 9) and Valencia (NRCG 6780, NRCG 17277, NRCG 14507, Gangapuri, NRCG 14345, NRCG 14379, NRCG 14435).

Screening of inter-specific derivatives for foliar disease and maturity duration

Twelve interspecific derivatives evaluated for yield contributing traits in RBD design with three replications during *kharif* 2017, 2018 and 2019. NRCG CS 446 and 254 were matured at par with TAG 24.

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

About 31 Spanish bunch advanced breeding lines along with 4 checks were screened for days to maturity three years (*kharif* 2017, 2018 and 2019). High yielding advanced breeding lines PBS 14068, PBS 14066, PBS 30037, PBS 16033, PBS 14080, PBS 15050, PBS 30002, PBS 14060 and PBS 30016 were matured in 100

days. Three breeding lines (PBS 15019, 15020 and PBS 30027) had low SLA.

Evaluation of Virginia bunch advanced breeding lines for kernel maturity and kernel characteristics (VBEMT)

About 31 *Virginia* bunch advanced breeding lines along with 4 checks were evaluated maturity duration and large seeded traits for three years (*Kharif* 2017, 2018 and 2019). Two advanced breeding lines PBS 25049 and PBS 24093 had at par pod yield per plant compared to check (KDG 128 and GG 20). Shelling per cent (>70%) was higher in advanced breeding lines PBS 24092, 24128, 24149, 25088 and 26020. Three advanced breeding lines (PBS 25083, 25085, 25092) exhibited higher kernel length to width ratio than somnath (2mm).

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

Screening of germplasm collections and advanced breeding lines for late leaf spot and early leaf spot during *kharif* 2017 and *kharif* 2019 respectively. Genotypes PBS 11085 and NRCG 1439

showed tolerance to LLS incidence.

Screening of advanced breeding lines for fresh seed dormancy

Screening of 62 Spanish breeding lines for fresh seed dormancy during *kharif* 2018 and *kharif* 2019, advanced breeding lines PBS14060, 14068, 16044, 11077, 11092, 15027, 15028, 16023 and 16038 exhibited 15 days fresh seed dormancy.

Maintenance of Advanced breeding lines

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

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

Advanced breeding lines PBS 15044 (IVT-II) was multiplied for seed supply for AICRP-G trials.

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Project No 04: Enhancement and Management of Groundnut Genetic Resources

PI: AL Rathnakumar*

Co-PIs: Gangadhara K, S.K. Bera, Ajay BC, Harish G, Kirti Rani.

(*transferred to IIOR, Hyderabad on 21th November 2019)

Field maintenance of Wild *Arachis* germplasm

A total of 106 accessions under 6 sections viz *Arachis* (54),

Caulorhizae(1), *Erectoides* (7), *Heteranthae* (7), *Procumbentes* (6) and *Rhizomatosae* (40) were maintained in the field gene bank. Seeds from annual species of section *Arachis* were harvested and conserved. Four amphidiploid derivatives have also been maintained for further use in crop improvement programme. Three hundred and sixty one wild *Arachis* accession in

eight sections of *Arachis* have been shortlisted from among global collection for acquiring from NBPGR.

Acquisition and distribution of germplasm

During 2019, a comprehensive list comprising 1499 accessions of cultivated types and 361 accessions of wild types have been prepared which were not available in the working collection for acquiring. The indent has been



Field view of multiplication of groundnut germplasm

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submitted to NBPGR and 880 accessions of cultivated types and 12 wild accessions will be acquired from NBPGR and will be multiplied in *kharif* 2020.

Large scale multiplication and conservation of germplasm accessions

A total of 161 accessions (South American collection) were multiplied in summer 2019. Twelve thermo tolerant (low and high temperature) promising varieties (DH 86, GJG 9, LGN 1, ICGV 00350, JL 220, JGN 3, TAG 24, K I S A N , O G 5 2 - 1 , KOPERGAON-3, ALR 3) identified after two years of field evaluation and three accessions viz. NRCGS 14324, 14367, and 14480 and one susceptible variety GPBD 4 were multiplied for further large scale evaluation and identification of traits associate with thermo tolerance. From a total of 17394 accessions on the basis of the identity of the accessions, country of origin, I C G numbers and corresponding NRCG numbers and on other physical features of kernels, 7959 accessions have been short listed as the core inventory accessions.

In *kharif*, 2019, all the 7769 accessions which comprised 3161 accessions in Spanish Bunch; 1246 accessions in Valencia group; 1420

accessions in Virginia Bunch; 1448 accessions in Virginia Runner; and 494 other accessions; 81 accessions originated from Argentina; 80 accessions of Bolivia and 79 exotic accessions were multiplied. Altogether 8009 accessions were multiplied and rejuvenated to sufficient quantity, harvested, dried and cleaned for further shelling and conservation. A comprehensive list comprising 1499 accessions have been prepared which were not available for acquiring and the indent has been submitted to NBPGR and 880 accessions will be acquired from NBPGR which will be multiplied in *kharif* 2020.

DUS Characterization

One Variety of Common Knowledge (2884/2090), and one Farmer's variety (2883 /2602) were characterized for 18 descriptor traits (13 qualitative and 5 quantitative traits) as per DUS guidelines at appropriate growth stages during *kharif* 2019 along with eight reference varieties.

Project 5: Development of pre-breeding lines resistant to biotic stresses and tolerance of abiotic stresses using inter specific hybridization and mutation breeding in groundnut

PI: SK Bera

Co-PIs: PP Thirumalaisamy and Narendra Kumar, Kirti Rani.

Hybridization:

Hybridization was done under field conditions during *kharif* season. A total of four crosses, J11×*A. Glabrata* (NRCG 11832), J11×*A. glabrata*, NRCGCS 592×NRCGCS 631 and TG37A×NRCGCS 134 were attempted. More than 200 flowers in each cross were pollinated and 22-61 putative hybrid pods were harvested. Kernels of these crosses will be sown in next crop season for identification of true F_1 s.

Advancement of breeding lines

Putative cross pods from three crosses, J11×*A. glabrata* (NRCG 11832), J11× Synthetic tetraploid and J11× Synthetic tetraploid were sown in *kharif* season. No true F_1 could be identified in cross J11×*A. glabrata* while 6-7 true F_1 s each were identified in rest two crosses. True F_1 plants were harvested from these two crosses at maturity and will be advanced further. Besides, 18 selections in F_{5-6} generation were made from five different crosses based on yield and foliar disease resistance.

Screening of RILs for resistance to stem rot

Screening of RILs for resistance to stem rot was done in screening block under artificially inoculated filed conditions during *Rabi* season. Screening of 262 RILs

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of a cross GG 20 X CS 19 along with parents was done in RBD with three replications. Each RIL was sown in single line on 1.5 meter bed. Mean mortality per cent of RILs ranged from 58% to 100%. RIL No.(GG 20 x CS 19)-12-6 was found with less than 60 per cent plant mortality and experiment will be repeated for confirmation.

Yield evaluation of breeding lines resistant to stem rot

Yield evaluation of selected 72 lines, moderately resistant to stem rot disease were repeated during rainy season. Genotypes were planted in augmented design with four blocks. Each genotype was sown in 3 lines of five meter bed. Out of 72 breeding lines (GG 20 × CS 19)-13-8 and (GG 20 × CS 19)-8-8 recorded significantly higher pod yield than checks based on pooled analysis over 2018 and 2019 seasons.

Screening of Interspecific breeding lines

Screening of Interspecific breeding lines was done in large cement pots under artificially inoculated conditions during *Rabi* season. A total of 50 kernels of each line were sown in cement pots. All the lines screened were found susceptible with 100% mortality except NRCGCS-134. NRCGCS-134

was found moderately resistant with less than 30% mortality and will be confirmed further.

Screening of RILs for resistance to Peanut Bud Necrosis Disease

Phenotyping of two RIL populations was done for resistance to PBNB at UAS, Raichur during Rabi season. RIL populations containing 108 and 206 RILs were developed from crosses JL 24 × NRCGCS85 and JL 24 × NRCGCS86, respectively. Scoring of disease incidence was recorded at 60 DAS, 90 DAS and at harvest. Disease scoring ranged from 0.0 to 25.3% in JL × NRCGCS 86 RILs, while it ranged from 0.0 to 21.5% in RILs of JL 24 × NRCGCS 85.

Screening of Interspecific breeding lines for resistance to PBNB

Interspecific breeding lines, 435 in number were screening for resistance to PBNB at UAS, Raichur over five seasons and 34 breeding lines were found resistance to PBNB. Out of which selected 14 lines were screened for resistance to PBNV under artificially inoculated conditions at ICRISAT. All the 14 lines were found susceptible to PBNV under artificially inoculated conditions. Selected 14 breeding lines though found resistant to PBNB over five seasons under

natural field conditions were susceptible to PBNV. Thus, resistance to PBNB in these 14 selected breeding lines could be due to resistance to Thrips or non-preference to Thrips or poor or delayed incubation of PBNV on leaf tissue.

Project No 6: Marker Assisted Breeding for Fungal Disease Resistance and High Oil Quality in Groundnut

PI: Sangh Chandramohan,

Co-PIs: S. K. Bera and Narendra Kumar

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

● Generation advancement of development RIL population

The F_9 lines (1025 lines) of the cross GJG 17 x GPBD 4 were sown in the field in Kharif 2019 and subsequently taken for generation advancement by single seed descent method (SSD). Similarly, the F_8 lines (507 lines) of the cross GJG 22 x ICGV 86590 were sown in the field in Kharif 2019 and subsequently taken for generation advancement by single seed descent method (SSD). These lines will be used as RIL mapping population for LLs and rust and also for other morphologically important traits. Similarly F_4 lines (360

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Table: List of germplasm used for identification of novel alleles from germplasm

	Germplasm	Primer used for screening									
		RS-5	Rs47	Rs42	RS-50	RS-51	FRS56	FRS49	SSR Go340445	Rs78	Rs103
1	Cs19	S	S	S	S	S	S	S	S	S	S
2	Cs323	R	R	R	R	R	R	R	R	R	R
3	Cs26	S	S	S	S	S	S	S	S	S	S
4	Cs377	S	S	S	S	S	S	S	S	S	S
5	Cs116	S	S	S	S	S	S	S	S	S	S
6	Cs364	S	S	S	S	S	S	S	S	S	S
7	Cs434	S	S	S	S	S	S	S	S	S	S
8	Cs42	S	S	S	S	S	S	S	S	S	S
9	Cs168	S	S	S	S	S	S	S	S	S	S
10	Cs402	S	S	S	S	S	S	S	S	S	S
11	Cs303	S	S	S	S	S	S	S	S	S	S
12	Cs428	S	S	S	S	S	S	S	S	S	S
13	Cs405	S	S	S	S	S	S	S	S	S	S
14	Cs409	S	S	S	S	S	S	S	S	S	S
15	Cs285	S	S	S	S	S	S	S	S	S	S
16	Cs407	S	S	S	S	S	S	S	S	S	S
17	Cs334	S	S	S	S	S	S	S	S	S	S
18	Cs296	S	S	S	S	S	S	S	S	S	S
19	Cs160	S	S	S	S	S	S	S	S	S	S
20	NRCG11581	S	S	S	S	S	S	S	S	S	S
21	NRCG 6707	S	S	S	S	S	S	S	S	S	S
22	NRCG 13052	S	S	S	S	S	S	S	S	S	S
23	NRCG 288	S	S	S	S	S	S	S	S	S	S
24	NRCG 13027	S	r	s	s	s	s	s	s	s	s
25	NRCG 13171	S	S	S	S	S	S	S	S	S	S
26	NRCG 10446	S	S	S	S	S	S	S	S	S	S
27	NRCG 6517	S	S	S	S	S	S	S	S	S	S
28	NRCG 12236	S	S	S	S	S	S	S	S	S	S

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29	NRCG 6678	S	S	S	S	S	S	S	S	S	S
30	NRCG 13105	S	S	S	S	S	S	S	S	S	S
31	NRCG 12205	S	S	S	S	S	S	S	S	S	S
32	NRCG 841	S	S	S	S	S	S	S	S	S	S
33	NRCG 9130	S	S	S	S	S	S	S	S	S	S
34	NRCG 9747	S	S	S	S	S	S	S	S	S	S
35	NRCG 4998	S	S	S	S	S	S	R	S	S	S
36	NRCG 6519	S	S	S	S	S	S	S	S	S	S
37	NRCG 1177	S	S	S	S	S	S	S	S	S	S
38	NRCG 4849	S	S	S	S	S	S	S	S	S	S
39	NRCG 13079	S	S	S	S	S	S	S	S	S	S
40	NRCG 4734	S	S	S	S	S	S	S	S	S	S
41	NRCG 1179	S	S	S	S	S	S	S	S	S	S
42	NRCG 4857	S	S	S	S	S	S	S	S	S	S
43	NRCG 4738	S	S	S	S	S	S	S	S	S	S
44	NRCG 13149	S	S	S	S	S	S	S	S	S	S
45	NRCG 12053	S	S	S	S	S	S	S	S	S	S
46	NRCG 11586	S	S	S	S	S	S	S	S	S	S
47	NRCG 11869	S	S	S	S	S	S	S	S	S	S
48	NRCG 11879	S	S	S	S	S	S	S	S	S	S
49	NRCG 13119	S	S	S	S	S	S	S	S	S	S
50	NRCG 6524	S	S	S	S	S	S	S	S	S	S
51	NRCG 11580	S	S	S	S	S	S	S	S	S	S
52	NRCG 666	S	R	S	S	S	S	S	S	S	S
53	NRCG 6529	S	S	S	S	S	S	S	S	S	S
54	Ak265	S	S	S	S	S	S	S	S	S	S
55	ALR1	R	R	R	R	R	R	R	R	R	R
56	ALR2	S	S	S	S	S	S	S	S	S	S
57	ALR3	S	S	S	S	S	S	S	S	S	S
58	DH-4-3	R	R	R	R	R	R	R	R	R	R
59	FDRS10	S	S	S	S	S	S	S	S	S	S
60	FDRS4	S	S	S	S	S	S	S	S	S	S

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61	FDRS79	S	S	S	S	S	S	S	S	S	S
62	GPBD4	R	R	R	R	R	R	R	R	R	R
63	ICGV00350	R	S	S	S	S	S	S	S	S	S
64	ICGV86590	S	S	S	S	S	S	R	S	S	S
65	JL-776	R	R	R	R	R	R	R	R	R	R
66	JL-24	S	S	S	S	S	S	S	S	S	S
67	Js88	R	R	R	S	R	R	R	R	R	R
68	KDG123	R	R	R	S	R	R	R	R	R	R
69	KDG128	R	R	R	R	R	R	R	R	R	R
70	R 2001-2	S	S	S	S	S	S	S	S	S	S
71	R 2001-3	S	S	S	S	S	S	S	S	S	S
72	R8808	S	S	S	S	S	S	S	S	S	S
73	RHRG06083	R	R	R	R	R	R	R	R	R	R
74	Rs138	S	S	S	S	S	S	S	S	S	S
75	Sg99	S	S	S	S	S	S	S	S	S	S
76	TAG24	S	S	S	S	S	S	S	S	S	S
77	TG26	S	S	S	S	S	S	S	S	S	S
78	TG37A	S	S	S	S	S	S	S	S	S	S
79	VRI5	R	R	R	R	R	R	R	R	R	R
80	VRI (GN) 6	S	S	S	S	S	S	S	S	S	S
81	TMV2	S	S	S	S	S	S	S	S	S	S
82	GJG22	S	S	S	S	S	S	S	S	S	S
83	SunOleic	S	S	S	S	S	S	S	S	S	S

R-Resistant allele S-Susceptible allele

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field in *Kharif* 2019 and subsequently taken for generation advancement by single seed descent method (SSD). The seeds were sown in the field and artificial disease epiphytic conditions were created by “spreader row technique” using susceptible lines (TMV 2).

QTL mapping for foliar fungal disease resistance

Phenotyping data was recorded for both LLS and rust performed at the 2019 of harvesting using modified 9-point scale from the cross GJG 17 x GPBD 4 (F_8 generation) and other important morphological traits for which parents were diverse viz. LLS, Rust, Leaf shape, Leaf tip, Stem color, Stem hairs, Pod constriction, Pod beak, Pod reticulation, Leaf size, Node interval, Stem thickness, Plant height, No. of Primary Branches, No. of Secondary branches, Dry pod weight, Kernel weight, No. of immature pods, No. of single seeded pods, No. of double seeded pods and Shelling percentage.

DNA isolation was carried out during the period. The recombinant inbred lines developed from the cross GPBD 4 x GJG 17, currently in F_8 generation was used for

DNA extraction. The high-quality DNA extraction from 800 recombinant inbred lines was completed during the period.

Genotyping of peanut germplasm using LLS-Rust resistance linked SSR markers

A total of 28 primers from LLS Rust resistance QTL region A03 and B10 were used for genotyping. All primers were used to perform PCR in 83 diverse peanut germplasm. The PCR products were run on PAGE and gels were documented to research for the presence of resistance alleles among 83 germplasm.

Screening of groundnut germplasm for foliar disease resistance:

Screening of groundnut germplasm consisting of released varieties, CS lines and NRCG lines for foliar fungal diseases (LLS and Rust) was conducted during *Kharif* using spreader row technique. The released varieties which were screened for LLS and Rust were, DH-4-3, JL 776, FDRS 79, RS 138, ALR 1, TG 26, RHRG 06083, TAG 24, KDG 128, KDG 123, ICGV 86590, SG 99, ALR 2, R 2001-3, FDRS 10, VRI 5, R 2001-2, JS 88, GPBD4, AK 265, ALR 3, R 8808, VRI Gn

6, ICGV 00350, JL-24, FDRS 4, TG 37A and TMV 2. All these varieties were scored on 9-point scale and ranged from 2 to 5 score and 7 score in TMV2. Selected CS lines were also included in the screening viz. CS 377, CS 116, CS 303, CS 405, CS 296, CS 402, CS 19, CS 434, CS 42, CS 168, CS 285, CS 428, CS 26, CS 160, CS 168, CS 409, CS 407, CS 323, CS 364, and CS 334. The score for LLS ranged from 3 to 6. The NRCG lines were also evaluated for LLS in *Kharif* viz. NRCG 6707, 13171, 13027, 1179, 6517, 12236, 11869, 6678, 13105, 13079, 841, 4998, 9130, 1177, 6529, 4849, 4738, 12205, 9747, 288, 666, 4857, 12053, 11580, 13052, 10043, 6519, 11586, 11879, 13119, 11581, 4734 and 13149. The score for LLS ranged from 3 to 5 on a 9-point modified scale. All the lines will be repeated in *Kharif* 2020.

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

A total of four Advanced backcrossed lines (ABLs_216, ABLs_2, ABLs_44, ABLs_36) as female and one high oleic acid content advance backcrossed line (ABLs_5841) as male were

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selected based on presence of linked markers for foliar disease resistant and high oleic acid content respectively. The hybridizations between four ABLs_216, ABLs_2, ABLs_44, ABLs_36 with ABLs_5841 were generated a total of 61 individual F₁ plants. Of which 41 (~67%) were confirm true hybrid based on CAPs marker. The true intercross F₁ were selfed to generate intercross F₂. A total of 343 F₂ plants from cross between ABLs_216, ABLs_2, ABLs_44, and ABLs_36 X ABLs_5841 were screened with CAPs marker to confirm homozygosity of both mutant alleles of FAD gene. Among 343 plants 40 were confirmed for homozygous double mutant for both alleles of FAD genes. These plants were also confirmed for the QTL regions on B03/A03 and B10/A02 by foreground screening with LLS and rust resistance-linked markers IPAHM103, GM2079, Seq8D09, GM2009, GM2301 and DGR-329. The biochemical and phenotypic evaluation was carried out of marker conformed F₂ introgression lines in kharif. The seeds harvested from each positive plant were subjected to fatty acid profiling by gas

chromatography. A total of 11 lines out of 40 lines were found to have oleic acid ≥ 79 per cent while estimated on Gag chromatography. However, the oleic acid content of the rest of 29 lines was ranged from 68-78 per cent. All these lines were subjected to generation advancement and phenotypic evaluation for the foliar diseases resistance in kharif since these lines also contained QTLs for foliar diseases resistance. These lines showed a significant level of resistance to ELS and LLS (score range 2-3) as compared to the susceptible check (score range 7-8).

Background selection of advance backcrossed introgression lines developed from cross between GJG-17 X GPBD-4 using SSR markers

71 BC3F4 advance backcrossed introgression lines were subjected to genotyping for background analysis. A total of 76 polymorphic SSR markers were identified. These primers are evenly distributed in 20 chromosomes. Out of 76 identified markers, 57 primers were amplified and genotyped in introgression lines. The PCR amplification of rest of the primers is under progress.

Identification of homozygous double mutant for *AhFAD2* gene in F₂ population of cross GJG-22 X Sunoleic95R

A total of 1300 F₂ seeds were sown in pot under glasshouse condition among them 986 were germinated. The genomic DNA of all 986 seedlings was isolated. A PCR was performed using Allele Specific (AS)-PCRs assay (Chen et al., 2010) for *AhFAD2B* gene to detect homozygous mutant F₂ lines. Out of 480 F₂ plants, 172 plants were confirmed homozygous for *AhFAD2B* gene.

Marker assisted selection for foliar disease resistance:

Marker assisted back crossing program for incorporation of LLS and Rust alleles using GPBD 4 as source. 136 plants were obtained from TG 37A x GPBD 4 cross and 194 BC2F₂ plants were obtained from the cross GG 20 x GPBD 4 cross.

Sub project of project - 6:

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

PI: SK Bera

Co-PIs: K. Gangadhara and S Chandramohan

Hybridization

Hybridization was taken up

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under field conditions during *kharif* season. A total of 10 crosses viz, KDG 128 × Girnar 4, K 6 × Girnar 4, DH 257 × ICGV 15080, CS-25-7-39 × Girnar 4, Girnar 2 × Girnar 4, JL 501 × ICGV 15080, SG 99 × Girnar 4, TG 51 × ICGV 15080, TG37A × BC₁F₂ (TG37A × Sunoleic 95R) and GG 20 × BC₁F₂ (GG 20 × Sunoleic95R) were attempted to introgress high oleic trait into 10 elite groundnut cultivars. Putative cross pods ranging from 11 to 119 were harvested in different crosses at maturity of the crop. Kernels from putative cross pods ranged from 18-195 in different crosses and will be planted in next crop season for further use.

Genotyping of F₁ plants for *ahfad2* alleles

Cross pods from eight crosses viz, HOS-30 × HOS-145, NRCG-9000 × HOS-130, (ICG 4747 × TMV2 NLM-1-5) × CS-587, CS-435 × HOS-191, CS-401 × HOS-116, GJG-22 × CS-587, CS-268 × CS-587 and ICGV 15080 × CS-587 were planted during summer season. A total of 1116 F₁ plants were genotyped with AS-PCR markers for *ahfad2* mutant alleles associated with high oleic trait

and a total of 266 positive plants were selected. During *kharif* season, 266 positive single plants progenies were planted and 11500 F₂ single plants from above eight crosses were genotyped with AS-PCR markers for *ahfad2* mutant alleles and 1100 single plants were found positive for both *ahFAD2* alleles. These 1100 single plants were further re-genotyped with CAPS markers and 117 plants were identified as homogygous for *ahFAD2* alleles along with high pod yield. These 117 selected plants were harvested plant wise at maturity.

Advancement of breeding lines with *ahfad2* alleles and selection of high oleic lines

A total of 393 F₃, F₂ and BC₁F₂ progenies developed from four crosses viz, GG 20 × Sun Oleic 95R, TG37A × Sun Oleic 95R, GG 7 × Sun Oleic 95R and TKG 19A × Sun Oleic 95R were advanced to next generation during summer season. Each plant progeny was sown in single line on 2.5 meter bed and harvested in progeny bulk. During *kharif* season 393 F₄, F₃ and BC₁F₃ progenies were further advanced to next generation. Each plant progeny was sown

in 2-4 lines on 2.5 meter bed and harvested in progeny bulk. At harvest 393 lines were phenotyped for oil content and fatty acid profile. A total of 87 breeding lines with 78-80% oleic acid content were selected for further seed increase and yield evaluation. Oil content ranged from 50% to-54% in these 87 selected lines. Similarly, 117 F₂ single plants progeny from eight crosses viz, HOS-30 × HOS-145, NRCG-9000 × HOS-130, (ICG 4747 × TMV2 NLM-1-5) × CS-587, CS-435 × HOS-191, CS-401 × HOS-116, GJG-22 × CS-587, CS-268 × CS-587 and ICGV 15080 × CS-587 were phenotyped for oil content and fatty acid profile. A total of 35 progenies from above eight crosses were identified with 78-80% oleic acid content.

Yield evaluation of high oil lines

Breeding lines with more than 56% oil content were evaluated for yield and related traits during *kharif* season. Four high oil content genotypes along with two check varieties were planted in RBD with three replications. Each genotype was sown in five lines on five meter bed. Two breeding lines, HOS-30 and HOS-89 recorded higher pod yield than checks. Based on

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pooled analysis over 2018 and 2019 HOS-30 and HOS-89 also recorded 25% higher pod yield than check.

Yield evaluation of high yielding lines

Evaluation of high yielding lines were evaluated for yield and related traits during *kharif* season. Forty-five breeding lines along with three check varieties were planted in RBD with three replications. Each genotype was sown in five lines on five meter bed. Based on pooled analysis over 2018 and 2019 six breeding lines, HOS-474, HOS-117, HOS-724, HS-395, HOS-93 and HOS-152 recorded 15% - 28% higher pod yield than check.

Novel germplasm Registered

Two novel high oleic groundnut genotypes, NRCGCS602 and NRCGCS 605 were registered at NBPGR, New Delhi.

High oleic genotypes recommended for AICRP testing

Five high oleic groundnut genotypes with 78-80% oleic acid were recommended for AICRPG testing during *kharif* 2019.

Seed multiplication of high oleic groundnut

High oleic groundnut varieties Girnar 4 and Girnar 5 were multiplied for 8.0 q and 4.0 q,

respectively during *kharif* season. Besides 20-25 kg of pods each of 23 high oleic lines were multiplied during *kharif* season. The high oleic lines will be tested further in AICRPG.

Project No: 17 Breeding for improvement of quality traits in groundnut

PI: Praveen Kona,

Co-PI: MK Mahatma

Hybridization programme

Total ten crosses were effected during *Kharif*, 2019 to improve the quality traits in groundnut related to seed size, oil, and protein content. Total 1911 crossed pods were harvested from ten crosses with a range of 77 (ICGV 15090 x PBS 29194) to 365 (GJG32 x PBS 29213). The mean success rate of the hybridization programme in ten crosses was 35.05 % with a range from 13.05 to 66.36 %. The highest success rate was observed in GJG32 x PBS 29213 (66.36 %) cross and lowest in ICGV 15090 x PBS 29194 (13.05%) cross (Table 1).

Identification Hybrid plants

Total 1399 crossed pods were harvested from eight crosses during *Kharif*, 2018 were sowed in summer, 2019. Total 238 probable F_1 s were identified from

eight crosses based on male parent characters (Table 2).

Generation advancement

Total 238 probable F_1 s from eight crosses were sowed to generate F_2 generation during *kharif* 2019. 1195 single plants in eight crosses in F_2 generation were selected and forwarded to next generation. Eighteen crosses of advanced generations were raised during *kharif*, 2019 and 433 individual plants were selected; 303 (F_5), 114 (F_6) and 16 (F_7) respectively.

New Advanced Breeding Lines

In F_7 generation, six crosses were sown to identify stable advanced breeding lines according to their objectives. In these 16 lines were selected of which 3 (PBS 29248, PBS 29249 and PBS 29250) belong to Virginia group and 14 are Spanish group (PBS 19040, PBS 19041, PBS 19042, PBS 19043, PBS 19044, PBS 19045, PBS 19046, PBS 19047, PBS 19048, PBS 19049, PBS 19050, PBS 19051 and PBS 19052). These individual plants will be multiplied in the next season for making sufficient seeds to conduct their evaluation trial.

TPG 41-mutated with EMS

A total of 32 mutant genotypes along with their parent TPG

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Table 1 Hybridization for improved quality traits

S. No.	Name of Cross	Purpose	Bud pollinated	F ₁ pods	Success (%)
1	KDG 123 x PBS 29213	Large seed size, High protein	812	298	36.69
2	TG37A x PBS 29213	Large seed size, High protein	443	244	55.07
3	ICGV 15090 x PBS 29213	Large seed size, High protein, High oil	564	131	23.22
4	Mallika x PBS 29213	High protein	545	136	24.95
5	ICGV 15090 x PBS 29194	Large seed size, High protein, High oil	590	77	13.05
6	TG37A x PBS 29194	Large seed size, High protein	478	192	40.16
7	Mallika x PBS 29194	High protein	465	106	22.79
8	GJG 33 x PBS 29194	Large seed size, High protein	696	209	30
9	GJG 32 x PBS 29213	Large seed size, High protein	550	365	66.36
10	GJG 32 x PBS 29194	Large seed size, High protein	400	153	38.25

Table 2 Identified individual hybrid plants in F₁ generation during summer 2019.

S. No.	CROSS	Characters	No. F ₁ pods	No. of F ₁ seeds	Probable F ₁ s
1	GG20 × PBS 29148	Large seed, High protein, low oil	101	145	19
2	KDG 123 × Mallika	Large seed, High protein, low oil	163	249	17
3	TG 37 A × Mallika	Large seed, High protein,	353	475	42
4	Mallika × PBS 29146	Large seed, High protein,	134	198	37
5	KDG 128 × PBS 29146	High protein, Low oil	201	300	32
6	ICGV 15090 × PBS 29148	High oil, High protein	149	235	33
7	ICGV 15090 × PBS 29146	High oil, High protein	200	315	23
8	PBS 29146 × PBS 29148	High protein	98	133	35

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41 as control were evaluated for various yield related traits in M_6 generation during *Kharif*, 2019. The population was generated by EMS mutagen treatment with 0.2% to 0.6% range of concentrations. Shelling percentage, PW/plant, HKW and number of pods per plant showed significant variation in all lines when compared to control. These 32 genotypes are forwarded to next generation.

Evaluation of advanced breeding lines for quality and yield traits

Total 84 advanced breeding lines of large seed project including both Spanish and Virginia bunch were evaluated for the yield and quality traits using four checks under augmented design during summer, 2019. All the traits *viz.*, HKW, HPW, SP, KL, KW, pod yield per plant showed significant variation when compared to checks. Genotype, PBS 29189 was recorded highest SP as 66.26 % followed by PBS 29232 (66.08 %) and PBS 29233 (65.86 %). Three genotypes *viz.*, PBS 29180, PBS 29067, PBS 29148 and PBS29079B recorded 80.15g, 76.36 g, 72.69 g and 71.27 g

hundred kernel weight, respectively and found superior over checks (57.25 g). The kernel length was varied from 1.24 cm (PBS 29230) – 1.92 cm (PBS 19014) whereas kernel width was in a range of 0.77 cm (PBS 29214) – 1.12 cm (PBS 29149). Total 40 genotypes recorded >30 % of protein of which PBS 29069 genotype recorded highest protein content (33.82 %). The oil content varied from 42.5 (PBS 29069) - 50.7 (PBS 29233).

Total 150 advanced breeding lines of large seed project including both Spanish and Virginia bunch were evaluated for the yield and quality traits using four checks under augmented design during *Kharif*, 2019. All the traits *viz.*, HKW, HPW, SP, KL, KW, pod yield per plant showed significant variation when compared to checks. Genotype, PBS 29171 was recorded highest SP as 72.8 % followed by PBS 29162 (70.63 %) and PBS 29169 (70.34 %). PBS29079B recorded highest hundred kernel weight (73.2 g) and found superior over checks (49.4 g). The kernel length was varied from 1.28 cm (PBS 29162) – 1.93 cm (PBS29079B)

whereas kernel width was in a range of 0.54 cm (PBS 29162) – 0.88 cm (PBS29079B, PBS 29147 and PBS 29148). The oil content varied from 40.07 % (PBS 29146) - 51.82 % (PBS 29202) and protein content was in range from 27.4 % (PBS 29202) to 34.99 % (PBS 29146). In pooled data analysis of *Kharif*, 2018 and *Kharif*, 2019 the genotype PBS29079B recorded highest 100KW (>72 g) and found superior over checks.

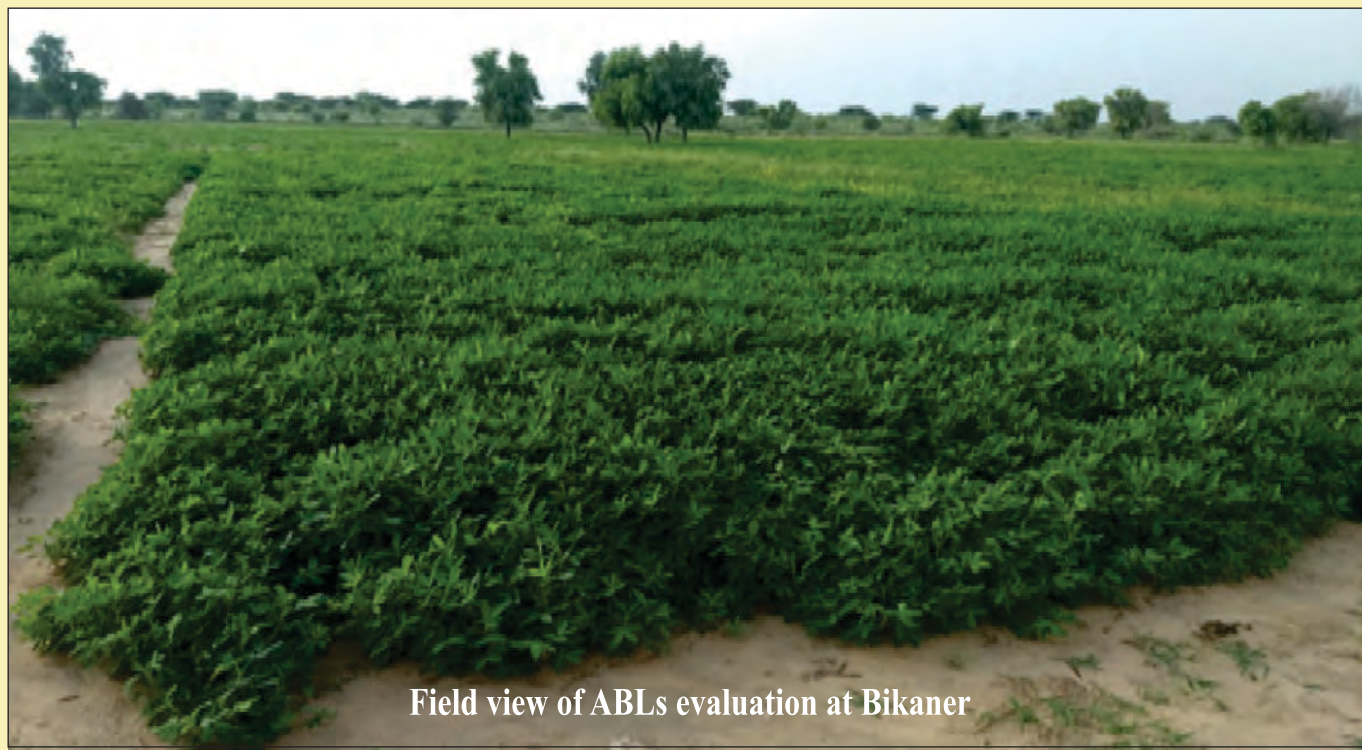
Multi-location evaluation of advanced breeding lines of groundnut

Forty advanced breeding lines with three check varieties were evaluated in randomized block design with three replications during *Kharif*, 2019 at two locations; ARC, Bikaner and ICAR-DGR, Junagadh. Significant genotypic and environment interaction was observed for hundred kernel weight (HKW), kernel length (KL), KG, shelling percentage (SP), number of pods/plant (NP/P), pod weight per plant (PW/P), oil and protein percent in two locations (Table 3). In both locations PBS 29079B recorded highest 100 KW (70 g at Junagadh and 121.97 g at Bikaner).

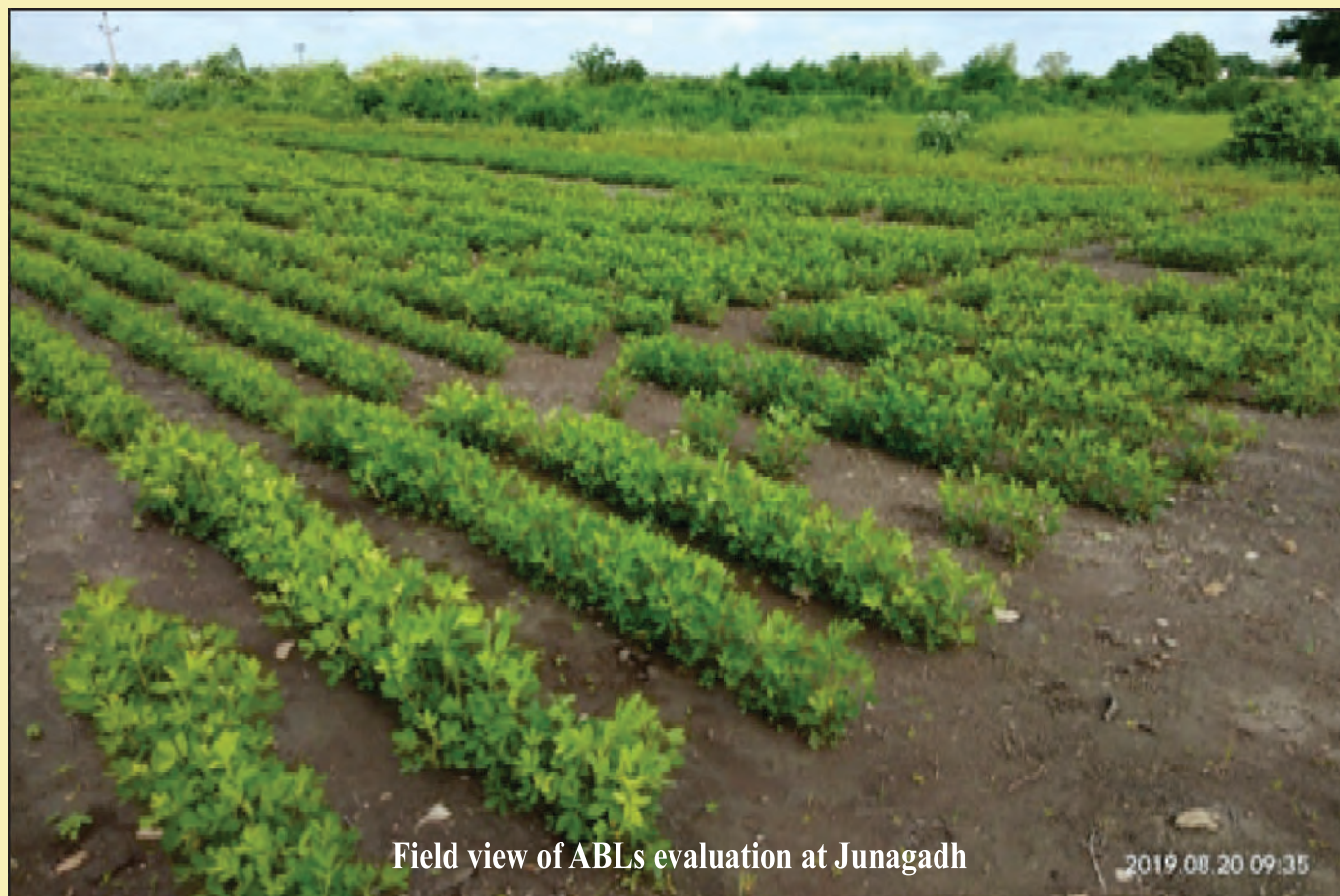
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Table 3 Multi-location evaluation of advanced breeding lines for quality traits

S. No.	Trait	Junagadh	Bikaner
1	HKW (g)	25.14 (PBS19013) - 70 (PBS29079B)	62.2 (PBS 29232) -121.9 (PBS29079B)
2	SP (%)	45.3 (PBS 29143)- 79.8 (PBS29079B)	47.4 (PBS 29082) – 73.2 (PBS29211)
3	KL(cm)	1.3 (PBS 29232, PBS 29233) - 1.7 (PBS 29079B, PBS 29189)	1.55 (PBS 29232) - 2.26 (PBS29079B)
4	KG (cm)	0.6 (PBS 19013) -0.77 (PBS 29143)	0.85 (PBS 29232) -1.09 (PBS 29143)
5	NP/P	7 (PBS 29212) – 17.5 (PBS 29230)	10 (PBS 29193) – 21 (PBS 29079B)
6	PW/P (g)	4.7 (PBS 29204) - 14.2 (PBS 29137)	14.02(PBS 19015)-43.06 (PBS 29079B)
7	Oil (%)	42 (PBS 29069) - 50.7 (PBS 29233)	44.8 (PBS 29082) – 53.04 (PBS 29187)
8	Protein (%)	27.48 (PBS 29233)- 33.98 (PBS 29069)	26.21 (PBS 29233)- 34.04 (PBS 29082)



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Evaluation of protein and oil accumulation at different stages of growth in high protein, high oil and dual purpose (for protein and oil) groundnut genotypes.

Three high oil (>50%) genotypes viz., ICGV 15090, PBS 19012, PBS 19023, three dual purpose (45-48% oil and 28-30% protein) genotypes viz., PBS 19014, PBS 19015, PBS 19024 and three high protein genotypes (>32%) viz., PBS 29081, PBS 29082, PBS 29146 were evaluated

for the oil and protein accumulation at 30 DAF, 40 DAF, 50 DAF and 60 DAF in three replications in random block design in summer and *Kharif*, 2019. There is a significant variation in accumulation of protein and oil in all the genotypes. In high oil genotypes, the protein accumulation was gradually increased in slower rate whereas as oil accumulation was drastically increased at each stage. In high protein genotypes, the accumulation

of protein at different stages after flowering in the kernels is high and drastically increased for every stage whereas the oil accumulation was slow and low in accumulation compared to high oil genotypes. In dual purpose genotypes, at all stages the protein and oil accumulation were increased gradually but at 60DAF oil accumulation was more (by 10 %) and protein accumulation was reduced drastically.

02 Groundnut pest and diseases-emerging problems and their management



Project 07: Refinement and Validation of Management Module for Soil Borne Diseases of Groundnut

PI: Ram Dutta

Co-PIs: MK Mahatma, PP Thirumalaisamy, Narendra Kumar and Ananth Kurella

Evaluation of different refined modules for stem rot disease: The experiment was conducted during summer 2019 for management of stem rot and during *kharif* 2019 for both stem rot and collar rot with two different sets of experiments. Altogether, 5 refined modules were evaluated with farmers' practice and absolute control.

- Effect of modules on stem rot and yield (Summer 2019): The maximum (38%) inhibition of stem rot was achieved by Module-M17A i.e. Deep

summer ploughing with mould board plough + seed of variety TG 37A + seed treatment with tebuconazole @ 1.5 g/ kg of seed + soil application of *Trichoderma harzianum* S1 @ 4 kg/ ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS, over farmers' practice followed by Module 15A (27% inhibition). The maximum pod (2289 kg/ha) and fodder (6417 kg/ha) yield was also supported by Module M17A, which was 22 and 19 per cent, respectively, higher than the farmers' practice. This was followed by Module M15A with increase of 15% pod and 13% fodder yield.

- Effect of modules on stem rot and yield (*Kharif*, 2019): The maximum (31%) inhibition of

stem rot was achieved by Module-M17A i.e. Deep summer ploughing with mould board plough + seed of variety GG20+ 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 (days after sowing) and third at 80 DAS, over farmers' practice followed by Module 15A (25% inhibition). The maximum pod (1361 kg/ha) and fodder (5806 kg/ha) yield was also supported by Module M17A, which was 36 and 23 per cent, respectively, higher than the farmers' practice. This was followed by Module M15A with increase of 20% pod and 19% fodder yield. The yield was in general less than the normal due to heavy and

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continuous rainfall in the productive period.

- Effect of modules on collar rot and yield (*Kharif*, 2019): The maximum (35%) inhibition of collar rot was also achieved by Module-M17A followed by Module 10A (29% inhibition) being at par with Module 15A (25% inhibition). Again for collar rot too, the maximum pod (1328 kg/ha) and fodder (5861 kg/ha) yield was also supported by Module M17A, which was 14 and 18 per cent, respectively, higher than the farmers' practice. This was followed by Module M15A with increase of 7% pod and 15% fodder yield. The yield was in general less than the normal due to heavy and continuous rainfall in the productive period.

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

The experiment was undertaken at Dharwad, Junagadh, Kadiri, Jalgaon, Bikaner etc.

- Three modules viz. M4V, M15V and M17V were effective in managing soil borne diseases as well as supporting yield. Module M4V was effective in managing collar rot and stem rot as well as supporting yield at Junagadh, Bikaner and Jalgaon. At Kadiri M15V was effective followed by M4V in managing collar rot and dry root rot. While maximum

yield was supported by M4V. M17V was effective at Dharwad for collar rot and stem rot as well as supporting yield.

Efficacy of selected *Trichoderma* spp./isolates against *Sclerotium rolfsii*. Efficacy of all 17 isolates selected, through assessment of chitinolytic activities, was evaluated during summer 2019 and *kharif* 2019.

- Efficacy of selected *Trichoderma* spp./isolates against *S. rolfsii* (*in-vitro*): Efficacy of all selected 17 isolates was tested in dual culture of *S. rolfsii* and *Trichoderma*. The inhibition varied from 10-27%, being highest with T354 (27%) followed by T7R (25%). All 17 isolates were also evaluated for growth promotion in groundnut with respect to shoot length, root length, root girth and no. of nodules produced in pots. Higher number of nodules over control were produced by T4R (58%) followed by T7R (38%). Highest root length was observed in T166 followed by T7R isolates.
- Efficacy of selected *Trichoderma* spp./isolates against *S. rolfsii* (*in-vivo*) during *kharif* 2019: Efficacy of all selected *Trichoderma* spp./isolates was evaluated. The stem rot ranged from 9-15% in plots treated with *Trichoderma* against 20% in

control. Maximum inhibition (54%) was recorded with isolate T-00 being at par with NRCG-T19 (50%), T4 R (51%) and T-292 (52%). However, maximum pod (1596 kg/ha) and fodder (6074 kg/ha) was supported by T-354, which was 49% and 38%, respectively, over control being followed by T-18, which supported 1459 kg/ha pods and 5667 kg/ha fodder.

Assay for chitinase and β -1, 3-glucanase activity from selected *Trichoderma* spp./isolates: All 17 selected, through assessment of chitinolytic activities, isolates were subjected for chitinase and β -1, 3-glucanase activity for further assessment of isolates.

- The highest chitinase activity, in terms of NAGA, of 5.6 mg/ml was recorded with isolate T-354 followed by T166 (2.6 mg/ml) being lowest in T226 (0.3 mg/ml), whereas Glucanase activity, in terms of glucose, was higher in T29 (123.6 mg/ml) followed by T8R (121.8 mg/ml).

Screening of varieties for soil-borne diseases of groundnut under concrete block conditions

Two groundnut genotypes GG-20 (susceptible) and NRCG CS-319 (tolerant) were inoculated at three different stages (40, 60 and 80 DAS) to identify the critical stage

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of infection by *S. rolfii*. Inoculations done at 40 DAS showed 100% stem rot incidence in both the genotypes. Inoculations done at 60 DAS shown disease incidence of 84% in GG-20 and 83% in CS-319. However, little wider difference in incidence was recorded in inoculations made at 80 DAS showing 66% incidence in CS-319 and 82% in GG-20.

Project No.: 8 Biology, Epidemiology and Management of *Alternaria* Leaf Blight in Groundnut

PI: PP Thirumalaisamy

Co-PI: Ram Dutta

1. Morphological characterization of isolates

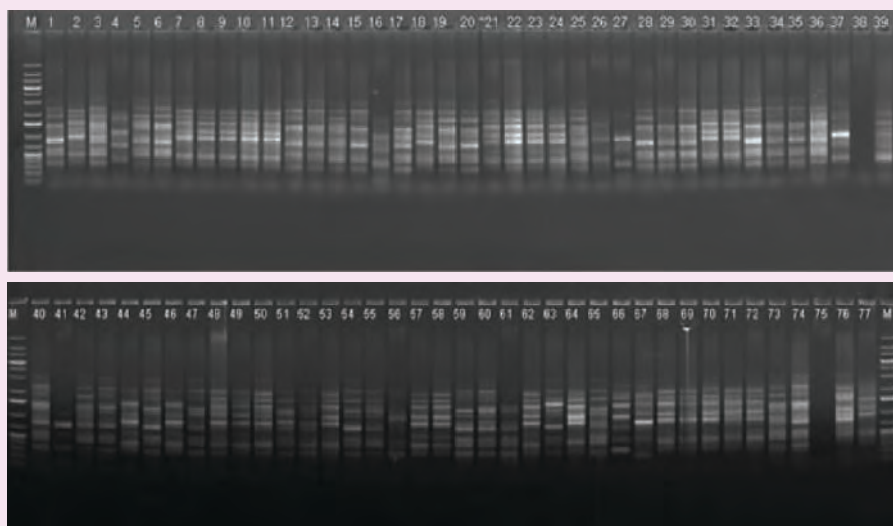
Total of 77 isolates of *Alternaria* sp. associated with leaf blight disease of groundnut were collected from different agro-climatic regions of India. All the isolates were morphologically similar. Ash colour to dark green mycelial growth was recorded. Black colour concentric ring from centre to periphery representing spores were also recorded. Muriform spores in chain were observed. However, isolates could not be differentiated based on colony morphology, mycelial growth rate, and spore characters.

2. Diversity analysis of *Alternaria* isolates

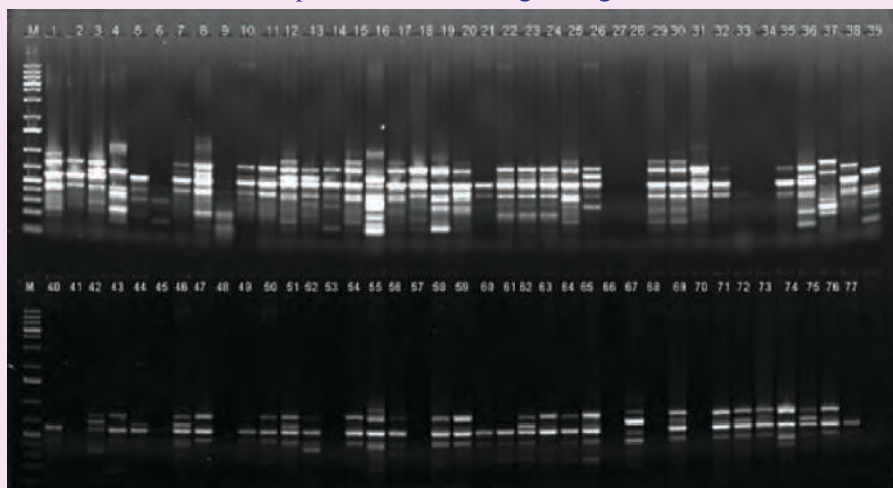
Leaves of TG 37A, GJG 31, and Girnar 2 were subjected for

assessment of pathogenicity of *Alternaria* sp. by detached leaf technique. The disease

highly virulent, virulent and less virulent of *Alternaria* sp. isolates were recorded. For



Electrophoresis of *Alternaria alternate* DNA amplified with OPP 11 primers and separated with 1.2% agarose gel.



Electrophoresis of *Alternaria alternate* DNA amplified with URP6 primers and separated with 1.2% agarose gel.

symptoms started after 6-7 days after incubation with appearance of yellow halo around the mycelial disc followed by necrosis. Differences in pathogenicity falling under the category of

genetic diversity analysis of *Alternaria* sp., operon primer sets (P series) and URP sets were used and significant differences were observed among isolates.

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There was no correlation exist among genetic variability analysis using random primers and pathogenecity of *Alternaria* isolates on groundnut cultivars TG 37A, GJG 31, and Girnar 2.

3. Epidemiological factors responsible for disease development

Epidemiological factors were analyzed for the disease severity. At crop age of 70-110



Reaction of *Puccinia arachidis* on resistant (RHRG 06083) and susceptible (TMV 2) cultivars

days, and RH below 60% and temperature above 37 degree C, *Alternaria* leaf blight occurred up-to 7 rating scale (max. 60% severity) of 1-9 scale.

Further, it was found, water stress was a predisposing factor for the *Alternaria* leaf blight. Withholding irrigation water for 4 weeks or above predisposed the groundnut crop to *Alternaria* leaf blight to the severity of 7 in 1-9 scale. Deficiencies of nitrogen and micro nutrients especially iron and zinc, damage of peanut by sucking pests viz., jassids and thrips, and peanut grown in the saline soil at 4 dsm⁻¹ or above were favoured the *Alternaria* leaf blight.

4. Management of *Alternaria* leaf blight in groundnut

Among the treatments comprising fungicides and bioagents, pyraclostrobin + metriam spray reduced the severity of leaf blight (rating scale of 3 in 1-9 scale) compared to control (rating scale of 7 in 1-9 scale) in TG 37A. In GJG 31, pyraclostrobin + metriam and tebuconazole has reduced the severity of leaf blight (rating scale of 4 in 1-9 scale) compared to control (rating scale of 7 in 1-9 scale).

5. Screening of cultivars for resistant to rusts and leaf spots

Cultivars were screened against rust, *Puccinia arachidis* in the 2 m length and 1m width concrete block in the years 2016, 2017 and 2019. Seeds were treated with fungicide,

tebuconazole 2 ds @1.5g per kg seeds and sown in second fortnight of June, in 30cm x 15cm spacing, and 20 healthy plants were retained after germination. Freshly collected uredospores of *P. arachidis* from DGR field were mixed in sterile distilled water and spore suspension @ 50000-100000 fertile spores per ml concentration was sprayed on the foliage at 40 days old plants. The disease started appearing on lower leaves of the susceptible cultivars about 15 days after inoculation. Scoring was done at 90 days old crop and at harvest. In the susceptible cultivars, the rust severity reached to 7-9 score of 1-9 rating scale. However, cultivars RHRG 6083, KDG 128 and KDG 123 were consistently (2016, 2017 & 2019) recorded with disease score of 1-3 and shown resistant reaction to *P. arachidis*. The symptoms on resistant cultivars appeared only at maturity stage of the crop as minute yellow flecks, small microscopically discernible size pustules without rupturing of host epidermal cell wall, containing few numbers of fertile spores. Additionally, these cultivars were also shown resistant reaction to late leaf spot disease.

Project 9: Studies on white grub

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and bruchid beetle and their management in groundnut

PI: Harish G

Co-PI: Ram Dutta and Rupak Jena

1. Survey for collection and identification of white grub

Survey was conducted in Villages namely, Navagam, Mitapur, Kadpipadi, Semasi, Mendhada, Samadiyala and Najapuretc of Junagadh district and white grubs were collected and sent for identification, species were identified as *Phyllognathus-dionysius*, *Holotrichia serrate*, *Holotrichia* sp. we also collected the data on reduction of white grub incidence due to intervention measures and the control of white grub in Junagadh district where upto



96 per cent control was achieved who followed timely Integrated pest control measures compared to previous year.

2. Improved storage practices for managing *Caryedon-serratus* in groundnut

An experiment was carried out ICAR-Directorate of Groundnut Research, Junagadh to improve the storability of groundnut pods using high density ploythene bag (HDPE 160 micron), Purdue Improved Crop Storage (PICS) bag and gunny bags, twenty five kg of groundnut pods were stored with treatment combination of with and without release of adult *Caryedonserratus*. Groundnut pods were stored for Six months and observations were recorded at monthly interval on number of eggs laid by *Caryedonserratus* and per cent pod damage. HDPE bags, PICS bags and gunny bags were found on par



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and effective up to five months when there is no prior infestation. However, if there is a prior infestation with bruchids (5 pairs of adult beetles) HDPE bags and PICS bags were found significantly effective over gunny bags. Results also showed that there was no significant buildup of aflatoxin in HDPE and PICS bags. Cumulative mean of eggs laid in gunny bags with prior infestation after six months of storage was 1541 eggs per 100 g of pods. Pod damage of 84 per cent was recorded after six months of storage. In terms of economics 100 kg capacity PICS bag cost around 120 rupees per bag and HDPE bag 160 micron and gunny bags of 50 kg capacity costs around 30 rupees per bag. Hence HDPE bag of 160 micron was cost effective and improve the storability of groundnut compared to gunny bags when stored under natural condition.

3. Host preference of bruchid beetles

An experiment was carried out at ICAR-Directorate of Groundnut Research, Junagadh to study the impact of varieties Girnar 2 and Girnar 3 and storage conditions on *Caryedon serratus*. The studies showed that *C. serratus* equally preferred Girnar 2 and 3 for

egg laying. However, initially pod damage was less in Girnar 3 due to smaller seed size and higher content of total phenols compared to Girnar 2 where damage was significantly higher due to large seed size and low total phenol content, but after three months of storage more than 50 per cent pod damage was recorded in Girnar 3 due to reduction in total phenol content from 0.32 in first month to 0.26 after three months of storage. HDPE bags of 160 Micron were found effective compared to gunny bags during storage. Germination percentage of seeds was also good when stored in HDPE bags compared to gunny bags

4. Seasonal incidence of insect pests of groundnut

Seasonal incidence of insect pests of groundnut was studied by sowing groundnut every month under unprotected condition. Sucking pests were estimated using sweep net catches. Thrips and leafhopper population was found throughout the year, but we observed two significant peaks of thrips population during 6th and 38th Standard week and leafhopper population had three peaks at 7th, 43rd and 45th Standard week.

5. Study on incidence of nematodes in groundnut

Soil samples were collected from research plots of ICAR-DGR and nematodes were isolated through Cobb's sieving and decanting method. The frequency of nematodes was 1024 per 20 ml in one of the samples collected from the Agronomy plot. Nematodes were classified into two groups viz., Plant parasitic and Free living nematodes. Plant parasitic nematodes like *Meloidogyne* sp., *Aphelenchus* sp. were isolated from each of the studied research plots, while parasitic nematodes like *Tylenchorynchus* sp., *Xiphinema* sp., *Tylenchulus* sp. were isolated from samples collected from agronomy plots. Free living bacterial feeding nematodes like *Chiloplacus* sp., *Heterocephalobus* sp., *Acrobeloides* sp., *Eucephalobus* sp., *Cephalobus* sp., *Pseudoacrobeles* sp. were isolated from the studied samples. The Shannon diversity index and Gussian packing index for plant parasitic nematodes was observed least in the plant breeding plot due to the use of pesticides and maximum in the agronomy plots possibly due to the effect of conservation agriculture.

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



Project 10: Development of Climate Resilient Groundnut-based Production Systems through Precision Management Practices

PI: Ram A Jat*

Co-PIs: Kiran K Reddy and Raja Ram Choudhary

(* Transferred on 13.12.2019)

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

A field experiment was conducted during *kharif* 2018 to validate suitable row ratio and timing of relay sowing of pigeonpea in bunch and semi-spreading varieties of groundnut. The objectives of study were to maximize system productivity and profitability per unit of land and decrease cost of cultivation, enhance resource use efficiency, and sustainable

intensification of groundnut based cropping systems. Two row ratios viz. 2:1 (R1) and 3:1 (R2) of groundnut+ pigeonpea relay cropping system were allotted in main plots and three relay sowings of pigeonpea i.e. 30 (S1), 40 (S2), and 50 (S3) days after sowing of groundnut were applied in subplots. The experiment was conducted in split plot design with three replications. Two separate experiments with same set of treatments were conducted with Spanish bunch (TG 37A) and Virginia bunch (GJG 22) varieties. Pigeonpea was sown during *kharif* 2018 and harvested during summer, 2019.

Pigeonpea grain yield and GPEY was recorded higher under 3:1 ratio relay sown in both Spanish and Virginia

bunch varieties but differences were not significant however, stover yield was found higher under 2:1 ratio. S1 being at par with S2 was found to give significantly higher grain yield and stover yield over S3. GPEY was found significantly higher with S1 in both the varieties.

The same field experiment was conducted for consecutive third season during *kharif* 2019. Groundnut varieties TG 37A and KDG 128 were sown on 18th June, 2019 at 30 x 10 cm and 45 x 10 cm spacing and harvested on 10th October and 20th October, 2019, respectively. While, pigeonpea variety GJP1 was relay sown after every 2 or 3 rows of groundnut as per the treatments on 17th July, 27th July, and 6th August, 2019

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Fig. 1. Pigeonpea relay sown after sowing of groundnut in 3:1 and 2:1 ratio in groundnut

which coincided 30, 40, and 50 days after sowing of groundnut. 100 per cent of RDF was applied to both groundnut (25:50:30 kg ha⁻¹ NPK) and pigeonpea (25:50:00 kg ha⁻¹ NPK) through urea, SSP and MOP. Two inter-culturing operations were done at 25 and 40 DAS.

In Spanish bunch variety, branches and number of immature pods per plant at 75 DAS, plant dry weight at 75 DAS, branches at harvest, number of mature pods per plant, plant dry weight at harvest, shelling per cent were recorded higher with 2:1 ratio. However, plant height at 75 DAS, dry weight of mature pods per plant, hundred kernel weight, pod yield and haulm yield were found higher under 3:1 ratio. With respect to Virginia bunch variety, branches per plant at 75 DAS, number and weight of immature pods per plant at 75

DAS, plant dry weight at 75 DAS and dry weight of immature pods per plant at harvest were found higher under 2:1 ratio. While, plant height at 75 DAS and harvest, branches per plant at harvest, number and dry weight of mature pods per plant at harvest, shelling percent, hundred kernel weight, pod yield and haulm yield remained higher with 3:1 ratio.

In Spanish bunch variety, number and weight of immature pods per plant at 75 DAS, plant height at harvest, dry weight of mature pods per plant at harvest, hundred kernel weight, shelling percent, and pod yield was found higher with S2, while haulm yield was higher with S3 but differences were non-significant. In case of Virginia bunch variety, plant height at 75 DAS, number of immature pods and their dry weight at 75 DAS with S1 while, number and

weight of mature pods at harvest, hundred kernel weight, shelling percent, and pod yield and haulm yield was found higher with S3.

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

A field experiment was conducted during *kharif* 2019 to find out optimum time of spray of paclobutrazol in *kharif* groundnut. The treatments were: control (water spray), paclobutrazol 100 ppm at 15 DAS, paclobutrazol 100 ppm at 20 DAS, paclobutrazol 100 ppm at 25 DAS, paclobutrazol 100 ppm at 30 DAS, paclobutrazol 100 ppm at 35 DAS, paclobutrazol 100 ppm at 40 DAS. The experiment was conducted in randomized block design with three replications. Groundnut variety GJG 22 was sown on 20th June, 2019 at 45 x 10 cm

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Fig. 2. Groundnut sprayed with paclobutrazol

spacing and harvested on 17th October, 2019.

Paclobutrazol significantly affected plant height at 45 DAS, dry weight of immature pods per plant and leaf area index at 45 DAS, plant height and pegs per plant at 75 DAS, number of mature pods and their dry weight at harvest, shelling percent, hundred kernel weight, pod yield and haulm yield. Plant height at 45 DAS was highest with control and paclobutrazol spray at 40 DAS and lowest was with paclobutrazol spray at 20 and 25 DAS. At 75 DAS and harvest plant height was highest with control and lowest with 30 and 35 DAS, respectively. Branches per plant were significantly lowest with control. Significantly higher number of mature pods and their dry weight per plant were under paclobutrazol spray at 30 DAS. Pod yield and haulm yield was found significantly higher with paclobutrazol

spray at 30 and 35 DAS, respectively. While lowest pod yield and haulm yield was under control.

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

A field experiment was conducted for consecutive fourth season during *kharif* 2018 to validate the impact of conservation agriculture in groundnut+pigeonpea and groundnut+cotton cropping systems in light black soils. The treatments were: four tillage practices viz. normal tillage (NT), minimum tillage (MT), zero tillage (ZT), and rota-till (RT) in main plots; two residue management practices viz. no residue (NR), and residue application (RR) in sub-plot; and two cropping systems viz. groundnut+pigeonpea (GP) and groundnut+cotton (GC) relay/intercropping systems in sub-sub-plots. The experiment

was laid out in split-split plot design with three replications. In plots having residue application treatments, pigeonpea and cotton residues were used. Harvesting of pigeonpea and cotton was done in summer, 2019.

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

The same experiment was conducted for consecutive fifth season during *kharif* 2019 to validate the impact of conservation agriculture. Groundnut and cotton was sown on 22nd June, 2019 while pigeonpea was relay sown on 23rd July, 2019. Groundnut was sown with pigeonpea and cotton in 3:1 ratio. 100 per cent of RDF was applied to

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Fig. 1: Groundnut+cotton (left) and groundnut+pigeonpea (right) cropping systems under conservation agriculture

groundnut (25:50:30 kg ha⁻¹ NPK), pigeonpea (25:50:00 kg ha⁻¹ NPK) and cotton (240:50:150 kg ha⁻¹ NPK) through urea, SSP and MOP. Groundnut was harvested on 10th October, 2019.

Groundnut pod and haulm yield was found higher with rota-tillage and zero tillage, respectively with differences being non-significant. Application of crop residues failed to affect crop yields significantly. Groundnut+pigeonpea cropping system was found to give higher groundnut pod yield and haulm yield over groundnut + cotton intercropping system.

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

An experiment was conducted in *kharif* 2019 in randomized complete block design (RCBD) having nine

treatments (T1-0kg N/ha; T2-15 kg N/ha; T3-20 kg N/ha; T4-25 kg N/ha; T5-30 kg N/ha; T6-35 kg N/ha; T7 - 40 kg N/ha; T8-45 kg N/ha; T9-50 kg N/ha) and three replications to know the effect of different levels of nitrogen doses on two different groundnut varieties viz. TG37A (Spanish bunch) and GG22 (Virginia bunch). Pod yield increased with increasing level of N doses and highest significant yield was found at

40 kg N/ha (3150 kg/ha) and 30 kg N/ha (2501 kg/ha) in TG37A and GG 22, respectively. While, significantly higher haulm yield was found at 50 kg N/ha in both the varieties. Fresh and dry root weight at 60 DAS was higher at 30 kg N/ha in both the varieties but differences were not significant. Fresh nodule weight and nodule count at 60 DAS were higher at 45 kg N/ha and 30 kg N/ha in TG37A and GG22, respectively.



Fig 1 : Experimental Field View

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Project 11: Efficient utilization of soil phosphorus in groundnut production system

PI: Kiran K Reddy

Co-PIs: Raja Ram Choudhary and Ram A Jat*

(* Transferred on 13.12.2019)

Effect of source of nitrogen, organic manure and PSB application on soil P dynamics and Puptake of groundnut

Summer 2019:

The experiment was conducted at ICAR-DGR farm, Junagadh. The experiment consisted 12 treatments (T1-control; T2-DGRC 1; T3-FYM @ 10 t/ha; T4-FYM+DGRC1; T5-Urea; T6-Urea+DGRC1; T7-Urea+FYM; T8-Urea+FYM+DGRC1; T9- Amm. sulphate; T10- Amm. Sulphate +

DGRC1; T11-Amm.sulphate+FYM; T12-Amm. sulphate+DGRC1+FYM) and three replications in randomized block design (RBD), with initial soil available P of 4.8 kg ha⁻¹. RDF (25:50:30kg N: P₂O₅:K₂O) was used. FYM @ 10t/ha was applied at the time of sowing. 5g of DGRC1 culture per kg of seed was applied. Groundnut pod yield was found to be significantly high ($P < 0.05$) in T12 (Ammonium sulphate+FYM+DGRC1) (2651 kg ha⁻¹) followed by T8 (2540 kg ha⁻¹). The difference in observed yield may be due to the differences in the acidity produced by the two nitrogenous fertilizers. This difference was observed only when the N fertilizer was applied along with FYM.

Ammonium sulphate has equivalent acidity of 110, compared to urea which has 80. DGRC1 alone had a yield advantage of over 300 kg compared to control (No P applied). When N fertilizers were applied with DGRC 1 without FYM, urea had a clear advantage in yield (>200 kg ha⁻¹) over ammonium sulphate (**Fig 1**). The other parameters like haulm yield (range 5.0-5.5 tha⁻¹), shelling % (range 70-75 %), shoot ht., root ht., nodule wt., HKW, and mature pod weight were found to be non-significant.

Alkaline phosphatase activity (ALP) was significantly high in T12 (158 µg of p-nitrophenol /g soil/h) followed by T2. Acid phosphatase activity was significantly more in T9 (153 µg p-nitrophenol/g soil/h)

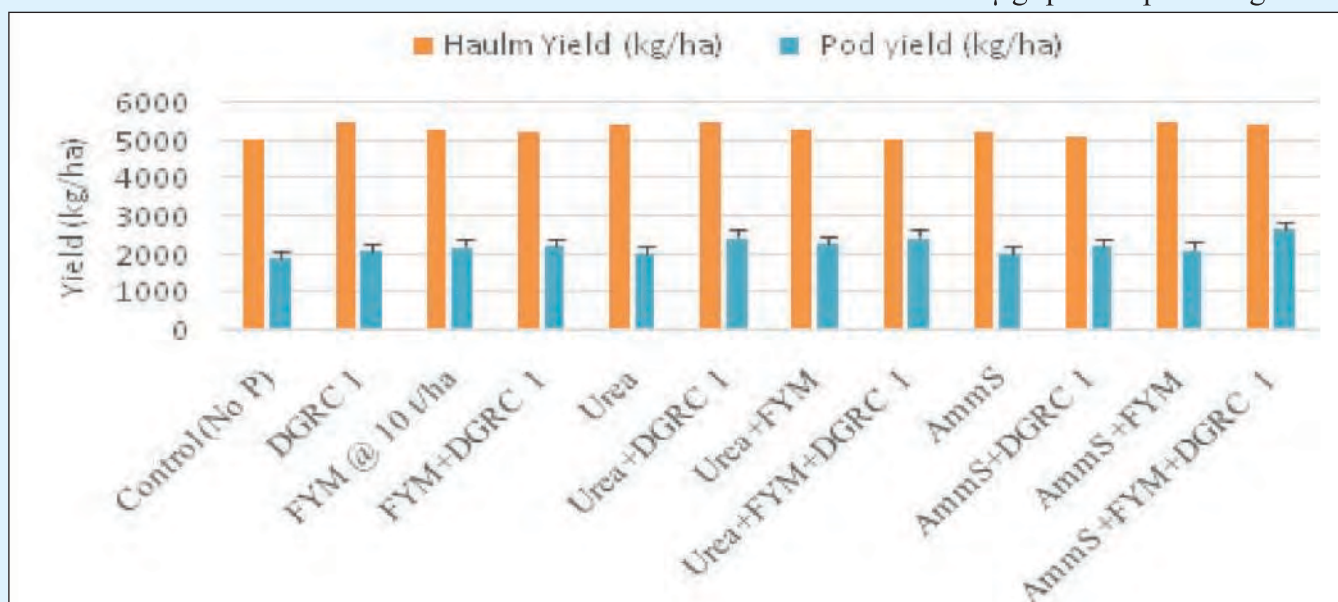


Fig 1: Effect of different treatments on pod and haulm yield

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followed by T7. Dehydrogenase activity was observed to be significantly high in T2 (5.8 $\mu\text{g TPF/g soil/h}$) followed by T12 (4.7 $\mu\text{g TPF/g soil/h}$). Available P at harvest (kg/ha) was significantly high in T6 (14.9 kg/ha) followed by T12 (14.1 kg/ha) and the least was observed in control (5.7 kg/ha). Total P uptake (kg/ha) was significantly high in T12 (20.2 kg/ha) followed by T11 (18.7 kg/ha) and the least in control (8.2 kg/ha). and PUE (%) was significantly high in T12 (40.4 %) compared to other treatments. In our treatments PSB (DGRC1) has increased the PUE by 8-10%.

Solubilization and mobilization of native and applied soil phosphorus by application of organic acids and PSB culture in groundnut

Kharif-2019: The experiment was conducted in ICAR-DGR experimental field with 12 treatments (T1-Control (No P); T2- 50% RDP; T3-75% RDP; T4- 100% RDP; T5-PSB+ 25 % RDP; T6-PSB+ 50% RDP; T7- PSB + 75 % RDP; T8- PSB; T9-No P+ organic acid mix (Citric acid: malic acid: oxalic acid 4:2:1) @ 60 kg/ha+ PSB culture; T10-50% RDP+ organic acid mix (Citric acid: malic acid: oxalic acid 4:2:1) @ 60 kg/ha+ PSB culture; T11-75% RDP+organic acid mix (Citric

acid: malic acid: oxalic acid 4:2:1) @ 60 kg/ha+ PSB culture; T12-100 % RDP+ FYM @10t/ha) and 3 replications in RBD design. The phosphate solubilizing bacterial (PSB) culture used was DGRC1. Fertilizer dose was 25: 50: 30 kg N: P_2O_5 : K_2O . The purpose of the experiment was to assess the role of organic acids in improving the P uptake (through solubilization from fixed P pool) and growth and yield of groundnut. Pod yield was significantly great ($P<0.05$) in T7 (PSB+75 % RDP) followed by T8 and T9 which were at par with each other. Pod yield in T7, T8 and T9 was about 3-fold greater than control (T1), which was 985 kg/ha. Pod yield in T7, T8 and T9 has about 150 kg/ha greater yield compared to T4 (100% RDP).

Haulm yield was significantly high in T12, which was at par with T11, T8 and T4 (**Fig 2**). There was an improvement in haulm yield by over 800 kg/ha when organic acid mix or PSB culture or FYM was used compared to control. No. of branches per plant were significantly more in T11 and the range was 4.0-6.4. Dry shoot weight per plant was significantly high in T3 and it ranged from 8.7-16.0 g. Dry root weight per plant was significantly high in T5 and it ranged from 0.4-0.70 g.

Nodule number per plant was significantly high in T2 and it ranged from 24.6-41.

Dry nodule weight per plant was observed to be significantly high in T3 and it ranged from 28.4-61.9 mg. Number of mature pods per plant was significantly high in T5 and it ranged from 6.2-10.4. Weight of mature pod per plant was significantly high in T2 and it ranged from 5.21-8.3 g. Hundred pod weight was significantly high in T12 and it ranged from 68.0-75.2g. Hundred kernel weight was significantly high in T9 and it ranged from 34.3-39.0 g.

Haulm P uptake was significantly high in T10 and it ranged from 4.8-13.2 kg P/ha. Pod P uptake was significantly high in T8 and it ranged from 3.0 to 8.8 kg P/ha. Total P uptake was significantly high in T10 and it ranged from 9.0-18.4 kg P/ha. P uptake was significantly high in T10 for shoot and T8 for root, kernel and shell. Range of P uptake in shoot, root, kernel and shell was 5.5-18.7, 0.11-0.36, 5.0-9.3 and 0.4-1.3 kg P/ha. Shoot length was significantly high in T6 and it ranged from 46.1-53.5 cm. Root length and shelling % were found to be non-significant, but they ranged from 12.0-13.3 cm and 72.7-76.2% respectively. Available P in soil (kg/ha) was

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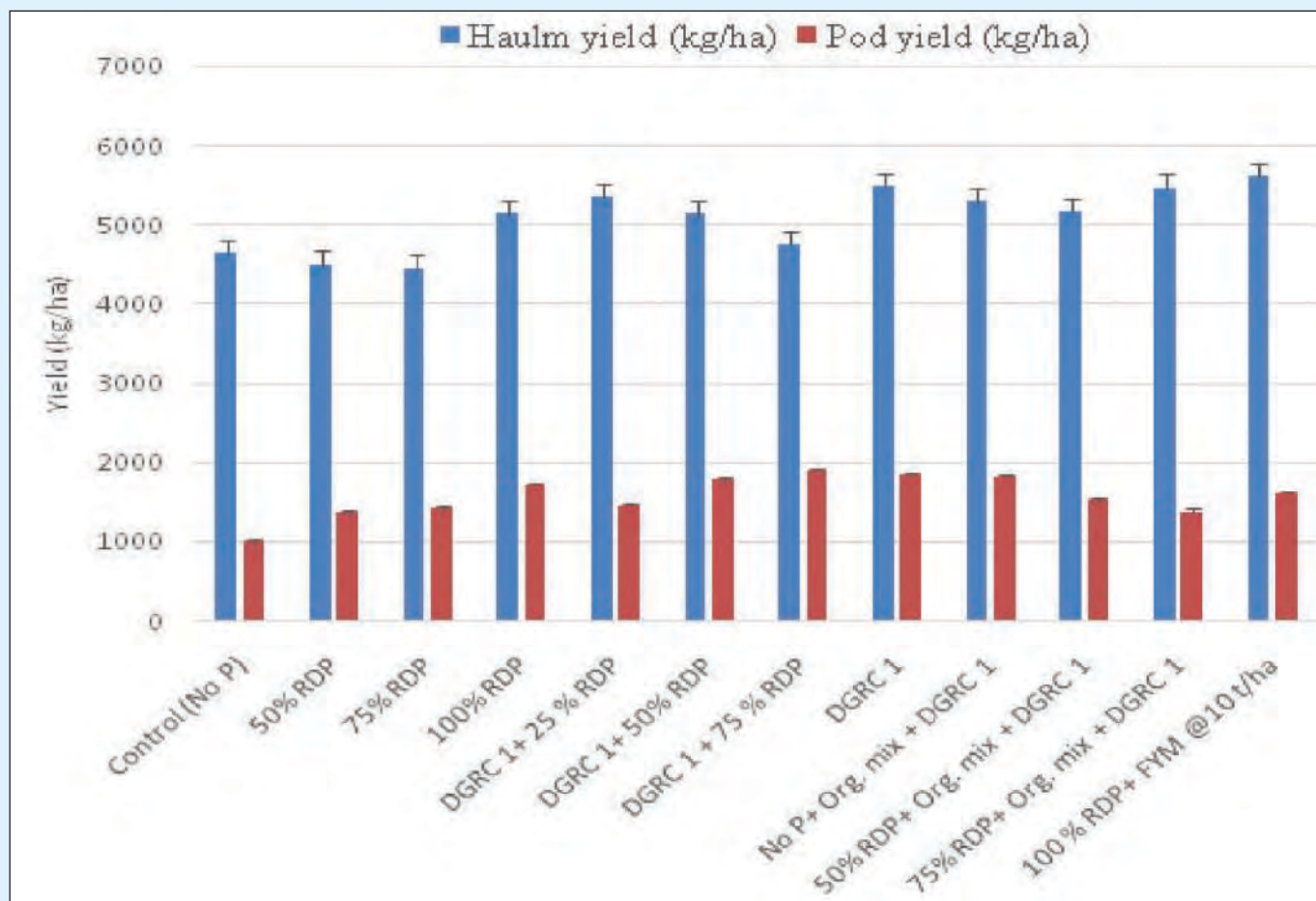


Fig 2: Effect of different treatments on pod and haulm yield

FYM: Farm yard manure; DGRC1: Phosphate solubilizing bacterial culture (PSB);
Org. mix: Organic acid mix (Citric acid: malic acid: oxalic acid 4:2:1) @ 60 kg/ha

significantly high in T9 and T10 and it ranged from 6.10-21.7 kg/ha.

Fluorescein diacetate activity (FDA) was significantly high in T7 and it ranged from 98.6-174.0 μ g of fluorescein/g/h. Organic carbon (%) was high in T11 and it ranged from 0.4-0.8%. Soil dehydrogenase activity was observed to be high in T1 and it ranged from 3.5-7.5 μ g of TPF/g/h. Soil

alkaline phosphatase activity was significantly high in T2 and it ranged from 157-173 μ g of p-nitrophenol/g/h. Soil acid phosphatase activity was significantly high in T9 and it ranged from 166-169 μ g of p-nitrophenol/g/h. Soil β -glucosidase activity was significantly high in T10 and it ranged from 64-102 μ g of p-nitrophenol/g/h. Phosphorus use efficiency (PUE) was

found high in T9 (43 %). This concludes that PSB (DGRC1) application in combination with organic acid mix enhances groundnut pod yield and improve soil fertility parameters

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



Project 12 : Iron and zinc bio-fortification in groundnut

PI: Sushmita

Co-PIs: AL Singh and K Gangadhara

Screening groundnut cultivars for high Zn and low phytic acid content in seeds

100 groundnut cultivars were studied for Fe and Zn biofortification by treating them with combinations of Zn fertilizers and organic sources during rainy season where application of Zn increased chlorophyll fluorescence (Fv/Fm), SCMR and finally the pod yield. Seeds of groundnut cultivars, when analyzed for Zn along with many other nutrients a wide range was observed and a few cultivars with high Zn in seeds were identified.

The phytic acid content in

seeds of 20 groundnut cultivars with high Zn were undertaken to identify high zinc density groundnut cultivars with low phytate using Megazyme kit (K-PHYT) for phytic acid which ranged from 0.70 to 2.97 g 100 g⁻¹. Four groundnut cultivars with lower phytic acid (0.70-1.12 g 100g⁻¹) were identified out of which two cultivars reflected Zn content in seeds ranging between 45-55 ppm while the other two were having Zn density of more than 60 ppm. Further, IC (Ion chromatograph) method for determining phytic acid in groundnut seed samples was developed and standardized. Samples of three groundnut cultivars were further estimated for their phytic acid content through IC which yielded higher values comprising all

phosphorylated forms of phytic acid and were more specific when compared to colorimetric assays wherein the nonspecific compounds are also detected.

A single cross between SG 99 and ICGV 06099 as low and high Zn density parents respectively, was effected from which 153 pods were harvested during summer 2018 and then F2 generation was planted in *kharif* 2019 for further generation advancement.

Zinc bio-fortification through Zn solubilizing microbial application.

The effectiveness of four Zn-solubilizing microbes (FP 82, FP 93, BHU-1 and BM-6) were compared with zinc sulphate (2kg Zn ha⁻¹) in a field experiment using 10 groundnut cultivars where these all

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increased growth and pod yield of cultivars. However, among the Zn-solubilizers, FP 82 and FP 93 showed better response to yield and at par to that of zinc sulphate. Interestingly, all these solubilizers increased Zn, Mn and K content in rhizosphere, leaves and seeds.

Zn bio-fortification through various commercial Zn-sources

In a field experiment using 10 groundnut cultivars, five commercial Zn fertilizers, Techno Zn (15 % Zn), Monzin (33 % Zn), Tag nano zinc granules, Tag nano zinc liquid (6% chelated Zn) and Zn-Param 35 (33% Zn) were tested during *Kharif* season where all these increased pod yield with varied responses. Among the cultivars, TG 37A, GJG22 and GPBD 5 were found to be the most responsive to all the treatments with maximum increase with chelated Zn source application; thereby implying that water solubility regulates the availability of Zn rather than the formulation of zinc sources.

Screening groundnut genotypes for iron-deficiency chlorosis

114 advanced breeding lines were screened for lime-induced iron-chlorosis (LIIC) in ear-marked screening blocks, during *kharif* season, out of which 15 were

identified as tolerant to iron chlorosis. On the basis of Visual chlorotic rating (1-5), a few cultivars with consistent VCR rating of 1 over the years were identified as tolerant to iron chlorosis while the ones with VCR rating 3 or more were identified as susceptible. A few LIIC tolerant and susceptible genotypes were undertaken for physiological characterization. SPAD, Fv/Fm and H⁺ extrusion studies showed that the tolerant cultivars maintained greater chlorophyll content with higher maximum photochemical efficiency (Fv/Fm) with respect to susceptible ones. A higher H⁺ extrusion (decrease in pH) in case of tolerant cultivars was found to be crucial for Fe availability in the rhizosphere.

Nutrient analysis of plant samples for various experiments

36 groundnut cultivars were undertaken for Zn estimation, out of which GG 7, GJG31, Tirupati 4, TAG 24, VRI 3, JL 24, NRCG 14368 and VG13115 showed Zn content > 50 ppm

Project 13: Physiological studies in groundnut under water-deficit and salinity stresses

PI: AL Singh

Co-PIs: Sushmita and Aman Verma
Physiological efficiencies among Indian groundnut cultivars

The photosynthesis (P_N), transpiration (E), stomatal conductance (g_s), chlorophyll fluorescence, SCMR and pod and haulm yields were studied in 100 cultivars during *Kharif* season and 40 cultivars during *Summer* season grown under various environmental factors where large variability was observed. Finally based on the various parameters and their positive correlations identified several physiologically efficient cultivars high in P_N , E and g_s and finally pod yield.

Elasticity of tolerance among recent cultivars to various drought situations

For the last one decade, screening and identification of tolerant genotypes for various drought situations has become the regular feature of this institute where the recently released groundnut cultivars are grown under protected (P), rainfed (RF), RF+hydrogel, exposed to mid-season (MSD, 50-70 DAS) and late-season drought (LSD, 70-90 DAS) under ROS and studied for various physiological, agronomic and yield parameters. In this series, 40 cultivars were studied during *kharif* season, where there was in general excess moisture during July, and August, but short spell of drought stress during third week of Sept and from 10th to 29th Oct the rainfed

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crops faced drought like situations affecting pod yield. The crop faced about more than 20 days of mid to end season droughts where pod and haulm yields were affected.

Though there was severe reduction in pod yield due to drought, several cultivars performed well with lesser reduction in yield. Accordingly identified cultivars for rainfed, MSD and LSD from the the 40 cultivars. Also found a few cultivars performing well under both MSD and LSD and also a few cultivars showed most elasticity and performed well under all the 5 situations.

Pod zone moisture contents influences yield, yield attributes and aflatoxin

Using drip irrigation in microplots during summer season, 24 groundnut cultivars, were first grown under normal conditions till 45 DAE and then exposed to various moisture content (>19.6 , $17.2-19.6$, $15.0-17.1$, $12.4-14.8$, and <12.4 % moisture content) from 50 DAE in their pod zone. The various groundnut cultivars, based on their phenophases, behaved differently to exposure of moisture contents in their pod zone and the moisture content below 15 % was very critical, below which

drastic reduction in yield was observed. Among these seven cultivars were very sensitive showing severe yield reductions. However, 6 cultivars were most tolerant showing appreciable yield even at less <15.0 % moisture content. Exposure of drought caused early maturity for a few days in the cultivars with determinate nature of growth with more immature pods in the highly stressed crop. Lesser moisture content caused in pod zone caused cracking and rupture of pods leading to aflatoxin development. There was aflatoxin development in the groundnut seed if grown below 12.4 % soil moisture pod zone.

Water requirement of groundnut cultivars for their cultivation under drought

During summer season, 40 groundnut cultivars were grown in micro-plot at only 400, 500 and 600 mm of total water distributed throughout the cropping season as per requirement of crop growth stages. There was clear cut demarcation in the physical appearance, Chlorophyll fluorescence and LAI (Leaf area index) in these cultivars grown under three different levels of irrigation treatments with high Chl fluorescence in the cultivars having higher photosynthetic rate and stomatal conductance while

the water sensitive cultivars showed low chl fluorescence. The cultivars with dense canopy showed LAI upto 6-7, while it was 3-5 in majority of cultivars, off course it varied with frequency and amount of irrigation.

The result revealed that the groundnut cultivars behaved differently depending on their water requirement (WR) and at 500 mm, 15 cultivars, at 400 mm 13 cultivars and only 11 cultivars at 600 mm showed >2500 kg/ha pod yield and hence ideal for growing crops. Interestingly five cultivars showed maximum elasticity by performing well under all the three situations hence should be preferred for assured cultivation.

Amelioration of drought through integrated approaches under rainfed

With an aim to minimise the yield losses in the field due to occurrence of drought, various management approaches (application of SOP (60 kg K/ha), Hydrogel (2.5 kg ha^{-1}), and spray of succinic acid (150 ppm) and Absciscic acid ($50 \mu\text{M}$)) were evaluated in 10 groundnut cultivars grown under rain-fed conditions in a field and compared with the one grown under protected conditions. The crop faced severe end season droughts from 10th Oct

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onward and also a short spell of drought during mid of Sept causing reduction in pod yield under rainfed. The data reveals mild to good effect of these ameliorant on increasing pod yield under rainfed conditions and some of these treatment could increase pod yield. However effect of these treatments varied with cultivars and ameliorants.

Influence of growth regulators on seed size

In a demonstration trial the commercial growth regulators Chamatkar (Mepiquate chloride), and Progibb (GA) applied as three foliar sprays at 40, 60 and 75 DAS arrested growth and increased pod yields, seed size and germination of groundnut and hence recommended.

Studied on soil salinity tolerance mechanism

In a salt treated screening block, 57 groundnut genotypes were grown at two (2 dS m^{-1} and 4 dS m^{-1}) salinity levels and studied for germination, plant survival, and yield attributes and physiological parameters. Finally the genotypes showing comparatively high tolerance with reasonable pod yield at 4 dS m^{-1} and highly sensitive one were compared. Higher salinity decreased most of the physiological parameters (photosynthesis, transpiration and stomatal

conductance) resulting in low yield and based on the physiological efficiency the genotypes doing well were recommended for their cultivation in saline areas.

Project 14: Evaluation of nutritional and bioactive compounds of groundnut

PI: MK Mahatma

Co-PIs: Aman Verma,

AL Rathnakumar, AL Singh

Comparative nutritional content of groundnut cultivars grown at different location

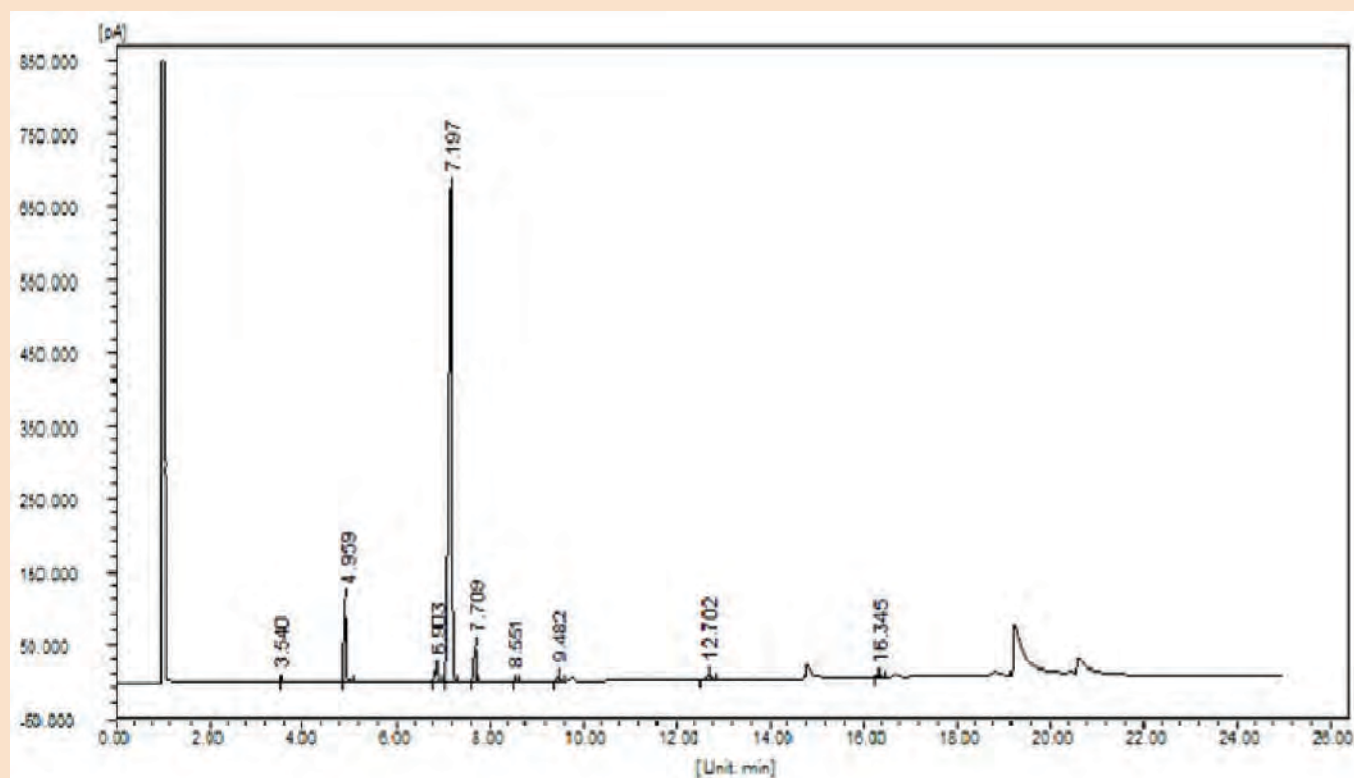
Twenty eight groundnut cultivars released from different places of India were grown at ICAR-Directorate of groundnut Research, Junagadh for comparative nutritional analysis. Oil, protein, sugar and phenol content altered due to changes in growing location (Junagadh). Average sugar content was higher in the cultivars grown at Junagadh (5.34 mg/g kernel) compared to their released location (4.95 mg/g kernel). Oil content was decreased in some cultivars and increased in some cultivars. Increase in oil content was observed in cultivars that released from BARC Kadi and ICRISAT. However, average oil content of all cultivars were lower (47.68%) at Junagadh as compared to grown at their

released location (48.11%). An inverse relationship was observed for protein content, i.e. protein content increased when oil content decreased.

Evaluation of Nutritional profile of high oleic acid containing groundnut genotypes

Total 18 high oleic acid containing genotypes were evaluated for nutritional content. Average oil content was higher (53.7%) in high oleic containing genotypes as compared to released cultivars (48.7%), while protein content was observed less (25.2%) than that of released cultivars (30%). Average sugar content was higher (7.4%) than that of released cultivars (5.5%). Results of Sugar profiles using Ion chromatograph revealed that average sucrose content is appreciably higher ($65.98 \text{ mg/g kernel}$) in high oleic acid containing genotypes compared to average of 31 released cultivars ($49.75 \text{ mg/g kernel}$). Fatty acid profile was also analysed by gas chromatograph which showed that average oleic acid was highest (81.15%) among various fatty acid. Maximum oleic acid was observed in HOS-172 (85.99%) and minimum in HOS-181 (69.64%).

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Analysis result

SeqID	Comp name	Retenttime [min]	Half width [min]	Height [fA]	Area [fA*s]	Area [%]	Contents [%]	Peak type
1	MYRISTIC	3.540	0.032	261.5	517.9	0.0131	0.0131	BB
2	PALMITIC	4.959	0.046	115499.7	342994.7	8.6587	8.6587	BB
3	STEARIC	6.903	0.074	19000.2	88802.1	2.2418	2.2418	BB
4	OLEIC	7.197	0.074	679581.7	3223678.2	81.3799	81.3799	BB
5	LINOLEIC	7.709	0.063	50380.5	203370.5	5.1340	5.1340	BB
6	LIENOLENIC	8.551	0.059	404.5	1430.7	0.0361	0.0361	BB
7	ARACHIDIC	9.482	0.083	6156.0	32315.4	0.8158	0.8158	BB
8	BEHENC	12.702	0.106	7601.5	51404.8	1.2977	1.2977	BB
9		16.345	0.118	2311.8	16755.4	0.4230	0.4230	BB
Total:				881197.4	3961269.4	100.0000	100.0000	

Fig: Chromatogram of fatty acids of high oleic acid genotype analysed by GC

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Ion chromatographic Method for Phytic acid estimation in groundnut seeds

Phytic acid (inositol hexakisphosphate) being a multivalent anion is best suited for detection through Ion chromatography (IC). A sensitive and accurate method for the estimation of phytic acid in groundnut seeds was developed and standardized through Dionex ICS-2000 IC system using sodium hydroxide as an eluent. The procedure involves suppressed conductivity detection using OnGuard II Ag/H cartridge. Sample

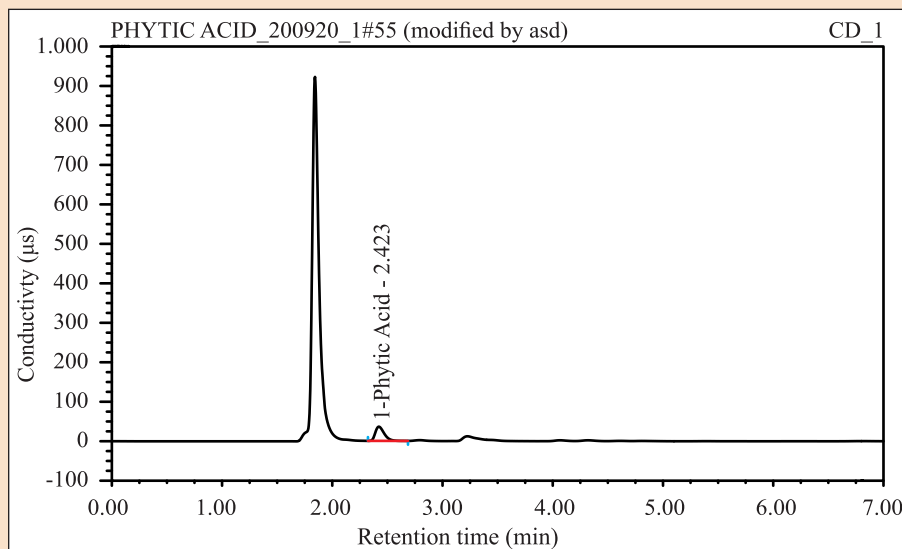


Fig.: Chromatogram of Phytic acid extracted from GJG-22 genotype extraction procedure was standardized using different molarity of HCl while

extraction. As groundnut is an oilseed crop, choice of full fat or defatted seed sample was also worked out.

SERVICES:

Oil, protein and moisture content of 3500 groundnut samples from different section of DGR and AICRP-G centers were measured by NIR spectroscopy.

Project 15: Studies On Microorganisms In Relation To Plant Health And Nutrition In Groundnut

PI: R Dey

Co-PIs: KK Pal and

PP Thirumalaisamy

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

Eleven new isolates of groundnut rhizobia, along with standard culture TAL

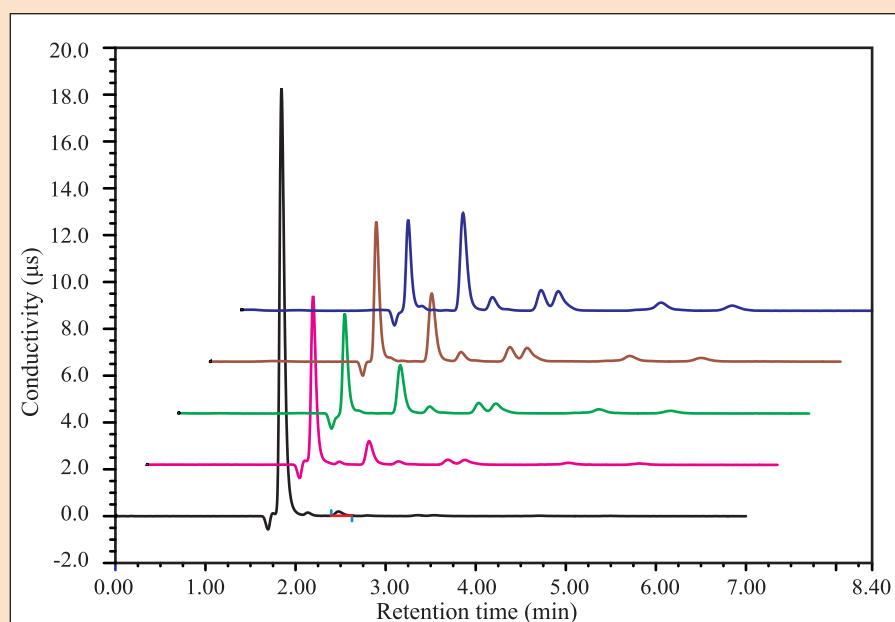


Fig. : Overlay of chromatograms of standard phytic acid. Separation: Guard (Dionex IonPac® AG11 4 x 50 mm) and analytical (Dionex IonPac® AS11 4 x 250mm) column; Eluents: 65 mM NaOH; Detection: chemically suppressed conductivity using ASRS 300 anion self-regenerating suppressor (4 mm)

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Table 1. Evaluation of competitive strains of groundnut rhizobia for enhancing BNF and yield of groundnut (cv TG37A) during summer 2019

Treatment	PY (kg/ha)	NN/p
Control	1700	20.13
TAL1000	1817	20.93
DGR23	1710	22.67
DGR24	2253	39.00
DGR25	2160	36.33
DGR11	1717	27.33
DGR19	1747	28.00
DGR35	2183	39.00
DGR26	1790	21.33
DGR10	2177	37.00
DGR17	1723	29.00
DGR18	1880	23.60
DGR20	1747	27.33
CD (0.05)	237	8.49

1000 were tested for their efficiency in increasing BNF and yield in groundnut in a field trial with cultivar TG37A during summer 2019. Seed inoculation with 4 of the isolates (DGR 24, DGR 25, DGR 35, DGR 10) resulted in significant enhancement of yield (27 – 32%). These isolates also resulted in increase in haulm yield (DGR 25), shelling out-turn, hundred kernel mass and nodulation (Table 1). Similar trend was

also obtained during *kharif* season of 2019.

B. Evaluation of epiphytes for management of Alternaria leaf blight

Phyllosphere or epiphytic bacteria can be used as potential biological control

agents for air-borne fungal pathogens. Five epiphytic bacteria viz. *Bacillus amyloliquefaciens* 13S3, *Bacillus subtilis* 1S1, *Bacillus subtilis* 5S1, *Bacillus subtilis* 7S2 and *Bacillus amyloliquefaciens* 9S2 were evaluated for their efficiency

Table 2. Effect of application of epiphytes in suppression of alternaria leaf blight and growth and yield of groundnut (cv. TG37A) during summer 2019

Treatment	PY (kg/ha)	HY (kg/ha)	Disease score (1-9 scale)
Control	2555	4475	7
<i>Bacillus amyloliquefaciens</i> 13S3	2600	4564	7
<i>Bacillus subtilis</i> 1S1	2626	4445	5
<i>Bacillus subtilis</i> 5S1	2558	4636	5
<i>Bacillus subtilis</i> 7S2	2696	4498	5
<i>Bacillus amyloliquefaciens</i> 9S2	2841	4657	4
CD (0.05)	155	180	

Table 3. Effect of application of epiphytes (bacilli) on growth, yield and control of late leaf spot of groundnut (cv TG37A) during *kharif* 2019

Treatment	PY (kg/ha)	HY (kg/ha)	Disease score (scale of 1-9)	
			LLS	Rust
Control	2357	2977	7	5
1S1	2493	3160	6	4
4S4	2678	3303	6	5
14E1	2745	3453	5	4
19S5	2593	3243	6	6
42S1	2570	3200	5	4
CD (0.05)	281	368		

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in minimizing the incidence of alternaria leaf blight in groundnut. The severity of leaf blight reduced from a score of 7.0 in uninoculated control to 4.0 when sprayed with *Bacillus amyloliquefaciens* 9S2 and 5.0 in treatments sprayed with *Bacillus subtilis* 1S1, 5S1 and 7S2. The bacteria were sprayed onto the leaf of groundnut with the epiphytes five times at 15 days interval beginning 15 DAE. Application of *Bacillus amyloliquefaciens* 9S2 enhanced the pod yield by 11.2% (Table 2). Evaluation of epiphytes during *kharif* 2019 for management of late leaf spot and rust indicated that application of epiphytes, 5 times during the crop growth at 15 days interval reduced disease severity of LLS from 7.0 in uninoculated control to 5.0 when inoculated with *Bacillus sp.* isolate 14E1. The incidence of LLS in infector row was also 9.0. Simultaneously, there was improvement in pod and haulm yield of groundnut (cv TG37A) significantly when inoculated with 14E1 (Table 3).

C. Characterization of Zn, K, and Mn solubilising microorganisms and quantitative estimations

Zn solubilisation:

Twenty-seven new potential Zn-solubilizing bacterial

Table 4. Evaluation of Zn solubilizing bacteria in solubilizing insoluble form of Zn (Zinc phosphate) in liquid medium (7 days after incubation at RT); available Zn in ppm

Isolate/Treatment	Zn in ppm
Control	2.29 ^c
<i>Enterobacter asburiae</i> strain ZM-1	13.56 ^a
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-2	12.48 ^{ab}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-3	13.58 ^a
<i>Acinetobacter pittii</i> strain ZM-4	12.42 ^{ab}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-5	12.93 ^{ab}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-6	12.50 ^{ab}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-7	12.96 ^{ab}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-8	12.75 ^{ab}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-9	12.59 ^{ab}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-10	13.59 ^a
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-11	13.63 ^a
<i>Acinetobacter oleivorans</i> strain ZM-12	12.19 ^{ab}
<i>Pseudomonas aeruginosa</i> strain ZM-13	12.57 ^{ab}
<i>Acinetobacter oleivorans</i> strain ZM-14	12.49 ^{ab}
<i>Pseudomonas aeruginosa</i> strain ZM-15	12.29 ^{ab}
<i>Pseudomonas aeruginosa</i> strain ZM-16	12.14 ^{ab}
<i>Acinetobacter pittii</i> strain ZM-17	12.28 ^{ab}
<i>Bacillus aryabhattai</i> strain ZM-18	13.11 ^a
<i>Acinetobacter lactucae</i> strain ZM-19	13.03 ^a
<i>Pseudomonas aeruginosa</i> strain ZM-29	13.00 ^{ab}
<i>Pseudomonas benzenivorans</i> strain ZM-30	11.17 ^{ab}
<i>Enterobacter hormaechei</i> subsp. <i>xiangfangensis</i> strain ZM-31	12.72 ^{ab}
<i>Pseudomonas aeruginosa</i> strain ZM-34	12.15 ^{ab}
<i>Acinetobacter calcoaceticus</i> strain ZM-35	12.92 ^{ab}
<i>Pseudomonas plecoglossicida</i> strain ZM-36	12.63 ^{ab}
<i>Microbacterium paraoxydans</i> strain ZM-37	12.36 ^{ab}
<i>Enterobacter cloacae</i> strain ZM-38	12.37 ^{ab}

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Table 5. Profile of organic acid secreted by different organisms during solubilisation of different forms of Zn

	Concentration of organic acids in ppm														
	ZnO					Zn ₃ (PO ₄) ₂					ZnCO ₃				
	Malic	Citr.	Succ.	Prop.	Oxa.	Malic	Citr	Succ.	Prop.	Oxa	Malic	Citr	Prop.	Oxa	Malonic
FP82	830.8	19.0	4.98	16.8		ND	15.2	373.0	1.8	17.1	151.9	1.02	ND	28.3	63.6
FP93	ND	ND	1.61	ND	11.6	56.2	ND	ND	ND	ND	175.3	ND	ND	ND	ND
<i>B.megaterium</i>	210.2	ND	ND	ND	ND	256.8	ND	ND	25.9	ND	127.3	ND	ND	ND	340.1
BM6	151.3	ND	ND	ND	ND	301.8	ND	ND	ND	2.8	151.3	ND	ND	ND	ND
BHU1	ND	ND	ND	2.3	9.7	334.9	6.1	2.2	ND	ND	255.5	ND	1.95	ND	ND

ND= not detected

isolates were evaluated *in vitro* for their capacity to solubilize insoluble form of Zn. These isolates solubilized 11.17 ppm to 13.59 ppm of Zn (source Zinc phosphate) against 2.29 ppm in uninoculated control after 7 days of inoculation at room temperature. All the zinc solubilizers were identified by 16S rRNA sequencing and majority of the isolates were found to be different species of the genera *Enterobacter*, *Pseudomonas*, *Acinetobacter* and *Microbacterium* (Table 4). The solubilisation of insoluble zinc into soluble forms was due to the production of organic acids. The profile of organic acids secreted by different organisms during solubilisation of different forms of zinc was studied and estimated in HPLC. Different organic acids like malic, citric, succinic, propionic, oxalic, malonic acid, etc. were

secreted by the zinc solubilising microorganisms (Table 5). Malic acid was found to be a major organic acid secreted during the process.

K solubilization:

Twelve newly isolated strains of

K-solubilising bacteria were evaluated *in vitro* for K-solubilisation and found to solubilize 13.13–32.53 ppm of K (source Potassium aluminosilicate). All the potential K-solubilizers were identified by 16S rRNA

Table 6. Evaluation of potential of potassium solubilizing bacteria in solubilizing potassium aluminosilicate as source (K in ppm in liquid medium after 7 days of incubation at RT)

Isolate/treatment	K in ppm
Control	11.03 ^{ef}
<i>Acinetobacter calcoaceticus</i> strain KM-1	13.13 ^{ef}
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain KM-2	21.43 ^{cd}
<i>Streptomyces roseofulvus</i> K3	17.23 ^{de}
<i>Pseudomonas boreopolis</i> strain KM5-1	22.97 ^{bcd}
<i>Acinetobacter lactuca</i> strain KM5-2	8.33 ^f
<i>Acinetobacter oleivorans</i> strain KM6-1	32.53 ^a
<i>Acinetobacter oleivorans</i> strain KM6-2	28.57 ^{abc}
<i>Acinetobacter lactuca</i> strain KM8-1	30.30 ^{abc}
<i>Acinetobacter lactuca</i> strain KM8-2	26.73 ^{abc}
<i>Pseudomonas taiwanensis</i> strain KM-9	22.03 ^{cd}
<i>Pseudomonas plecoglossicida</i> strain KM-10	17.47 ^{de}
K13 (not identified)	13.47 ^{ef}

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Table 7. Profile of organic acid secreted by different organisms during solubilisation of Potassium aluminosilicate

Isolate	Concentration of organic acid in ppm					
	Oxalic	Malic	Malonic	Citric	Succinic	Propionic
ACC10	26.5	ND	133.1	2375.8	ND	ND
Bmegaterium	29.5	59.8	133.9	8333.7	ND	ND
BHU1	118.9	ND	ND	ND	89.0	2.4
Fp93	ND	ND	ND	ND	66.4	7.5
Fp121	115.0	ND	ND	ND	2.6	13.7
Fp133	28.4	37.0	ND	ND	ND	3.6
SEN29	5.8	ND	25.6	ND	61.8	ND
J20	4.9	ND	ND	ND	58.9	ND
Bm6	36.3	ND	ND	ND	ND	ND
S1(6)	25.8	ND	ND	ND	77.4	ND
SEN15	ND	ND	ND	ND	ND	55.8
ACC3	ND	ND	ND	ND	12.2	75.7

ND= not detected

sequencing and majority of the isolates were found to be belonging to the genera *Enterobacter*, *Pseudomonas* and *Acinetobacter* (Table 6).

The profile of organic acids secreted by K-solubilizing bacteria during K-solubilization *in vitro* was studied and estimated by HPLC. The organic acids like oxalic, malic, malonic, citric, succinic and propionic could be detected in the culture filtrate, oxalic and succinic being the major organic acids.

Mn solubilisation:

Around thirty tentative Mn solubilising isolates have been

obtained and the qualitative method for solubilisation studies are underway.

D. Evaluation of Zn- and K-solubilising microbial inoculants for their efficiency in increasing Zn and K availability

Zn solubilisation:

Twenty-four Zn-solubilising microbial cultures were tested in a pot trial to study the effects of inoculation of groundnut with Zn-mobilising bacterial cultures on growth, yield, and Zn uptake. All the zinc solubilizers were identified by 16S rRNA

sequencing and found to be different species of the genus *Enterobacter*, *Pseudomonas*, *Acinetobacter* and *Microbacterium*. Inoculation with 15 of the Zn-solubilising bacterial cultures resulted in significant increase in pod yield (g/p), ranging from 10-37%. The maximum increase in pod yield was obtained with *Enterobacter cloacae* subsp. *dissolvens* ZM-7. Ten of these isolates also resulted in significant increase in plant biomass (g/p), ranging from 8.7% to 17.3%. Similar trend was also obtained during kharif 2019 in pots.

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K-solubilization:

A pot trial was conducted during summer 2019 to evaluate the inoculation effects of potash-solubilizing bacterial isolates on growth, yield and K-mobilization in

increase in pod yield (g/p), ranging from 24 to 39.6%. The maximum increase was obtained with *Pseudomonas pleoglossicida* K9. All the K solubilizers were identified by 16S rRNA sequencing and found

resulted in significant increase in plant biomass formation in groundnut, ranging from 10.7 to 16.5%. (Table 8). When evaluated during *kharif* season, similar trend was also obtained.

Table 8. Evaluation of potassium-solubilizing bacteria in potted conditions (summer 2019)

Treatments	PY (g/p)	PB (g/p)
Control	3.51	9.13
Control K	4.11	10.14
<i>Acinetobacter calcoaceticus</i> strain KM-1	4.27	10.35
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain KM-2	4.45	10.22
<i>Streptomyces roseofulvus</i> K3	4.11	10.56
<i>Pseudomonas boreopolis</i> strain KM5-1	4.23	10.20
<i>Acinetobacter lactucae</i> strain KM5-2	5.11	11.76
<i>Acinetobacter oleivorans</i> strain KM6-1	5.23	11.21
<i>Acinetobacter oleivorans</i> strain KM6-2	4.10	10.40
<i>Acinetobacter lactucae</i> strain KM8-1	5.33	11.74
<i>Acinetobacter lactucae</i> strain KM8-2	5.17	11.81
<i>Pseudomonas taiwanensis</i> strain KM-9	5.74	11.27
<i>Pseudomonas plecoglossicida</i> strain KM-10	4.20	10.84
<i>Flavobacterium anhuiense</i> strain KM-11	4.10	9.74
<i>Sinorhizobium meliloti</i> strain KM-12	4.20	9.95
<i>Bacillus wiedmannii</i> strain Af-4	4.29	10.13
CD (0.05)	0.67	0.80

groundnut. Out of 14 K-mobilizing bacterial isolates tested, inoculation with 5 isolates resulted in significant

to be belonging to the genus *Enterobacter*, *Pseudomonas*, and *Acinetobacter*. Inoculation with these 5 isolates also

Project 16: Application of Microorganisms for Management of Biotic and Abiotic Stresses in Groundnut

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A. Evaluation of role of different endophytes for alleviation of drought stress and saving of irrigation water and mechanisms of alleviation (Summer 2019)

To ascertain whether substantial irrigation water can be saved by application of endophytic bacteria in summer groundnut, it was found that application of endophytes and 5 irrigations can provide as much pod yield (average 2414 kg/ha) that can be obtained with 10 supplementary irrigations after emergence (2445 kg/ha) without endophytes. Inoculation of endophytes improved the pod and haulm yield of groundnut at all level of irrigations (Table 1).

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Table 1. Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut (Summer 2019; TG37A)

Treatments	No of supplementary irrigations				Mean
	3	4	5	10	
Control	1431	1683	2054	2445	1903
REN47N	1702	2179	2509	2533	2231
SEN29N	1702	2050	2419	2528	2175
J20N	1653	1956	2241	2472	2080
R51N	1604	2029	2405	2604	2160
J22N	1873	2099	2494	2507	2243
Mean	1661	1999	2354	2515	2111
	LSD (0.05)				
Treatment	191				
Irrigation	76				
Treatment X Irrigation	187				

Table 2. Application of endophytes for alleviation of drought stress in groundnut (cv TG37A), Summer 2019 (2 irrigations after emergence)

Treatments	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKM	Yield impr. (%)
Control	1220	2527	60.98	40.09	-
J20N	1562	3042	63.69	42.03	28.06
J22N	1639	3120	63.61	43.25	34.34
REN47N	1442	2890	62.02	41.72	18.17
REN51N	1507	3073	63.38	43.53	23.50
SEN29N	1548	3133	61.98	40.57	26.91
CD (0.05)	276	323	1.05	1.79	

Maximum benefit was provided by *Bacillus firmus* J22N, followed by *Pseudoxanthomons mexicana* REN47N.

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.

To ascertain the role of endophytes in alleviation of drought stress, a separate experiment was conducted with two supplementary irrigations after emergence (50 DAE and 75 DAE) with cultivar TG37A. It was found that there was improvement in yield of groundnut by 18-34% due to inoculation of endophytes (Table 2). Maximum benefit was accrued due to inoculation of *Bacillus firmus* J22N.

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

Five endophytes (*Bacillus firmus* J22N, *Bacillus subtilis* REN51N, *Pseudomonas pseudoalcaligenes* SEN29N, *Acinetobacter junii* J20N and *Pseudoxanthomonas mexicana* REN47N) were evaluated during summer 2019 with cultivar TG37A for alleviation of salinity stress, if any, and with salinity level of around 4.53 at harvest. Results indicated that there was drastic reduction in yield of groundnut with the application of saline water, and at around 4.53 EC soil salinity at harvest.

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Table 3. Effect of endophytes in alleviation of salinity stress in groundnut (cv TG37A) during summer 2019 (Soil EC at harvest: 4.53)

Treatments	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKM (g)	EC (dS/m)	pH	% reduction in yield losses	% reduction in biomass losses
Control	942	2022	57.37	36.77	4.52	8.21	-	-
J20N	1235	2367	59.60	41.00	4.46	8.15	31.1	17.0
J22N	1180	2378	58.87	39.43	4.46	8.17	25.3	17.6
REN47N	1120	2195	60.20	40.30	4.59	8.18	18.9	8.6
REN51N	1171	2445	59.37	39.43	4.52	8.24	24.3	20.9
SEN29N	1189	2298	58.73	39.30	4.55	8.16	26.2	13.6
CD (0.05)	178	265	1.35	2.03	-	-	-	-

Table 4. Effect of C3-CAM transition in imparting salinity tolerance in groundnut (Soil EC at harvest 4.88), summer 2019

	Pod Yield (kg/ha)			Haulm Yield (kg/ha)			EC (dS/m)		pH		% reduction in yield	% reduction in biomass
Treatments	1	2	Grand Total	1	2	Grand Total	1	2	1	2		
DGRMB19	2674	1642	2158	4840	3220	4030	0.44	4.90	8.89	8.41	38.59	35.29
DGRMB5	2671	1385	2028	4808	2360	3584	0.45	4.88	8.88	8.4	48.16	49.93
TG37A	2423	852	1638	4253	1793	3023	0.45	4.87	8.67	8.46	64.84	60.38
Grand Total	2589	1293	1941	4634	2458	3546						
LSD (0.05)												
Treatments	167			207								
Salinity	135			179								
T X S	233			309								

1= No salts; 2= salts applied

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Results indicated that though there was drastic reduction in yield of groundnut with the application of saline water and at around 4.53 EC of soil salinity at harvest, there was reduction in yield. Application of endophytes like *Acinetobacter junii* J20N, *Bacillus firmus* J22N, and *Pseudomonas pseudoalcaligenes* SEN29N and prevented the reduction in yield losses by improving the yield by 31.1%, 25.3%, and 26.2%, respectively (942 kg/ha in control and 1180-1235 kg/ha with these endophytes) at soil EC of around 4.53 at harvest (Table 3). Attempt was made to understand whether there was modulation in the C3-CAM transition in salinity stress alleviation by these endophytes. To do so, it was required first to understand whether C3-CAM transition occurs in cultivated groundnut under salinity stress.

To understand the phenomenon, a separate experiment was undertaken with TG37A and two of its C3-CAM transited and drought tolerant variants with soil salinity level of around 4.87 at harvest. It was found that while imposition of salinity at 4.87 of soil EC reduced the biomass production in the cultivar

TG37A by almost 60% (6676 kg/ha in normal soil condition to 2645 kg/ha in around 4.87 soil EC in TG37A), the over-expressive C3-CAM transited variants of TG37A like DGRMB19 minimized the biomass reduction (7514 kg/ha on normal condition to 4862 kg/ha) and maintained at 35% level of reduction (Table 4). In terms of pod yield, whereas pod yield of TG37A was reduced by 65%, it was restricted to 38% in case of DGRMB19. The expression of modules of CAM could not be completed as RT-PCR was out of order and will be completed during summer 2020. Further validation will be required. Besides, twenty CAM variants of TG37A were obtained having maximum level of night time carboxylation and will be further validated.

This phenomenon will be further confirmed during summer 2020 along with modulation by endophytes, if any, by imposing salinity stress.

Evaluation of CAM transited variants (DGRMB5 and DGRMB19) along with GG2, GG5, GG7 and TG37A were evaluated at CCSRI, Mandvi in collaboration with Dr. S. Acharya at initial soil EC of 1.08 and EC beyond 6.75 at

harvest with irrigation water quality of 1850 TDS (initial) to 4500 TDS (harvest). The soil salinity became so high and quality of irrigation water became so poor that none of the checks could survive whereas CAM transited variants, DGRMB5 (125 kg/ha on the basis of pod yield) and DGRMB19 (257 kg/ha on the basis of plot yield) could. Dr. Acharya has also selected 87 plants and will be evaluated during summer 2020.

C. Evaluation of C3-CAM transited variants of TG37A

The C3-CAM variants obtained from TG37A were multiplied, without application of supplementary irrigation after emergence, for maintenance of genetic stock and also for use in multiplication during *kharif* 2019. Similarly, seven drought tolerant variants of TG37A (DGRMB3, DGRMB5, DGRMB13, DGRMB17, DGRMB19, DGRMB29 and DGRMB31) were evaluated alongside TG37A with two levels of irrigations, two and full (10), after emergence. It was found that whereas reduction of biomass was around 45% in TG37A with two supplementary irrigations against normal condition, C3-CAM

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Table 5. Evaluation of performance of CAM transited groundnut variants in normal and drought stress conditions (summer 2019)

Treatments	PY (kg/ha)			HY (kg/ha)			Biomass		Biomass	Yield
	1	2	Mean	1	2	Mean	1	2	Reduction (%)	
TG37A	1034	2180	1607	2007	3313	2660	3040	5493	44.65	52.58
DGRMB13	1637	2833	2235	2544	3590	3067	4181	6423	34.90	42.22
DGRMB17	1627	2680	2153	2537	3533	3035	4164	6213	32.99	39.30
DGRMB19	2156	3000	2578	2929	3937	3433	5085	6937	26.70	28.14
DGRMB29	1476	2467	1971	2350	3453	2902	3826	5920	35.38	40.18
DGRMB3	1574	2533	2054	2559	3643	3101	4134	6177	33.08	37.86
DGRMB31	2062	2957	2510	2764	4013	3389	4827	6970	30.75	30.25
DGRMB5	1787	2717	2252	2588	3757	3172	4374	6473	32.43	34.23
Mean	1669	2671	2170	2535	3655	3095				
LSD (0.05)										
Treatments	121			243						
Level of irrigations	73			93						
TXL	205			263						

Table 6. Seed production (q)

CAM Variants	Summer 2019	kharif 2019
DGRMB24	13.90	8.10
DGRMB32	15.50	10.50

transited variants showed biomass reduction from 27-35% in similar conditions. Least reduction in biomass was obtained with DGRMB19. In

case of pod yield, reduction was around 53% in TG37A with two irrigations whereas it varied from 28% to 42% in different CAM variants (Table 5).

During kharif 2019, twelve CAM variants of TG37A were evaluated for yield under rainfed condition keeping TG37A (NC), JL501 (ZC),

GG7 (LC), and GG2 (LC) as checks. The pod yield of variants ranged from 2111 kg/ha to 2829 kg/ha against 2055 kg/ha for TG37A (NC), 2124 kg/ha for GG2 (LC), 2054 kg/ha for GG7 (LC) and 2302 kg/ha for JL501 (ZC). Yield of DGRMB5, DGRMB19, DGRMB24, DGRMB31, and DGRMB32

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Table 7.Yield evaluation of C3-CAM variants of TG37A strictly under rainfed conditions during *kharif*2019

Treatments	PY (kg/ha)
DGRMB1	2292
DGRMB3	2774
DGRMB5	2698
DGRMB13	2377
DGRMB17	2111
DGRMB19	2746
DGRMB20	2116
DGRMB24	2829
DGRMB29	2151
DGRMB31	2609
DGRMB32	2713
DGRMB41	2123
TG37A (NC)	2055
GG2 (LC)	2124
Gg7 (LC)	2054
J1501 (ZC)	2302
CD (0.05)	268

were significantly higher than checks (Table 7).

D. Evaluation of endophytes for enhancing growth and yield of groundnut (5 endophytes; rainfed, field by plant growth promoting attributes (kharif2019)

Table 8. Evaluation of endophytes for plant growth promotion and yield enhancement of groundnut strictly under rainfed conditions (cultivar TG37A) during *kharif*2019

Treatment	PY (kg/ha)	HY (kg/ha)	Shelling out-turn (%)	HKM (g)
Control	2605	3657	67.50	39.1
J20N	2828	3693	67.50	39.0
J22N	3106	4220	70.00	42.1
REN47N	2643	3653	67.57	40.3
R51N	3064	4440	70.17	41.2
SEN29N	2851	3820	67.47	39.5
CD (0.05)	384	533	1.40	2.00

Five endophytes (*Bacillus firmus* J22N, *Bacillus subtilis* R 5 1 N, *Pseudomonas pseudoalcaligenes* SEN29N, *Acinetobacterjunii* J20N and *Pseudoxanthomonas maxicana* REN47) were evaluated during *kharif* 2019 with cultivar TG37A to assess the plant growth promoting abilities of the cultures. Seed inoculation with the endophytes, in general, resulted in increase in plant biomass production, shelling percentage and hundred kernel mass. Significant enhancement in pod yield was obtained in treatments receiving J22N and R51N cultures (Table 8).

E. Evaluation of moisture-deficit and salinity- stress tolerant groundnut rhizobia for enhancing BNF

Drought:

Four groundnut rhizobia viz. DGR10, DGR11, DGR17, DGR19 along with standard isolate NC92 were evaluated with application of irrigation at 15 days interval after emergence (total five irrigations after emergence). These rhizobia were capable of tolerating matric potential of -2.5 MPa to -3.5 MPa. Application of DGR19 significantly enhanced the pod yield, haulm yield, nodulation and shelling out-turn of groundnut (cv TG37A).

F. Evaluation of CAM transited groundnut genotypes for salinity tolerance (collaboration with CCSRI, Mandvi, Bhuj; Dr.S.Acharya)

A trial was conducted at CCSRI, Mandvi, Bhuj with six CAM transited variants of TG37A viz. DGRMB5,

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DGRMB5-B, DGRMB24, DGRMB32, DGRMB19 and DGRMB42. They were tested against national (TG 37A) and zonal check (GG 7) under high EC (4.55 dSm^{-1}) and low organic carbon (0.39%) during kharif 2019. Whereas DGRMB19 (3687 kg/ha), DGRMB5 (3663 kg/ha), DGRMB42 (3473 kg/ha) and DGRMB32 (3425 kg/ha) gave 15.67, 14.93, 8.96 and 7.46 per cent higher pod yield than the zonal check GG 7 (3187 kg/ha). The highest shelling out-turn was obtained with DGRMB19 (74%) as compared to 71.67 and 70.00 of national (TG 37A) and zonal check (GG 7), respectively.

G. Endophytes for alleviation of salinity stress at Mandvi, Bhuj with different crops (collaboration with CCSRI, Mandvi, Bhuj; Dr. S. Acharya)

Three groundnut endophytes viz. *Bacillus firmus* J22, *Bacillus subtilis* REN51 and *Pseudomonas, pseudo-alcaligenes* SEN29 were evaluated with four varieties viz; GG2, Gg5, GG7 and TG 37. Application of endophytes alleviated salinity stress and improved pod yield of groundnut by 18-20 per cent across cultivars and gave significantly higher yield than uninoculated control. Among the endophytes J22 was the best. Besides, 33 demonstrations on different crops (cotton, til, mung,

guar and bajra) in seven villages viz; Bhariya, Gadshisha, Deupar, Ratnapar, Rajpar, Maska and Bidada exhibited that application of *Bacillus firmus* J22 gave reduced incidence of fungal disease, drying of pants besides giving higher yield with better filling of grains. Application of J22 in cotton Hybrid GTHH BtII at CCSRI, indicated that J22 strain gave the highest (1962 kg/ha) seed cotton yield followed by SEN 29 (1900 kg/ha); which was 22.7 and 18.8 per cent higher than check with no endophyte treatment (1599 kg/ha). The differences in yield were attributed mainly to more number of bolls/plant.

H. Evaluation of CAM-transited groundnut genotypes for drought tolerance at hotspot location (collaborators KVK Gadag; KVK Kalyandurga; KVK, Chitradurga; KVK Reddipalli; KVK Tumkuru)

To demonstrate the potential of CAM transited groundnut genotypes in moisture-deficit stress situation, OFT (plot size 0.5 to 1.0 acre) was conducted at farmers field through KVKs located at Reddipalli and Kalyandurga (Andhra Pradesh) and Tumkuru, Chitradurga and Gadag (Karnataka) totally under rainfed condition (without application of protective irrigation). Whereas there was 50-65 days of drought after

sowing at Kalyandurga, Reddipalle and Tumkuru, no drought was there at Gadag and there was dry spell of 30-45 days at Chitradurga. Two CAM transited variants of TG37A viz. DGRMB32 and DGRMB24 were evaluated along with TG37A and a local check (Kadiri 6 in Andhra Pradesh and TMV2 in Karnataka) during kharif 2019. Results of Gadag has not been considered for evaluation as there was normal rainfall and no stress was experienced. Results indicated that in Andhra Pradesh, DGRMB24 outperformed Kadiri 6 and TG37A significantly (Table 8) under identical situation of drought (50-65 days of drought after sowing). DGRMB24 gave 11.8% higher pod and 15.5% higher haulm yield than Kadiri 6. Similar results were also obtained as compared to TG37A (Table 9).

In Karnataka, OTFs were conducted in farmers field at Tumkuru, Chitradurga and Gadag. There was drought spell of 65 days at Tumkuru after sowing whereas it was 30-45 days at Chitradurga. At Gadag, there was more than normal rainfall and no stress was experienced by the crop. Combined results of Tumkuru and Chitradurga indicated that DGRMB24 gave significantly higher (8.7%) higher pod yield than TG37A but at par that of local checks (Table 10).

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Table 9. Results of OFT conducted in Andhra Pradesh during *kharif* 2019 under rainfed situation with CAM variants of TG37A

Pod yield (kg/ha)					
Farmer	DGRMB24	DGRMB32	Kadiri6	TG37A	Mean
KVK, Kalyandurga					
Aswath Reddy	1695	1324	1693	1649	1590
Chanamalappa	1770	1683	1541	1630	1656
Chanamalla P	1672	1618	1548	1643	1620
KVK, Reddipalli					
KVK Reddipalli	2114	2220	1760	1581	1949
Naganna	1780	1691	1541	1442	1614
Yerriswamy	1847	1740	1647	1787	1755
Mean	1813	1713	1622	1624	1694

CV: 9.08, [LSD@0.05](#): 124.7 (Farmer); 101.8 (genotype)

Haulm yield (kg/ha)					
Farmer	DGRMB24	DGRMB32	Kadiri6	TG37A	Mean
KVK, Kalyandurga					
Aswath Reddy	2842	2227	3496	2574	2785
Chanamalappa	3193	3164	2595	2739	2923
Chanamalla P	3150	3094	2625	2783	2913
KVK, Reddipalli					
KVK Reddipalli	3374	3767	1600	2740	2882
Naganna	3186	3117	2736	2624	2916
Yerriswamy	2053	1840	2357	1980	2058
Mean	2966	2868	2568	2564	2744

CV: 9.93, [LSD@0.05](#): 220.8 (Farmer); 180.3 (genotype),

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Table 10. Performance of CAM transited variants of TG37A in drought-prone areas of Tumkuru and Chitradurga

Pod Yield (kg/ha)					
Farmer	DGRMB24	DGRMB32	TG37A	Local check	Mean
KVK, Chitradurga					
Chandrappa	2011	2135	2002	2165	2079
Narasimhamurtthy	2067	1809	1857	2173	1977
Krishnamurthy	2026	1865	1805	2248	1986
Mahalingappa	2106	1938	1840	2119	2001
Nagaraj	2167	2007	1867	2246	2072
KVK, Tumkuru					
Eramuddappa	1330	1267	1247	1263	1277
Girijamma	1397	1277	1310	1327	1328
Muddobalaiah	1503	1377	1407	1430	1429
Muddurangaiah	1300	1187	1217	1233	1234
Nagarathnamma	1223	1300	1190	1240	1238
Thipperangappa	1360	1240	1270	1287	1289
Overall Mean	1681	1582	1547	1703	1628

CV: 6.6, [LSD@0.05](#): 87.3 (Farmer); 52.6 (genotype)

05 Socio-economic Research and Extension for Groundnut Development



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

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(*Transferred on 23.11.2019

**Transferred on 13.12.2019)

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

Better resource use efficiency is need of the hour among groundnut growers of India. Since, the cost of cultivation is increasing incrementally, the efficient use of input in field for higher productivity is the one found to be goal of the rainfed farming to produce

more with less input cost. As such groundnut is usually grown as one of the primary rainfed crop in Tumkuru district and one of choicest crop in the districts of Gadag, Dharward districts of Karnataka. There exist wider yield gaps in groundnut when compare to other major groundnut growing states of India. To attain higher productivity, capacity building of farmers on improving their efficiency in resource use is essential and that lead to higher production among small and marginal farmers per unit input.

For collecting primary data, survey was undertaken among 120 farmers of Tumkuru, Dharwad and Gadag districts with structured interview schedule during *kharif* 2019.

Farmers were chosen by following multi-stage random sampling method. In this study, those farmers having up to 1.5 ha were considered as marginal farmers and 1.5 to 3.0 ha as small farmers and interviewed directly among 40 farmers from each district and from each district 10 farmers from four randomly chosen villages. To analyse technical efficiency the frontier production function model was used and to analyse economic efficiency, cost of cultivation with respect to each component along with labour usage was analysed.

Uneven balancing of fertilizers, with generally available fertilizers in the agro-service centres and over use of farmstead machineries including draught animals led

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to over exploitation of the reachable resources. This led to development failures with cost structure escalating in commonly used resources and poorly managing the micronutrients or the one hitherto not habituated to use. Hence, resource use efficiency in value terms was analysed among the small and marginal farmers. In the study areas, small and marginal farmers invest about 35% of cost in seed and post harvesting practices. The machinery usage in post-handling practices were minimal to medium and most of the marginal and small farmers having possession of seed cost and manpower required for sowing. The total cost of cultivation was about Rs.35790/ha. Allocative efficiency is concerned; the allocation for seed is influenced by rain pattern. Higher the pre-monsoon shower higher the seed rate and investment in fertilizer, and this pattern among marginal and small farmers seems to be same. The change may have to be effected in seed use especially using of newly released varieties than age old TMV-2. The reason farmers prefer this variety is, because local market prefers this variety. Apart from seed,

fertilizers, plant protection chemicals were used as per the accumulated knowledge of groundnut cultivation and immediate previous year experience. Further, fertilizer usage also influenced by credit worthiness of the farmers among the agro supply service providers. The BC ratio range is between 1:1.2 to 1:1.9. Majority of marginal farmers (72.0 per cent) operating with 62.50 per cent of technical efficiency. About 28 per cent farmers operating with 68.0 per cent of technical efficiency. This reveals that among small and marginal farmers, with the same investment, about 34.5 per cent yield improvement can be achieved. This speaks about the yield gap exists in groundnut due to inefficient use of inputs and machinery resources. Hence, there need to build the capacity of small and marginal farmers on better allocative efficiency in the rainfed areas.

Assessing the extent of farm-manual abilities of

groundnut growers:

With same respondents a study was carried out on assessing the extent of farm managerial abilities of small and marginal farmers. It was found that majority of the small (51.60%) and marginal farmers (40%) found to have medium farm managerial abilities. This study found low managerial ability among 36.60% of marginal farmers and 30.0% of small farmers. Among small farmers, only about 18.30% 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 also 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, co-ordinating the activities than small farmers. As far as knowledge of scientific practices was

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

TE range	Farmers (%)	Average TE	% of output lose due to inefficiency
< 70%	72.0	62.50	37.50
70-80%	28.0	68.00	32.00

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

Extent of farm-managerial abilities	Marginal Farmers (60)		Small Farmers (60)	
	No. of Farmers	Percentage	No. of Farmers	Percentage
High >77	14	23.4	11	18.3
Medium ≤77	24	40.0	31	51.6
Low ≤50	22	36.6	18	30.0

concerned almost all farmers respondents were in medium range. Hence capacity building of farmers is necessary in this component.

Visit of farmers

This year (2019-20), about 500 visitors from various states viz. Gujarat, Maharashtra, and Rajasthan visited this Directorate. It includes a total of 500 plus farmers from 4 different states, and women farmers. These visits were sponsored 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 field experiments, Technology Park, laboratories, museum, library etc. and interaction meetings with the scientists were also arranged.

Development activities for tribal and hill regions: Reaching the unreachable

For tribal development the government of India designed

with crop and nutritional development packages. Through ICAR-DGR, the tribal farmers living in the groundnut growing areas vastly benefited since groundnut being a nutritious nut as well as pretentious fodder for their precious animal husbandry. Further, tribal mostly cultivate poor yielding groundnut varieties along with minor cereals and red gram as intercrops under rain fed conditions. A vast track of tribal belts endowed with minor millets and unutilized virgin lands. Though they cultivate, but cultivate with primitive ideas and practices with less yielding varieties. Thus, training of tribal farmers on improved technologies and supply inputs was need of the hour to establish remunerative groundnut farming system in tribal areas.

With this rational in mind, the ICAR-DGR through Tribal Sub Plan (TSP) had collaboration with SAUs and

KVKs where tribal farmers are more in number and able to cultivate groundnut if they trained. During 2019-20 to conduct the On-Farm Demonstration on groundnut with latest varieties and technologies about Rs.25.67 lakhs was sanctioned to Agricultural Research Station, Vizianagaram, and KVK, Narmada covered about 200 tribal farm families.

06 Highlights of AICRP on Groundnut: 2019



I. Crop Improvement

1. Maintenance, multiplication and characterization of groundnut germplasm

- 53 wild *Arachis* accessions representing six sections of the genus *Arachis*: section *Arachis* (35 accessions); *Erectoides* (10 accessions); *Caulorhizae* (2 accessions); *Rhizomatosae* (2 accessions); *Extranervosae* (2 accessions); and *Heteranthae* (2 accessions) are being maintained in the field gene bank at TNAU, Vridhachalam.
- In the same centre, a field gene bank comprising four allotriploids {(*A. hypogaea* cv. VRI 4 × (*A. correntina* × *A. helodes*); *A. hypogaea* cv. VRI 2 × *A. correntina*; *A. hypogaea* cv. VRI 2 × *A. kempff-mercadoi* and *A. hypogaea* cv. VRI 2 × *A. cardenasii*}; three auto-

tetraploids developed from two diploid species of the section *Arachis* (*A. villosa* and *A. stenosperma* and one species from the section *Erectoides* viz. *A. rigonii*); 11 amphidiploids ($2n=4x=40$) obtained through direct hybridisation between diploid wild species and tetraploid cultivated species were also being maintained.

- A total of (4523) germplasm accessions are being maintained at 13 centres. This included 60 wild accessions; 19 interspecific derivatives; exotic collection; 3202 Spanish bunch accessions; 53 Valencia accessions; 810 Virginia Bunch accessions; 374 Virginia Runner accessions; and four other germplasm accessions.

2. Hybridization programme

- For developing high-yielding

groundnut cultivars possessing resistance to various biotic and biotic stresses which limit yield, 100 single-crosses during *rabi*-summer and 190 crosses in *kharif* 2019 were made at different AICRP-G centers.

- During *rabi*-summer progenies of 393 crosses were advanced to their respective next filial generation from which a very large number (4298) of selections were made.
- During *kharif* season; progenies of 1513 crosses were advanced to their respective next filial generation from which very large specific selections were made (14307). Of the total crosses, which were advanced to different filial generations, in *rabi*-summer, 309 crosses were in early generations (F_1 - F_3) and in *kharif* progenies of 1154 crosses were in early

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generations (F_1 - F_4) and the rest were in advanced generations (F_5 onwards).

3. Varietal evaluation at multi-location

- A three tier system of evaluation of groundnut entries under the nomenclature of Initial Varietal Trial, Stage I (IVT I); Initial Varietal Trial, Stage II (IVT II) and Advanced Varietal Trial (AVT) was adopted and the trials were allotted to 24 centers located in five agro-ecological zones of groundnut in *kharif* and 20 centers located in five agro-ecological zones *rabi*-summer.
- During *kharif* 2019, nine entries of Spanish Bunch; 10 entries of Virginia were tested in IVT-I at 25 locations across the five zones. The IVT-I trial will be repeated as such for second year as IVT-II in same locations for promotion of entries to AVT.
- A total of 16 SB entries, 10 genotypes of Virginia and 2 large seeded genotypes were tested in IVT-II across the five zones with appropriate checks.
- In *kharif* 2019, none of the test entries tested under IVT-II of Spanish and Virginia trials were promoted to AVT, while during *rabi*-summer, two entries (TG 81 and AG 2012-06) were promoted to AVT. TG 81 (Proposed by BARC)

promoted to AVT in Zone I (Mainpuri and Ludhiana) with a high pod (4389 kg/ha) and kernel (3013 kg/ha) yield (10% higher kernel yield over the best check, TAG 24). Entry AG 2012-06 (Proposed by AU, Anand) promoted to AVT in Zone II (Gujarat and southern Rajasthan) with a high pod (3108 kg/ha) and kernel (2088 kg/ha) yield (8% higher over the best check, TG37A) and Zone IIIa (Dharwad, Hiriya, Raichur, Rahuri, Shirgaon) with a high pod (3441 kg/ha) and kernel (2329 kg/ha) yield (10% higher over the best check, Kadiri Haritandhra) and are currently in verge of their evaluation.

- In ALSVT (Advanced Large Seeded Varietal Trial), two entries along with four checks varieties evaluated at five locations. None of the test genotype could surpass significantly over best check GJG-HPS-2 for pod (2560 kg/ha and) and kernel yield (1750 kg/ha) and hence no identification.
- In AVT during *kharif* 2019, the Spanish bunch genotype K 1812 was found superior over the best check R 2001-2 in Zone V comprising Tamil Nadu, Andhra Pradesh and, Karnataka. Across different stages of testing from 2017 to 2019, the genotype, K 1812 (Proposed by ARS, Kadiri),

recorded a high pod (3514 kg/ha) and kernel yield (2445 kg/ha) against the best zonal check variety, R 2001-2 with 3173 kg/ha of pod 2144 kg/ha of kernel yield. Over different check varieties, the increase in pod yield of K 1812 was 10.7% over R 2001-2; 44% over GPBD 4; and 17.4% over R 2001-3 and 38.7% over VRI Gn.6. Increase in kernel yield of K 1812 over these check varieties was 14.1% over R 2001-2; 44.2% over GPBD 4; and 19.1% over R 2001-3 and 39.2% over VRI Gn.6, respectively. Oil content of K 1812 was 51%. Hence proposed for identification.

- In *rabi*-summer 2018-19, 15 entries were tested under Initial Varietal Trial; stage-I (IVT-I) at 20 location across five zones and trial has been repeated as IVT-II in *rabi*-summer 2020.
- In AVT during *rabi*-summer 2018-19, the genotype Dh 257 was found superior over the best check TAG 24 in Zone IIIa (Dharwad, Hiriya, Raichur, Rahuri, Shirgaon). Across different stages of testing from 2016-17 to 2018-19, the genotype, Dh 257 (Proposed by UAS, Dharwad), recorded a high pod (3397 kg/ha) and kernel yield (2453 kg/ha) against the best zonal check variety, TAG 24 with 2827 kg/ha of pod 2014 kg/ha of kernel yield. Over different

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check varieties, the increase in pod yield of Dh 257 was 20.2% over TAG 24; 42.9% over R 8808; and 16.9% over R 2001-3 and 27.3% over Kadiri Haritandhra. Increase in kernel yield of Dh 257 over these check varieties was 21.8% over TAG 24; 46.2% over R 8808; and 25.3% over R 2001-3 and 30.7% over Kadiri Haritandhra respectively. Oil content of Dh 257 was 48%. Hence proposed for identification.

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

- 10 entries in HOVT-I-Spanish, 9 entries in HOVT-I-Virginia were tested in six locations which will be repeated in HOVT-II-Spanish and HOVT-II-Virginia in *kharif* 2020 in all six locations.
- Eight entries in HOVT-II-Spanish and six entries in HOVT-II-Virginia were tested *kharif* 2019. Pooled analysis of data of HOVT-I & II could not be done as data on fatty acid profile is awaited due to Nationwide lockdown.

5. Early Maturity Trial

- For identification of early maturity groundnut varieties for special niches, 13 entries were tested under this trial at five location in *kharif* 2019 and will be repeated in *kharif* 2020.

6. Breeder Seed Production

- During *kharif* 2019, DAC indents to the tune of 9343.31q of breeder seeds were received

for 50 groundnut varieties. Based on the availability of nucleus/breeder seed stage I, a production target of 8747.45q was assigned for 46 groundnut varieties to 19 centres. During *kharif* 2019, a total quantity of 2914.93q breeder seed could be produced. To mitigate the short fall, a compensatory programme was undertaken during *rabi*-summer 2019-20 and the anticipated production is about 5894.30q. Thus, the total expected production of groundnut breeder seeds during 2019-20 would be 8809.23q.

Crop Production

Kharif 2019

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

The experiment was conducted continuously for three years i.e., 2017, 2018 and 2019 at Mohanpur. The mean data indicated that significantly highest pod yield was found with weed free check followed by pre-emergence application of Pendimethalin @ 1.5 kg a.i. ha⁻¹ followed by early tank mix post emergence herbicides of Imizathapyr + quizalofopethyl @ 50:50 ratio.

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

The experiment was conducted for three years at Dharwad,

Bhubaneswar and Hiriyur. At all the centres sole groundnut recorded significantly higher groundnut pod yield. But in terms of groundnut pod equivalent yield it was at far with groundnut + little millet (4:2) at Dharwad, groundnut + finger millet (2:1) at Bhubaneswar and Groundnut + finger millet (5:2) at Hiriyur.

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

The trial was allotted at Bawal, Gwalior and Jodhpur. Bawal centre did not report any result. At Jodhpur significantly higher pod yield was observed with 125 % RDF while plant population @ 4 lakh ha⁻¹ gave highest pod yield without having significant effect on pod yield.

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

The experiment was conducted continuously for three years at Hiriyur, Kadiri and Tirupati. At Hiriyur, DGREB-3 (i/c 15 days interval) obtained significantly higher pod yield, at Kadiri significantly higher yield was gained with DGREB-2 and at Tirupati DGR Endophytic Bacteria 1 (DGREB 5) with normal inter cultural operations provided highest pod yield without having significant effect.

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5. Identification of remunerative groundnut based cropping systems

The experiment was conducted at Dharwad, Jalgaon, Junagadh and Vridhachalam during *kharif* 2018 for second year. At Dharwad Significantly highest groundnut crop pod equivalent yield was obtained with Groundnut-Sorghum sequence cropping system (3969 kg ha^{-1}) over all the cropping systems evaluated. At Jalgaon significantly higher groundnut pod equivalent yield was found with Groundnut+Pigeonpea (4:2) cropping system. At Junagadh significantly higher groundnut pod equivalent yield was found in groundnut + sesame (1:1)–Onion cropping sequence and Vridhachalam centre not reported data for the year 2018-19.

6. Application of bio-formulations in *kharif* groundnut production

The experiment was conducted at Dharwad, Durgapura, Gwalior, Jalgaon, Junagadh, Kadiri, Jhargram, Shirgaon and Tirupati for three years. At Dharwad, Gwalior and Junagadh, seed treatment with NPK liquid formulation + Zn solubilizing bacteria resulted in reduction of RDF to the extent of 25%. At Durgapura, seed treatment with bio-grow gave resulted in reduction of RDF to the extent of 25%. At Jalgaon, Kadiri, shirgaon and

Tirupati application of 100 % RDF along with bio-grow recorded significantly highest dry pod yield. At Jhargram, during *kharif* 2019, seed treatment with bio-formulation of NPK liquid grade fertilizer + Zn solubilizer (B2) along with 100% RDF gave the higher yield.

7. Integrated water management in rainfed groundnut

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

8. Identifying suitable crop geometries for mechanical intercropping in Spanish bunch type groundnut

The trial was conducted at Jalgaon, Junagadh and Bikaner. At Jalgaon, intercropping of groundnut + pigeon pea (3:1 row proportion) ($60/30/30 \text{ cm}$) recorded significantly higher groundnut pod equivalent yield which was at par with

intercropping of groundnut pigeon pea (2:1 row proportion) ($60/30 \text{ cm}$). At Junagadh, Groundnut-Pigeonpea intercropping system-3:1 ($60/30/30 \text{ cm}$) recorded significantly higher groundnut pod equivalent yield. At Bikaner different crop geometries did not have any significant effect on groundnut pod yield. Bhubaneswar and Hiriya did not report any data.

9. Developing Conservation Agriculture practices in groundnut-wheat cropping system

The trial is conducted at Durgapura, One year results indicated that groundnut sown on permanent beds with and without residue produced significantly higher pod yield and at Jalgaon, after harvesting of wheat, the groundnut crop sown on reduced tillage (one blade harrowing just after harvesting of wheat) with residue incorporation recorded higher dry pod yield. Bikaner and Ludhiana did not report any data.

10. Improving phosphorus use efficiency in *kharif* groundnut with microbial cultures

The trial was conducted at Bikaner, Hiriya, Junagadh, Jhargram, Puducherry, Tindivanam and Vridhachalam.

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At Bikaner significantly highest pod yield was recorded with application of 60 kg P_2O_5 with DGRC culture. At Hiriya, application of 40 kg/ha of P + DGRC culture recorded significantly higher dry pod. At Junagadh, different phosphorus doses alone and in combination with DGRC culture did not have any significant effect on pod yield. At Jhargram, Puducherry and Vridhachalam application of 60 kg P_2O_5 /ha+ DGRC recorded significantly higher pod. Ludhiana center did not report any data.

11. Integrated weed management in kharif groundnut

The experiment was conducted at Dharwad, Durgapura, Gwalior, Hiriya, Jodhpur, Puducherry, Tindivanam, Tirupati and Vridhachalam and Palem. Raigarh center did not reported data. At Dharwad, Hiriya, and Vridhachalam, significantly higher dry pod yield obtained with treatment pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + manual weeding at 25-30 DAS. At Durgapura, Jodhpur and Tirupati, two manual weedings at 25 and 40 DAS recorded significantly higher dry pod yield. At Gwalior, Puducherry and Palem, application of pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + quizafop – p-

ethyl @ 50 g/ha at 15-20 DAS recorded significantly highest pod yield. At Tindivanam, significantly higher dry pod yield was recorded with application of Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + quizafop – p- ethyl @ 50 g/ha at 15-20 DAS.

12. Optimization of seed rate for groundnut cultivars having differential seed sizes

The experiment was conducted at Bikaner, Bhubaneswar, Durgapura, Jalgaon and Junagadh. Jagtial center not reported data. At Bikaner, significantly higher pod yield was obtained with HNG-10 @ 210 kg ha⁻¹ and Mallika @ 280 kg ha⁻¹. At Bhubaneswar, significantly higher pod yield was obtained with Dharani (seed rate as calculated by considering HKW and recommended plant population). At Durgapura, variety RG 510 (HKW 50 g) with seed rate considering HKW and RPP recorded maximum pod yield. At Jalgaon, significantly higher pod yield was recorded by PhuleMorna with seed rate as calculated by considering HKW and recommended plant population. At Junagadh significantly higher pod yield was recorded by GJG 32 (Bunch type, 45cm x 10cm) (seed rate as calculated by considering HKW and recommended plant population).

13. Identifying optimum row ratio for rainfed groundnut + maize/pearl millet intercropping system

This experiment is conducted at Dharwad and Bikaner with maize and pearl millet, respectively. At, Dharwad, among the intercropping treatments, groundnut + maize (5:1), groundnut + maize (4:1) and groundnut + maize (3:1) recorded significantly higher groundnut pod equivalent yield than groundnut + maize (2:1) and Sole maize and were at par with sole groundnut. While at Bikaner, highest groundnut equivalent yield was obtained at sole groundnut followed by 5:1 and 4:1 (Groundnut: Bajra) ratios.

14. Identifying suitable crop geometry and nutrient dose for Spanish bunch groundnut during kharif

This trial was conducted by Junagadh. Significantly higher pod yield was recorded by 30 x 10 cm (3.33 lakh/ha pp) with 100% RDF + Biofertilizer (Rhizobium, PSB, and KSB

15. Effect of zero budget natural farming practices on groundnut productivity

This field experiment is conducted by Hiriya and Gwalior. At both centres, significantly higher pod yield recorded where recommended doses of fertilizers were applied.

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16. Effect of nutrient management and crop establishment methods of rice on groundnut productivity under rice-groundnut cropping system

This experiment is initiated by Bhubaneswar and Mohanpur during *kharif* 2019 with rice crop and experiment is under progress. The data will be included in the *rabi*-summer report 2019-20.

17. Effect of paclobutrazole on productivity of groundnut

Palem centre not reported data. At Vijayanagram, the plant height decreased significantly with increased concentration of paclobutrazol. The dry pod yield was highest with the application of PBZ@200ppm.

18. Agronomic management of AVT

- Agronomic practices for AVT entry (Girnar-4) : In Dharwad, AVT groundnut entry Girnar-4 recorded significantly higher dry pod yield over check KDG-123 under similar management i.e., recommended package practices. The increment is to the extent of 8.96 per cent.
- Agronomic practices for AVT entry (K-1574) : In Dharwad, AVT groundnut entry K-1574 recorded significantly higher dry pod yield over check TGLPS-3 under similar management i.e., recommended package practices. The

increment is to the extent of 24.47 per cent.

- Agronomic practices for AVT entry (ICGV06189) : In Dharwad, AVT groundnut entry ICGV06189 recorded significantly higher dry pod yield over check TGLPS-3 under similar management i.e., recommended package practices. The increment is to the extent of 10.91 per cent.
- Agronomic practices for AVT entry (DH-257) : In Junagadh, significantly higher pod yield recorded by GJG 32 as compared to DH 257.
- Agronomic practices for AVT entry (Girnar-5) : At Junagadh, no significant different was observed in pod yield over check variety KDG 128..
- Agronomic practices for AVT entry (K1812) : In Kadiri, K-1812 recorded significantly higher pod yield over local check Kadiri-6 under similar management.

Recommendations (Kharif 2019)

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

- Pre-emergence application of Pendimethalin @ 1.5 kg a.i. ha⁻¹ followed by early tank mix application of post emergence herbicides of Imazethapyr @ 37.5 g a.i. ha⁻¹ + Quizalofopethyl @ 25 g a.i. ha⁻¹ (Action : Jhargram / Mohanpur)

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

- Intercropping of Groundnut + millets (Foxtail millet, Little millet and Finger millet) in 4:2 row ratios (Action: Dharwad)
- Intercropping of Groundnut + millets (Foxtail millet, Little millet and Finger millet) in 2:1 row ratios (Action: Bhubaneswar)
- Intercropping of groundnut + millets (foxtail, finger and little millet) in 6:1 row ratios (Action: Hiriya)

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

- Application of DGREB-3 with inter-cultivation 15 days interval (Action : Hiriya)

4. Application of bio-formulations in *kharif* groundnut production

- Seed treatment with NPK liquid formulation (250 ml ha⁻¹) + Zn solubilizing bacteria (125 ml ha⁻¹) + 75% RDF of respective center (Action : Dharwad, Gwalior and Junagadh)
- Seed treatment with Bio-grow (125 ml ha⁻¹) + 75% RDF of respective center (Action : Durgapura)
- Seed treatment with Bio-grow (125 ml ha⁻¹) + 100% RDF of respective center

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(Action : Jalgaon, Kadiri, shirgaon and Tirupati)

Rabi-summer 2018-19

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

The experiment was conducted at Puducherry and Rahuri during *rabi*-summer, 2018-19. At Pudducherry DAPG-producing fluorescent pseudomonads FP 86 and at Rahuri FP 98 was found to give significantly higher pod yield.

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

The experiment was conducted at Junagadh during *rabi*-summer, 2018-19. Application of 50 kg K₂O ha⁻¹ in 8 equal splits produced significantly highest pod yield.

3. Evaluation of suitable varieties of groundnut with nutrient levels for potato-groundnut crop sequence

The trial was allotted to Dantiwada and Mohanpur. Only Mohanpur centre reported data for *rabi*-summer 2018-19. Highest dry pod yield was found with variety TG 51 with no inorganic fertilizer application to groundnut crop succeeding potato crop in sequence.

4. Irrigation management in potato-groundnut systems in light

The trial was allotted to Dantiwada and not reported data for the year 2018-19.

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

The trial was allotted to Bhubaneswar, Dharwad (Kumta), Kadiri (Vijayanagaram), Mohanpur, Raigarh, Tindivanam and Vridhachalam for *rabi*-summer 2018-19 and all the centres except Kadiri (Vijayanagaram) and Raigarh have reported the results.

At Bhubaneswar best herbicidal response to weed density and weed dry matter was observed from application of Pendimethalin 30% EC @ 1.5 kg ha⁻¹ + 1 Hand weeding (25 DAS) as well as with 2 Hand weeding (20 and 40 DAS).

At Dharwad Significantly higher dry pod yield obtained with weed free treatment (2264 kg ha⁻¹) which was at par with pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + One hand weeding at 25 DAS (2151 kg ha⁻¹). Further, pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + One hand weeding at 25 DAS (2151 kg ha⁻¹) was at par with pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + quizalofop-p-

ethyl 5% E.C. @ 50 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) (2066 kg ha⁻¹) and pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + imazethapyr 10% S.L. @ 75 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) (2062 kg ha⁻¹).

At Mohanpur, the highest pod yield (2899 kg ha⁻¹) was obtained with the treatment weed free which was significantly superior to rest of the treatments. Among the herbicidal treatments, pre-emergence application of pendimethalin followed by Imizathapyr had the positive response on crop growth. Yield increased about 25 % due to applications of herbicides over un-weeded control.

At Tindivanam application of pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + Imazethapyr 10% SL @ 57 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) gave higher yield (2108 Kg ha⁻¹).

At Vridhachalam, Adoption of pendimethalin 30% EC @ 1.5 kg a.i. ha⁻¹ (PE) + One Hand weeding at 25 DAS recorded higher pod yield (1815 Kg ha⁻¹) and it was statistically superior to the rest of the herbicide combination treatments.

6 Agronomic practices for rice-fallow groundnut

The trial was conducted at Dharwad (Kumta), Kadiri

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(Vizianagaram), Mohanpur, Shirgaon, Tindivanam and Vriddhachalam during 2018-19 and all the centres except Kadiri (Vijayanagaram) have reported the results.

At Dharwad, Groundnut varieties namely Dh-101 and Dh-86 performed equally under rice groundnut system. However, groundnut variety Dh-101 recorded higher dry pod yield (2476 kg ha^{-1}) than Dh-86 (2299 kg ha^{-1} and 2483 kg ha^{-1}).

At Mohanpur, TAG24 (2988 kg ha^{-1}) and TG51 (3122 kg ha^{-1}) remained at par with respect to pod yield.

At Shirgaon, the groundnut variety TKG Bold recorded significantly higher pod (2480 kg ha^{-1}) over groundnut variety Konkan Gaurav (2135 kg ha^{-1}).

At Tindivanam, the variety TMV 13 (2132 kg ha^{-1}) is more suitable for rice fallow cultivation as compared to TMV 7 (1966 kg ha^{-1}).

At Vriddhachalam, VRI 8 (2340 kg ha^{-1}) produced higher pod yield over VRI 7 (2050 kg ha^{-1}).

At Dharwad (Kumta), Mohanpur, Shirgaon, and Vriddhachalam application of 125% RDF + *Rhizobium* resulted in significantly higher pod yield. While at Tindivanam, application of 100% RDF (25:50:75 NPK Kg/ha) along with *rhizobium* seed treatment recorded higher dry pod yield

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

The trial was allotted to Dharwad, Jalgaon, Junagadh, Kadiri, Mohanpur, Rahuri and Tirupati for *rabi*-summer 2018-19 and all the centres except Kadiri have reported the results.

Application of 100 per cent RDF was found to produce significantly higher yield over rest of the treatments at all the centres except Rahuri. At Rahuri, application of 75 per cent RDF produced higher pod yield.

At Dharwad, Junagadh and Mohanpur, application of NPK liquid formulation + Zn solubilizing bacteria produced significantly higher pod yield over control. At Jalgaon and Rahuri, significantly higher pod yield was obtained with the application of biogrow. But, the yield levels were at par with the application of either with NPK liquid formulation + Zn solubilizing bacteria or with biogrow in these centres. At Tirupati no significant effect of application of bio-formulations was observed on pod yield of groundnut.

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

During 2018-19, the trial was conducted at Jalgaon, Junagadh, Pudducherry and Rahuri centres as a continued trial (2 years) and at Akola, Tindivanam and Vriddhachalam as new trail.

At Jalgaon, Pudducherry and Akola, application of 75% RDF + 2% WSF at 45,60,75 DAS, at Junagadh and Rahuri application of 75% RDF + 1.5% WSF at 45,60,75 DAS, at Tindivanam, application of 75% RDF + 2.0% WSF at 45 and 60 DAS and at Vriddhachalam, soil application of 100% recommended dose of fertilizers was recorded higher pod yield and was at par with soil application of 75% RDF with foliar application of 2.0% WSF at 45, 60 and 75 DAS.

9. Water and nutrient management in groundnut + sugarcane intercropping system

The trial was allotted to Lucknow and Modipuram and not reported data for the year 2018-19.

10. Improving phosphorus use efficiency in *rabi*-summer groundnut with microbial cultures

This trial was allotted to Bhubaneswar, Hiriya, Junagadh, Jhargram, Pudducherry, Tindivanam, Tirupati and Vriddachalam during 2018-19 and except Hiriya and Vriddhachalam,

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all the centres were reported data. Vriddhachalam not conducted this experiment due to scarcity of water. At Bhubaneswar, Jhargram and Puducherry, application of 60 Kg ha⁻¹ of P to Groundnut with DGRC culture strain treatment obtained higher yield and at Junagadh, Tindivanam and Tirupati application of 40 Kg ha⁻¹ of P with DGRC culture recorded higher pod yield.

11. Integrated weed management in *rabi*-summer groundnut

This trial was allotted to Akola, Bhubaneswar and Kadiiri during 2018-19 except Kadiiri other two centres reported data. At both centres, Pendimethalin 30EC + Imazethapyr 2EC @ 1.0 Kg ha⁻¹ PE (Ready mix) + manual weeding at 25-30 DAS recorded significantly higher pod yield among the different chemical weed management treatments.

12. Optimization of sowing window and irrigation scheduling in *rabi* groundnut

This experiment was conducted at Palem during 2018-19. Highest pod yield ha⁻¹ was obtained with irrigation scheduling at 1.0 IW/CPE (3141 kg ha⁻¹) and sowing on October 15th has recorded significantly higher pod yield (3701 kg ha⁻¹).

13. Optimization of seed rate in *rabi* groundnut

This experiment was conducted at Palem during 2018-19. Significantly higher pod yield ha⁻¹ was obtained with line sowing (3755 kg ha⁻¹) and seed rate @ 200 kg ha⁻¹ has recorded significantly higher pod yield (4271 kg ha⁻¹).

14. Optimization of sowing window and irrigation scheduling in summer groundnut

Highest pod yield ha⁻¹ was obtained with irrigation scheduling at 1.0 IW/CPE (2866 kg ha⁻¹) and sowing on January 15th has recorded significantly higher pod yield (3044 kg ha⁻¹).

15. Agronomic management of AVT

At Ludhiana, New strain J 87 gave significantly higher pod yield than check variety TG 37A. The new strain J 87 gave significantly higher pod yield (3741 kg ha⁻¹) than check variety TG37A (2912 kg ha⁻¹). Among the other traits except shelling two genotypes significantly differ. The spacing geometry was different J 87 and TG37A. The new strain J 87 gave high pod yield at 30 x 22.5 cm spacing while 30 x 15 cm was more congenial for TG37A. the ancillary traits such as days to maturity, pods per plant, sound mature kernels, plant height, 100 kernel weight and kernel yield gave significant

difference at different spacing. Though, nutritional requirement RF 125% numerically gave higher productivity but it was non-significant than recommended fertility of package of practices. However, RF 75% gave significant low productivity than recommended levels of fertility for pod yield and other traits.

Rabi-summer 2018-19

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

- Seed treatment with FP 86 or DAPG-4 (Action : Puducherry)
- Seed treatment with FP 98 or FP-86 (Action : Rahuri)

2. Evaluation of suitable varieties of groundnut with nutrient levels for potato-groundnut System

- Recommendation of groundnut varieties namely TG 51, TAG 24 and TG 37A and application of NPK @ 200:150:150 kg ha⁻¹ to potato crop during previous season, no need to apply to groundnut crop which is in sequence under potato-groundnut cropping sequence (Action : Mohanpur)

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

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- Application of pendimethalin 30% EC @1.5 kg a.i. ha⁻¹ + 1 Hand Weeding at 25 DAS (Action : Bhubaneswar, Vriddhachalam)
- Application of pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + One hand weeding at 25 DAS or Pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + quizalofop-p-ethyl 5% E.C. @ 50 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) or Pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + imazethapyr 10% S.L. @ 75 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) (Action : Dharwad(kumta), Mohanpur)
- Application of pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + Imazethapyr 10% SL @ 57 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) (Action : Tindivanam)

4. Agronomic practices for rice-fallow groundnut

Varieties:

- Groundnut varieties Dh-101 and Dh-86 (Action : Dharwad-Kumta region)
- Groundnut varieties TAG 24 and TG 51 (Action : Mohanpur)
- Groundnut variety TKG Bold (Action : Shirgaon)
- Groundnut variety TMV 13 (Action : Tindivanam)
- Groundnut variety VRI 8 (Action : Vriddhachalam)

Nutrient management

- RDF (125%) + *Rhizobium* (Action : Dharwad (Kumta),

Mohanpur, Shirgaon, and Vriddhachalam)

- RDF(100%) + *Rhizobium* (Action : Tindivanam)

Crop Protection

Altogether 25 trials, 9 during rabi-summer 2018-19, 16 during kharif 2019 from entomology and pathology were conducted. The Research Highlights with two recommendations from trial conducted are presented:

ENTOMOLOGY (Kharif)

• Insect-pests situation:

Thrips and leafhopper incidence respectively ranged from 1.2 to 10.2 thrips/terminal bud and 0.4 to 25 hoppers/top 3 leaves. Highest incidence of sucking pests was observed in Latur. The foliar damage caused by *Spodoptera*, *Helicoverpa*, and leaf miner respectively ranged from 2 to 35, 5 to 7 and 6 to 26 per cent. Highest foliar damage was observed at Raichur for *Spodoptera*, and in Pavagada for *Helicoverpa* and leaf miner. Plant death due to termite incidence was reported from Ludhiana (<18%).

• Occurrence of natural enemies:

Low to moderate incidence of predatory arthropods like, coccinellids, green lacewings and spiders were observed in groundnut. Parasitization by *Chelonussp.* was up to 11 percent

in Raichur. Epizootics (up to 96 per cent) of *Metarhiziumrileyi* on all the larval stages of *Spodoptera* was observed in Dharwad. Long-legged predatory dipteran fly, *Chrysosomaleucopogon* was observed in Vriddhachalam (1.5-2.0/plant) in groundnut wherever, sorghum was grown as border row.

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

Peak *Spodoptera* moth catches was observed during 28th and 29th SMWs (4.4 moths/trap) at Dharwad, 32nd and 33rd SMWs (3.8 moths/trap) at Vriddhachalam, 40th SMW (90 moths/trap) at Latur and 45th SMW at Raichur (99.6 moths/trap). The peak *Helicoverpa* moth catch was observed during 39th (37.8 moths/trap) and 40th (45 moths/trap) SMWs respectively at Raichur and Latur. Similarly, leaf miner catches peaked during 38th (4.4 moths/trap) and 39th (25 moths/trap) SMWs respectively at Raichur and Latur. Peak catches of sucking pests like, thrips and leafhopper was observed respectively during 41st (8.2 thrips/trap) and 43rd (8.8 hopper/trap) SMWs at Raichur. Highest adult white grub catches (5 beetles/trap) in the light trap installed in

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groundnut adjacent to sugarcane field was reported from Vriddhachalam.

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

At Latur, 31 entries scored foliar damage of ≤ 2 for leafhopper and five entries scored foliar damage of 1 for *Spodoptera* on 1-9 scale. Similarly, 74 entries scored foliar damage of ≤ 2 for leaf miner and three entries scored foliar damage of 1 for *Spodoptera* on 1-9 scale at Raichur.

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

At Ludhiana, lowest termite (4.0% damaged plants) and white grub (0.1% damaged plants) infestations were observed respectively with treatment T7 (i.e., seed treatment with imidacloprid 600FS @ 2 ml/kg followed by foliar spray of imidacloprid 40%+fipronil 40% @ 5 g/10 L at 60 DAS) and treatment T4 (i.e., seed treatment with imidacloprid 600FS @ 2 ml/kg followed by soil drenching with imidacloprid 17.8SL @ 3 ml/10 L at 60 DAS). Pod yields with treatments T7 and T4 were 2583 and 2495 kg/ha, respectively. At Vriddhachalam, lowest earwig infestation (7% damaged pegs) was observed with treatment T1 (i.e., seed treatment with imidacloprid

18.5%+hexaconazole 1.5% @ 8 g/kg). Pod yield and ICBR were highest with treatment T1 (1408 kg/ha and 1: 7.6, respectively).

- **Biorational management of groundnut defoliator pests:**

Among Bt formulations T2- *Bt* Commercial formulation (Delfin) @ 1 g/L was found effective bio formulation with a highest pod (1734 kg/ha) and haulm (6250 kg/ha) yield with ICBR of 1:1.13 at Raichur followed by Vriddhachalam (Pod 1522 and haulm 2706 kg/ha) with ICBR of 1:1.6, however, less than Quinalphos 25 EC @ 2 ml/L and Chlorantraniliprole 18.5SC @ 0.3 ml/L.

- **Host preference studies on fall armyworm under no choice conditions:**

Efforts were made to rear fall armyworm (FAW), *Spodoptera frugiperda* an invasive pest on maize in the laboratory on groundnut at Vriddhachalam and Raichur with contrasting results. At Vriddhachalam, FAW completed its life cycle on groundnut variety, VRI-2 whereas, it could not complete its life at Raichur. Hence, further validation is required before arriving at conclusion.

PATHOLOGY (Kharif)

- **Diseases situation:**

Monitoring of major diseases at farmers' field and research

stations was reported. Maximum Late leaf spot (LLS) was reported from Vriddhachalam (9 scale) followed by Dharwad and Raichur (8 scale); Aliyarnagar, Jalgaon, Ludhiana, Pavagada (7 scale); Junagadh (6 scale). Early leaf spot (ELS) was reported from Kadiri (7 scale) followed by moderate at Junagadh and Pavagada (5 scale) and low in other research stations. Rust was maximum at Aliyarnagar and Dharwad (7 scale) followed by Junagadh and Vriddhachalam (5 scale). Maximum Alternaria leaf blight (ALB) was reported from Vriddhachalam (5 scale) and low in other research stations. PBNB was reported from Raichur (19-69%) and Pavagada (7-19%). Collar rot was maximum at Pavagada (<19%) followed by Bikaner (>14%), and Vriddhachalam (15%). Maximum stem rot incidence was reported from Raichur and Dharwad (>28%). Dry root rot was recorded high at Raichur (<26%), being at par at Vriddhachalam and Kadiri (16%). PSND was reported from Kadiri (10%).

- **Influence of climate variability on the occurrence of foliar diseases (ELS, LLS and Rust):**

Even distribution of rainfall in each standard meteorological week coinciding from

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2nd fortnight of June to September, and a gap of no rain in a week before crop age of 90-100 days favored late leaf spots to 7-9 score in the centers viz., Aliyarnagar, Jalgaon, Junagadh, Raichur, Dharwad and Virudhachalam. However, ELS and rust were appeared about 5 scale or below.

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

Among genotypes screened, ISK-I-2019-32 was promising to LLS at Aliyarnagar and Raichur, and for stem rot at Junagadh. Similarly, genotypes ISK-I-2019-17, IES-2019-18 and ALSVT-2019-3 showed resistance to LLS at Latur and Raichur. HOVT-SB-I-2019-7 was found resistant to rust at Aliyarnagar and Latur. Similarly, genotypes IVK-I-2019-14, ISK-I-2019-2, ISK-I-2019-7, ISK-I-2019-29, ISK-I-2019-31 and ASK-I-2019-7 showed resistance to rust at Aliyarnagar and Latur. Genotypes IVK-I-2019-10, IVK-I-2019-19 and IVK-I-2019-20 showed multiple disease resistance to LLS and rust at Aliyarnagar, and LLS at Latur. Genotype HOVT-SB-I-2019-2 showed multiple resistances to LLS and rust at Aliyarnagar and Latur. IVT I 2019-4 showed resistance to

LLS and DRR at Raichur. Genotypes IVT I 2019-23 and HOVTVG-I-2019-2 showed resistance against LLS, stem rot and PBNB at Raichur. Similarly, genotypes ISK-I-2019-17, IVT-I-2019-4, IVT-I-2019-8, ALSVT-2019-1, ALSVT-2019-2, ALSVT-2019-3 and HOVT-SB-I-2019-3 showed resistance to LLS and stem rot at Raichur. ISK-I-2019-28 showed resistance to stem rot at Jalgaon and Raichur. ASK-2019-7 showed multiple resistance to stem rot and collar rot at Jalgaon, and PBNB at Raichur. Similarly, genotypes IVK-I-2019-20, IES-I-2019-1, ISK-II-2018-18 and ISK-II-2018-25 showed multiple resistance to stem rot and collar rot at Jalgaon.

- **Screening of peanut germplasm /genotypes for major diseases:**

GPBD-5 and G2-52 showed resistance to LLS (grade 1) at Dharwad. Four entries viz., VG 17037, VG 18097, VG19561 and VG19654 <2 score to LLS at Virudhachalam. GJG-32 was found with <5% stem rot at Junagadh.

- **Development of technologies for management of collar-rot:**

T₄ at Bikaner and T₆ at Ludhiana
{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 seed followed by Seed treatment with PGPR @ 625g/ ha of seed + Soil application of Trichoderma @ 4 kg/ ha enriched in 250 kg FYM/ha at 35 and 80 DAS; T₆: Intercropping with bajra (10:2 rows) + Sowing at a depth of 2.5 cm + seed treatment with Carboxin + Mancozeb @ 2 g/kg seed + Tebuconazole 25.9EC @ 1.5 mL/L @ 10 DAG}

- **Validation of management modules for soil borne diseases:**

T₄ at Aliyarnagar, Bikaner, Jalgaon, Junagadh, Kadiri and Virudhachalam and T₆ at Dharwad and Raichur

{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 @ 625 g for per ha of seeds + Soil application of Trichoderma @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 70 DAS and T₆: Popular Variety + Deep summer ploughing with mold board plough + Soil application of Trichoderma @ 4 kg/ ha enriched in FYM + Seed treatment with Tebuconazole @ 1.5 g/ kg of seed + Soil application of

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Trichoderma @ 4 kg/ ha enriched in FYM at 35 DAS + Soil application of Trichoderma @ 4 kg/ ha enriched in FYM at 70-80 DAS}

- **Influence of dates of sowing and plant stand on incidence of PSND/PBND of groundnut:**

2nd fortnight of June sown groundnut with additional 10% seeds recorded significantly low incidence of PBND/PSND and low population of thrips at Raichur, Kadiri and Pavagad with highest pod and haulm yield at Kadiri and Raichur

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

Module 4 at Pavagada, Junagadh, Jalgaon and Vriddhachalam, module 1 at Dharwad and Raichur and module 3 at Kadiri.

{Module 1: Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg seed + Border crop with bajra (3 or 4 rows) + Need based spray of Thiodicarb 75 WP @ 1 g/L for defoliator 50-70 DAS + Need based spray of Hexaconazole 5 EC @ 1 mL/L 50-70 DAS; Module 3: Seed treatment with Carboxin 37.5% + Thiram 37.5% @ 3 g/kg seed and with Thiamethoxam 5% FS @ 3 g/kg seed + Need based spray of Rynaxypyr 20% SC @ 100

ml/ha for defoliator 50-70 DAS + Need based spray of Propiconazole 13.9% or Difconazole 13.9 % EC @ 1ml/L 50-70 DAS; Module 4: Soil application of Trichoderma @ 4 kg/ ha enriched in 250 kg FYM/ha + Seed treatment with Trichoderma @ 4 g/kg seed + Spot drench with Carbendazim @ 1g /L for soil borne diseases + Foliar spray of Carbendazim 12% + Mancozeb 63% @ 2 g/L at 40 and 65 DAS + Foliar spray of Beauveria bassiana @ 10g/L at 40 and 65 DAS + Foliar spray of Rynaxypyr 20%EC @ 100 ml/ha for defoliator at 50-70 DAS}

- **Management of leaf blight and wilt disease of groundnut occurring at Rajasthan:**

T₄ (Carbendazim 12% + Mancozeb 63% WP (Saaf 75% WP) (10 g saaf in 5L water for 100 sq m area).

ENTOMOLOGY (Rabi-Summer)

- **Insect-pests situation:**

Incidence of thrips (range: 1.9 to 26 thrips/terminal bud) and leafhoppers (range: 0.3 to 7 hoppers/top 3 leaves). Highest incidence of leafhoppers and thrips was observed in Pavagada at all crop stages. The foliar damage due to defoliator pests like, *Spodoptera*, *Helicoverpa* and leaf miner respectively ranged

from 10 to 40, 11-20 and 10 to 20 per cent. Highest foliar damage caused by defoliator pests was witnessed in Vriddhachalam.

- **Occurrence of natural enemies:**

Across centres, low to moderate incidence of predatory arthropods like, coccinellids, green lacewings and spiders were observed in groundnut. Parasitization by *Chelonus* sp. was up to 10 per cent in Raichur.

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

Peak *Spodoptera* moth catches was observed during 5th SMW at Raichur (77.4 moths/trap), 6th SMW at Vriddhachalam (12.8 moths/trap) and 9th SMW at Dharwad (26 moths/trap). Similarly, peak *Helicoverpa* and leaf miner moth catches were observed during 1st SMW (35.8 moths/trap) and 52nd SMW (4.4 moths/trap) at Raichur. Peak catches of sucking pests like, thrips and leafhopper was observed respectively during 2nd (10.8 thrips/trap) and 5th (8.2 hopper/trap) SMWs at Raichur.

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

Screening trials carried out in all the centres during rabi-summer season were not considered either due to low

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pest pressure (<7 on 1-9 scale) in the susceptible check or due to none of the entries scored below 2 on 1-9 scale.

PATHOLOGY(Rabi-Summer)

● **Diseases situation:**

Monitoring of major diseases at farmers' field and research stations was reported. Maximum Late leaf spot (LLS) was reported from Vridhachalam (9 scale) followed by Aliyarnagar and Jalgaon (7 scale). Maximum Early leaf spot (ELS) was reported from Dharwad (4 scale) followed by Aliyarnagar (1-4 scale). Rust was maximum at Aliyarnagar (7 scale) followed by Dharwad (5 scale) and Vridhachalam (4 scale). Maximum Alternaria leaf blight (ALB) was reported from Jalgaon (6 scale) followed by Dharwad (5 scale). PBNB was reported from Raichur (<32%), Kadiri (<14%) and Pavagada (<19%). Collar rot was maximum at Raichur (34%) followed by Vridhachalam (<16%). Maximum stem rot incidence was reported from Aliyarnagar (<20%) followed by Pavagada (<16%) and Vridhachalam (<16%). Dry root rot was recorded high at Raichur and Kadiri (<19%).

Crop Protection

● **Screening of IVT-I & AVT and other coordinated trial**

material for resistance/ tolerance to major diseases:

Among genotypes screened, INS-I-2018-1, INS-I-2018-15, INS-I-2018-28 and INS-I-2018-29 were promising to LLS at Aliyarnagar and stem rot at Raichur. Genotype INS-I-2018-27 was found resistant to LLS at Aliyarnagar and stem rot at Jalgaon. INS-I-2018-13 showed resistance against LLS and stem rot at Jalgaon and stem rot alone at Raichur. Genotypes AIS-2018-3, AIS-2018-8, AIS-2018-9 and AIS-2018-12 were found resistant to stem rot and PBNB at Raichur. Genotype AIS-2018-11 showed resistance to stem rot and PBNB at Raichur and LLS at Aliyarnagar.

● **Relationship between thrips species and PBNB:**

Incidence of PBNB reached to 34% at Raichur followed 26% at Pavagada, and 12% at Kadiri. *Scirtothrips dorsalis* and *Thrips palmi* were recorded at Raichur and additionally *Frankliniella schulzei* was recorded at Kadiri. Prominent weeds with thrips or its damage were recorded on *Parthenium hysterophorus*, *Boerhavia erecta*, *Cleome viscosa*, *Celosia argentea* and *Amaranthus viridis* at Kadiri; *Tridax procumbens*, *Parthenium hysterophorus*, and *Euphorbia hirta* at Pavagada and Raichur.

● **Management of major foliar diseases using fungicides:**

As per pooled data for >2 seasons T_4 at Junagadh, Vridhachalam and Dharwad. T_2 at Jalgaon and Aliyarnagar.

{ T_4 : Seed treatment with tebuconazole 2DS @ 1.5g /kg seeds + foliar spray of tebuconazole 50% + trifloxystrobin 25% WG @ 1.32 g / L on 40 and 65 DAS; T_2 : Tebuconazole @ 1 ml / L at 40 and 65 DAS}

AICRP-G FLDs:

Kharif 2019

- During *Kharif*- 2019 FLDs were allotted in 9 states having 18 groundnut research FLD centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Manipur, Tamil Nadu and West Bengal. The FLDs were allotted on Whole Package (WP), Integrated pest management (IPM) and Improved Variety (IV). The FLDs allotted were 400 FLDs for 18 centers and results were received for 268 FLDs, from 12 centers which indicated 67 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.

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- The average pod yield achieved was 2242 kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 1818 kg/ha with farmer's traditional practices. The yield increase observed was 26 per cent. The minimum yield difference observed was 13 percent and the maximum was 60 per cent.
- The average cost of cultivation with improved practice was Rs. 50021/ha in comparison with Rs. 47604/ha with farmer's practice. The maximum observed was Rs. 88367/ha in improved practice and Rs. 82733/ha with farmer's traditional practice.
- The average Gross Marginal Returns with improved practice was Rs.117675/ha and Rs. 95562/ha with respect to traditional practices. Net returns observed was Rs. 67667/ha and Rs. 47958/ha for improved practice and farmer's practices respectively. The average B:C ratio was 2.28 and 1.96 for improved practice and farmer's practices respectively.

Rabi-summer 2018-19

- The Rabi-Summer 2018-19 FLDs were allotted in 7 states having 16 groundnut research FLD centers. The states in which FLDs conducted were

Gujarat, Karnataka, Maharashtra, Rajasthan, Tamil Nadu, Puducherry, Odisha and West Bengal. The FLDs were allotted on Whole Package (WP). The FLDs allotted were 430 FLDs and the results were received for 250 FLDs, from 11 centers which indicated 58 per cent of implementation.

- There were 7 new varieties' production potential and profitability were compared with 11 old ruling varieties which are cultivated with farmers' traditional cultivation practices.
- The average pod yield achieved was 2536 kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 2028 kg/ha with farmer's traditional practices. The yield increase observed was 26 per cent. The minimum yield difference observed was 14 percent and the maximum was 52 per cent.
- The average cost of cultivation with improved practice was Rs. 47294/ha in comparison with Rs. 44029/ha with farmer's practice. The maximum observed was Rs. 65072/ha in improved practice and Rs. 62544/ha with farmer's traditional practice.
- The average Gross Marginal Returns with improved

practice was Rs.113074/ha and Rs.89679/ha with respect to traditional practices. Net returns observed was Rs.65734/ha and Rs.46327/ha for improved practice and farmer's practices respectively. The average B:C ratio was 2.48 and 2.09 for improved practice and farmer's practices respectively.

07 Externally funded projects

1. ICAR Seed Project on Seed Production in Agricultural Crops

Nodal Officer & PI: Narendra Kumar

Co-PI: Ghous Ali, Scientist, Agronomy, Arid Regional Campus (ARC)-ICAR-CSWRI, Bichhwal Industrial Area, Bikaner

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

Duration: 2017-2020

Fund outlay: Total 27 lakh out of rupees 8.15 lakhs released in 2019

- and Girnar-3 (17.57q) during 2019.
- Produced a total 18.6q nucleus seed of variety Girnar-2 (12q) and Girnar-3 (6.6q) during 2019.
- Supplied a total 27.1q breeder seed of variety Girnar-2 (10.6q), Girnar-3 (16.5q) to eleven indentors during 2019.
- Generated a revenue of rupees 9,92,214.0 from selling of the groundnut breeder seed and other produce.
- Groundnut fodder of 6.0 ha. area of Girnar-2 was handed over to ICAR-CSWRI-ARC, Bikaner.

nucleus and breeder seed production in about 40% and 60% area of both the varieties Girnar 2 and Girnar 3. Accordingly breeder and nucleus seed production programme of Girnar-2 and Girnar-3 variety was undertaken in 4.8ha. and 1.1ha. at DGR-RRS, Bikaner and DGR, Junagadh respectively. Under this project, produced 48.0q and 17.57q (Seeds unit: 11.10q and Farm section: 6.47q) breeder seed and 12.0q and 6.6q nucleus seed of Girnar 2 and Girnar 3 variety respectively.

Table-1: Variety-wise seed of different classes produced under ISP during kharif- 2019

Variety	Indent (q)		Plot no.	Area sown (ha.)		Total production (q)	Seed Production (q)		
	DAC	BSP-I		BS	NS		Breeder Seed (BS)	Nucleus Seed (NS)	TFL Seed
Girnar-2	—	—	RRS, BKN	4.8	1.1	60.0	48.00	12.0	—
Girnar-3	—	—	DGR, JND	4.8	1.1	24.17	17.57	6.60	—
Total	—	—		9.6	2.2	84.17	65.57	18.60	—

Summary

- Breeder seed production of Girnar-2 and Girnar-3 variety was taken in 4.8 ha and 4.8 at Bikaner and DGR, Junagadh respectively during 2019.
- Nucleus seed production of Girnar-2 and Girnar-3 variety was taken in 1.1ha and 1.1ha. at Bikaner and DGR, Junagadh respectively during 2019.
- Produced a total 65.57q breeder seed of variety Girnar-2 (48.0q)

- Organized Kisan Divas on 23rd December 2019, in which 64 farmers including 12 woman farmers participated at ICAR-DGR Junagadh.

Breeder Seed Production Achievement

Kharif 2019:

This year there was no DAC indent of breeder seed of Girnar-2 and Girnar-3 varieties for kharif-2020. Director, DGR suggested for taking up

At Bikaner due to unpredicted two times rainfall at the time of harvesting and drying of variety Girnar 2 resulted pod loss inform of rotting and colourdis colouration of pods. At ICAR-DGR, Junagadh due to high rainfall and water stagnation during whole kharif season in plot no. H-6 (1.4ha) and O4/2 (0.8ha), breeder seed monitoring team rejected these plots because of reduction in pod size from the

07 HRD programmes and field visits



Kisan Divas organized on 24th December 2019 at ICAR-DGR, Junagadh



Breeder seed production of Girnar 3 at DGR, Junagadh



AICRP-G monitoring at DGR-RRS, Bikaner



Seed production field at DGR-RRS, Bikaner



Girnar 2 harvesting at Bikaner



Dr. RK Singh, ADG (Commercial Crops), ICAR and Director, CICR, Nagpur visited DGR, Junagadh on 08.05.2019



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Table 2: Details of seed materials supplied during 2019

S N	Variety	Breeder seed		Quality seed (q)		Resource generation (Rs.)	Provided on Gratis (Rs.)
		Indentor (no.)	Quantity (q)	Indentor (no.)	Quantity (q)		
1	Girnar-2	6	10.6	5	11.5	435050.0	77000.0
2	Girnar-3	5	16.5	3	0.63		
3	Girnar-2	—	28.8*	—	—	480164.0	
4	Girnar-3	—	72.0*	—	—		
					Total	1915214.0	77000.0

*Disposed-off as general produce due to non-lifting by indentor

normal size of this variety though it was genetically pure. Now there is enough nucleus seed of Girnar-2 (12q) and Girnar-3 (6.6q) to meet out demand of breeder/quality seed of Girnar-2 and Girnar-3 for the *kharif*-2021, which will be produce in *kharif*-2020.

Distribution of seed/planting material

During 2019, seed unit has supplied a total 27.1q breeder seed of varieties Girnar-2 (10.6q) and Girnar-3 (16.5q) to eleven different indentors and a total 12.13q quality seed of varieties Girnar-2 (11.5q) and Girnar-3 (0.63q) to eight different indentors. Due to non-lifting against the indent of breeder seed of variety Girnar 2 (28.8q) and Girnar-3 (72.0q) was disposed-off as general produce in the local market with the approval of the Director, DGR, Junagadh (Table-2).

Distribution of seed material for area extension programme

As per instruction of DDG (CS), ICAR and approval of Director, DGR Junagadh supplied a total 9.8q quality treated kernels of Girnar 2 (9.3q) and Girnar 3 (0.5q) to the three institutes viz., ICAR-Indian Institute of Sugarcane Research, Lucknow, U.P., Mahatma Gandhi Chitrakoot Gramodaya Vishwavidhyalaya Chitrakoot, M.P. and ICAR-Central Plantation Crops

Table 3: Details of seed materials supplied for groundnut area extension during 2019

Institution	Variety	Quality Seed (q)	Expected area (ha.)
Indian Institute of Sugarcane Research, Lucknow, UP	Girnar-2	6.2	5
Mahatma Gandhi Chitrakoot Gramodaya Vishwavidhyalaya Chitrakoot, M.P.	Girnar-2	2.5	2
Central Plantation Crops Research Institute, Kasaragod, Kerala	Girnar-2	0.6	0.4
	Girnar-3	0.5	0.4

Research Institute, Kasaragod, Kerala with the objective of groundnut area extension programme in respective states.

Resource generation

During 2019, seed unit has generated total revenue of 992214.0 through supplied of a total 27.1q breeder seed of varieties Girnar-2 and Girnar-3 (915214.0) and 10.13q quality seed of varieties Girnar-2 and Girnar-3 (77000.0) was supplied on *gratis* to the different indentors.

Capacity building and technology dissemination

During the 2019, under HRD component of ICAR seed project organized groundnut farmers fair on 24th February 2019 at DGR, Junagadh, in which 250 farmers from 15 villages of Junagadh district attended this fair. Kisan Divas was organized on 23rd December 2019 at DGR, Junagadh. In this

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Table 4: Details of HRD programme organized during 2019

SN	Programme name	Date	No of farmers	Place of farmers
1.	Groundnut farmers fair	24 th February 2019	250	15 village of Junagadh district
2.	Kisan Divas	23 rd December 2019	64	03 village of Junagadh district

programme 64 farmers participated from 03 MGMG villages viz. Ivnagar, Mithapur, Alidra. The aim this programme was to provide knowledge on improved technologies of groundnut cultivation.

2. All India network project on soil biodiversity-biofertilizers

PI: KK 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:

- Four groundnut rhizobia viz. DGR-Rhi10, DGR-Rhi11, DGR-Rhi17, DGR-Rhi19 along with standard isolate NC92 were evaluated with application of irrigation at 15 days interval after emergence.

Application of DGR-Rhi10, DGR-Rhi11 and DGR-Rhi19 significantly enhanced the pod

Table 1. Evaluation of rhizobia under moisture-deficit stress (five alternate irrigations at 15 d interval from date of germination), cultivar TG37A (summer 2019)

Treatment	PY (kg/ha)	HY (kg/ha)	SP (%)	HKM (g)
Control	1706	3132	61.53	42.77
NC92	1670	3300	62.43	43.00
DGR-Rhi10	1941	3635	61.88	45.00
DGR-Rhi17	1809	3378	62.85	43.80
DGR-Rhi11	1972	3354	63.28	45.47
DGR-Rhi19	2011	3505	64.57	46.30
CD (0.05)	191	366	2.14	1.75

yield, haulm yield, nodulation and shelling out-turn (Table 1) of groundnut (cv TG37A).

3. 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: KK 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 osmo adaptation 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:

- The role of alternate route of carbon gain from dissolved carbon dioxide in imparting salinity tolerance by employing P P D K , P E P C , M D H , isocitratelase and malate synthase leading to production of malate was validated in extreme haloarchaeon 3A1-DGR. Besides, expression of serine-glyoxylate cycle leading to production of glycine as osmo-protectant has also been confirmed. To understand whether similar network of pathways are being

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operational in halophilic bacilli, comparative analysis of complete genome sequence data of *Bacillus* sp. SB49 (NaCl tolerance upto 30%, NCBI Accession No. CP048117), *Virgibacillus* sp. MSP4-1 (salinity tolerance 8-23.5%, NCBI Accession No. CP048021), and *Bacillus* sp. NSP9.1 (NaCl tolerance upto 15%, NCBI Accession No. CP048273) was made and common set of genes of sodium-hydrogen antiporter, malate dehydrogenase, carbonic anhydrase, malate synthase, isocitratelase, phosphoserine aminotransferase, phosphoserine phosphatase, and serine hydroxymethyl aminotransferase were found in the genomes of these halophilic organism. However, gene for a key enzyme, phosphoenolpyruvate carboxylase (PEPC), has not been found in the genome of *Bacillus* sp. NSP9.1. Further analysis are underway to identify the required sets of genes for expression of alternate route of carbon gain as found in extreme haloarchaeon 3A1-DGR.

cDNAs were synthesized from the mRNA obtained from *Virgibacillus* sp. MSP4-1 and *Bacillus* sp. SB49 by growing them at without NaCl and 30% NaCl for *Bacillus* sp. SB49 and 8% and 23.5% NaCl for *Virgibacillus* sp. MSP4-1 for real time validation of the

genes that might be involved in osmotolerance. So far, over-expression of two genes viz. malate dehydrogenase (*mdh*/MDH) and malate synthase (*ms*/MS) have been studied. There was 3.42- and 2.84-fold increase in expression of malate dehydrogenase in *Bacillus* sp. SB49 and *Virgibacillus* sp. MSP4-1 when grown at 30 and 23.5% NaCl as compared when grown at without NaCl and 8% NaCl, respectively. The expression of malate synthase was 4.12 and 3.97-folds respectively under previously mentioned conditions for *Bacillus* sp. SB49 and *Virgibacillus* sp. MSP4-1. Validation of expression of all other genes are underway at present.

4. National Innovations in Climate Resilient Agriculture (NICRA)

Center PI: Thirumalaisamy PP

Centre Co-PI: Harish G

Total amount: 18 Lakh

Duration: April 2017- March 2020

Objectives

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

Summary

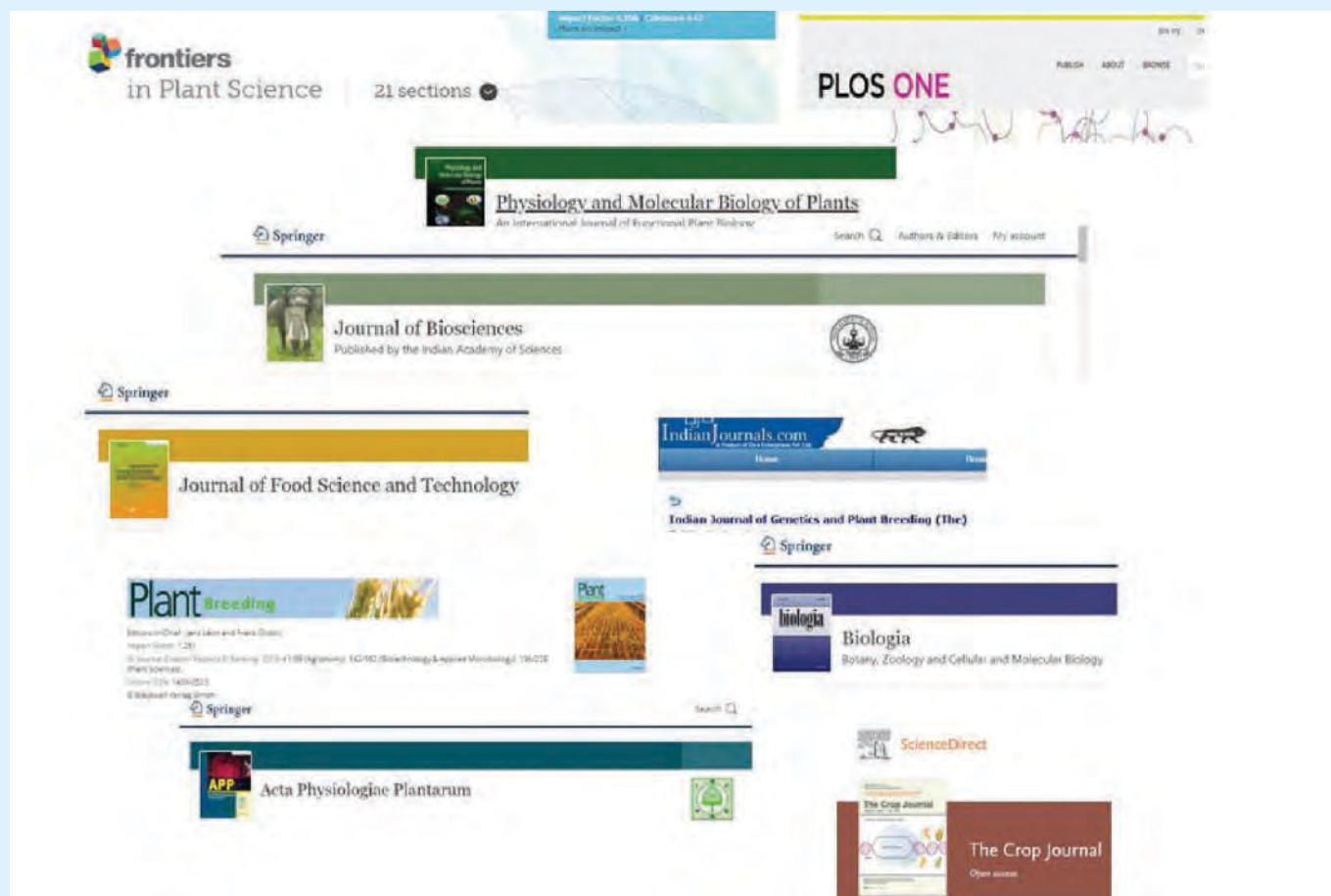
During *kharif* 2019, total of 1492 mm rain-fall was

received in 55 rainy-days distributed from second fortnight of June to first fortnight of November, 2019. Rain-fed sowing was taken from 3rd week of June to first week of July, 2019. Thrips infestation was occurred in the vegetative phase, nevertheless, the severity was below ETL. Outbreak of *Helicoverpa* was recorded from 40-60 days old crop. Infestations of *Spodoptera*, black weevil were also recorded. Leaf minor infestation was recorded in the month of October 2019 especially on late sown groundnut.

Among major foliar diseases (early & late leaf spots, rust), rust was appeared at 65 days old crop and it was in slow progress and severity of 6-8 scale were recorded in many fields at the of harvest. Late leaf spot appeared in the month of October first week, and within a period of 10 days, it reached to 7-8 score in 1-9 scale. Early leaf spot was not severe in 2019, and 2-4 score was recorded in the crop age of 40-60 days. Collar rot and stem rot incidences were occurred below 5%.

Rabi-summer trail was taken up in the month of February 2020 and real time pest dynamics data recording was not done due to COVID-19.

08 Publications / Work Plan-2019 / Institute Meetings



Research articles

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 - प्रवीण कोना, नरेंद्र कुमार, गंगाधरा के., बेरा एस. के. एवं महेश कुमार महात्मा (2019) कन्फेक्शनरी मूँगफली - महत्व एवं उन्नत किस्में. गिरनार गिरनार 6:3-5
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 - राजा राम चौधरी, किरण कुमार रेड्डी, अमन वर्मा एवं प्रताप सिंह झाला (2019) मूँगफली में खरपतवार नियंत्रण. गिरनार 1-2
 - रूपक जेना, हरीश जी, अनंत कुरेल्ला तथा राजा राम चौधरी (2019) सूत्रकृमि: फसलों के छिपे शत्रु. गिरनार: 39-40
 - सुष्मिता सिंह, अमन वर्मा एवं अनुज सिंह (2019) कार्बन डाईऑक्साइड में वृद्धि: कृषि के लिए वरदान या अभिशाप. गिरनार: 41-43

08

Work Plan 2019

Programme 1: Genetic improvement of groundnut

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

Ajay BC, Gangadhar K, Nataraj KC, Malleswari Sadhneni

Breeding for alternaria leaf blight resistance in groundnut

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

Breeding for Fresh seed dormancy and reducing maturity duration in groundnut

Gangadhara, K., Rathnakumar, AL, Ajay BC, Chandramohan, S, Sushmita S and Praveen Kona

Genetic Enhancement and Management of Groundnut Genetic Resources

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

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

Sangh Chandramohan, Bera SK and Narendra Kumar

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

Bera SK, Thirumalaisamy PP, Narendra Kumar and Kirti Rani

Breeding for improvement of quality traits in groundnut

Praveen Kona and Mahatma MK

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

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

Ram Dutta, Mahatma MK, Thirumalaisamy PP, Narendra Kumar and Ananth Kurella

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 Rupak Jena

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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, Kiran K Reddy, Raja Ram Choudhary

Efficient utilization of soil phosphorus in groundnut production system

Reddy Kiran K, Raja Ram Choudhary 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 and Gangadhara K

Physiological studies in groundnut under water-deficit and salinity stresses

Singh AL, Sushmita and Aman Verma

Evaluation of nutritional and bioactive compounds of groundnut

Mahatma MK, Aman Verma, 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, Mahatma MK, Harish G, Ajay BC, Narayanan G and Reddy KK

Programme 5: Socio economic research and extension for groundnut development

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 Ram A

08 Meetings



Research Advisory Committee (RAC) Meeting

The 21st meeting of the Research Advisory Committee was held at ICAR-DGR, Junagadh from 12-13th September 2019. The meeting was chaired by Dr. A Bandyopadhyay with RAC members Dr. IU Dhruj, Dr. BB Singh, Dr. LM Garnayak, Sh. Mahendrabhai Pithiya, Sh.

welcome of RAC members by the Dr. Radhakrishnan T, Director, followed by self-introduction of the participants. The Director presented an outline of the groundnut situation in India, the research programmes being carried out in the Directorate and the major achievements so far, the last QRT report and his views on

RAC presented the action taken report on the recommendations of the last meeting of RAC held on 27th and 28th March 2018. Works done report of the ongoing projects were delivered before the committee for extensive discussion and the future work plan was tweaked as per the suggestions of the research advisory committee.



Vrajlal bhai Hirpara and Dr. Radhakrishnan T., Director, ICAR-DGR, Junagadh. The meeting started with the

the direction of research and technology development that should be pursued. Dr. M.K. Mahatma, Member Secretary,



Kisan Mela-cum-Exhibition on the 40th Foundation day

A Kisan Mela cum exhibition was organized at ICAR-

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Directorate of Groundnut Research, Junagadh on 1st October 2019 in commemoration of 40th Foundation Day of the Directorate. About 750 farmers including 200 women farmers participated in the *KisanMela* cum exhibition. Dr Radhakrishnan T., Director, ICAR-DGR welcomed the gathering and briefed the purpose of the mela. Assistant Director of Agriculture, Sh. Chavada, Junagadh, Dr NK Gontia, Principal and Dean, College of Agricultural Engg. & Technology, JAU, Junagadh, Dr VV Rajani, Director of Extension Education, JAU, Junagadh were the special guests and Dr JB Misra, former Director DGR, Junagadh and Technical Advisor, IOPEPC, Mumbai was the Chief Guest of the function.

The major theme of the Mela was 'Jal Shakti. Two lectures were arranged for the benefit of the farmers. The first one

was 'Jal Shakti: Promotion of Irrigation Efficiency and Water Conservation Measures' delivered by Dr NK Gontia, Principal and Dean, College of Agricultural Engg. & Technology, JAU, Junagadh, and the second was on 'Use of Bio-control Agents for Increasing Groundnut Productivity and Farmers Income' delivered by Dr DM Jethva, Assoc. Prof. Bio-Control Lab, JAU, Junagadh. Each lecture was followed by an interactive session on the topics delivered.

Twenty eight stalls were put up by different agencies / firms which depicted micro-irrigation systems, submersible pumps, farm machines, improved Groundnut varieties bred by Public (ICAR-DGR, BARC, SAUs of different states and JAU), Private Groundnut Seed Firms, New molecules for control of major groundnut pests and diseases, micro-nutrients and from Petroleum



Conservation Agency. Farmers shared their experiences in high productivity cultivation of groundnut. The live specimens were also exhibited by the farmers. Finally the farmers were honored for their best exhibits of technologies, crop husbandry which resulted in higher yields. Finally, the meeting ended with a vote of thanks.

40th Foundation day celebration

The ICAR-Directorate of Groundnut Research, Junagadh celebrated its 40th Foundation on 1st October, 2019. The Chief guest of the function was Dr JB Misra, former Director ICAR-DGR, Junagadh and Technical Advisor, IOPEPC, Mumbai and Dr. I.U. Dhruj, former Director Research, JAU, Junagadh was the special guest. In the welcome address, Dr. Radhakrishnan T., Director, ICAR-DGR, extended his warm welcome to the guests and the entire DGR staff. He congratulated

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the employees for glorious past of the Directorate and emphasized on achieving the future goals to make groundnut more remunerative. The foundation day lecture was delivered by the chief guest of the day, Dr. JB Misra, followed by the address made by Dr. I. U. Dhruj. Four retiring staffs of ICAR-DGR were honored with mementoes. The formal celebration was concluded with a vote of thanks given by Dr. A.L. Rathnakumar, Principal Scientist, ICAR-DGR. The DGR staff and their family members showed their active participation in the cultural programme and the participants were felicitated by the Director, Dr. Radhakrishnan T.

Industries Interface meeting

To address issues concerning groundnut productivity, export and need of groundnut industries and to bring all stakeholders in a common platform, ICAR-Directorate of Groundnut Research has organized an Industries Interface meeting at this Directorate on 28th December, 2019. Dr. V. P. Chovatia, Vice-Chancellor of Junagadh Agricultural University; Shri Khushwant Jain, Chairman, IOPEPC; Dr. I. U. Dhruj, Ex-Associate Director of Research, JAU, Junagadh; Dr. Mainsh Pandey, Sr. Scientist, ICRISAT; Mr. Samir Shah, President, Saurashtra Oil Millers Association and Dr. Radhakrishnan T., Director, ICAR-DGR and representative from different industries and institutions participated in the event. Deliberations were made on significance of confectionary groundnut, need for production of export-oriented groundnut, importance of promoting cultivation of high oleic groundnut and

microbial technologies for enhancing productivity of groundnut. All the dignitaries highlighted the importance of developing high yielding groundnut varieties, which are industry-worthy, having high oleic acid, and can address the concerns of climate change. After due deliberations, the following consensus has been arrived unanimously:

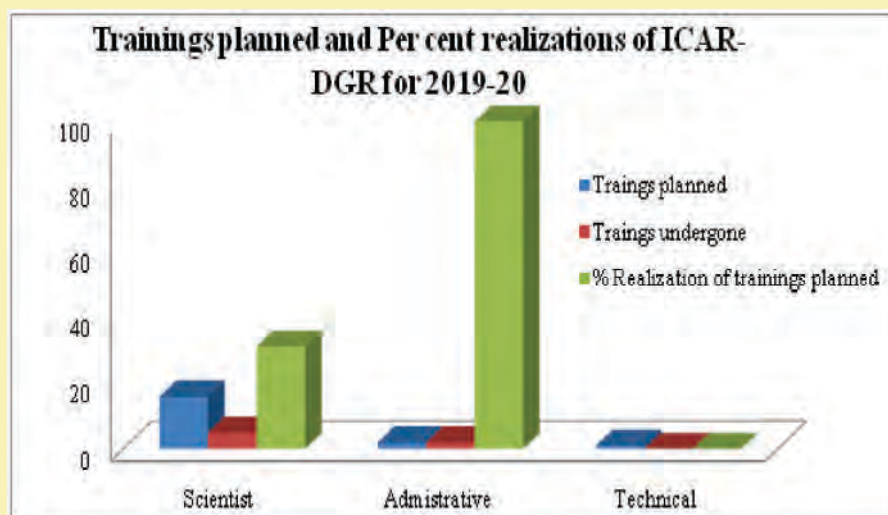
- Need for initiation of research on development of varieties having round and uniform shaped kernel, attractive colour, and boldness to meet the requirement of confectionery industries
- Development, popularization, and cultivation of high oleic groundnut should be streamlined to make the high oleic groundnut oil available in the market at the earliest for health conscious customers
- Low cost production technologies like biofertilizers should be popularized and make them available in the market at the earliest to enable them to reach to the needy farmers to improve yield and income



09 Training and Capacity Building

HRD activities at ICAR-DGR during 2019

To improve skills in the advanced areas of modern science, the staff members of ICAR-DGR undergone various training programs. Six scientists and one administrative staff undergone training on various aspects viz., genome editing, Analysis of experimental data, transparency audit under RTI and repair and maintenance of building guest house.



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

SN	Employee Name	Employee Category	Training program Name	Period	Venue	Duration (days)
1	Dr Chandramohan Sangh	Scientific	International Hands on Training on Genome Editing Technologies	14-25 Oct 2019	ICRISAT, Hyderabad	10
2	Dr Kiran Kumar Reddy	Scientific	Assessing soil plant atmosphere continuum for enhanced input use efficiency	01-21 Oct 2019	PAU, Ludhiana	21
3	Dr Kona Praveen	Scientific	Training programme on Analysis of Experimental Data	22-27 Aug 2019	NAARM, Hyderabad	06
4	Mr. Rupak Jena	Scientific	Novel techniques in mass culturing of smart microbial bio-control agents for development of bio-pesticides	3-23 Dec 2019	NBIAR, Bengaluru	21
5	Dr. P.P. Thirumalaisamy	Scientific	Recent advances of Bio-informatics in Agricultural Research: A practical perspective	12-21 Dec 2019	IASRI, New Delhi	10
6	Mr. Indraraj Meena		Administrative Transparency audit under RTI	30-31 Jan 2020	IRMRA, Anand	02
7	Mr. Indraraj Meena		Administrative Repair and maintenance of building guest house	21-23 Jan 2020	CIAE, Bhopal	03

Inputs: Dr. Ram Dutta and Dr. K. Gangadhara

09 Participation and papers presentation in conference / seminar / symposia/ meetings



Radhakrishnan T

- Participated in brainstorming session on “Translational genomics for Agriculture” held at NABC complex on 02.07.19
- Attended the brainstorming session called by the MoS on 13.07.19
- Presented a paper and chaired a session in the International Conference on Genomics and Breeding for Crop Improvement and Alumni Meet at the CCSU, Meerut during 04 to 06 Dec.19
- Presented lead paper at “National Workshop on Oilseeds and Oil Palm production, processing, value addition and marketing” at Hyderabad on 23.12.19
- Attended and co-chaired a session in the national seminar on Oilseeds 2020 at IIOR at

Hyderabad during 07 to 08 Feb.20

- Attended and acted as a panellist in the International Workshop on Next generation genomics for developing climate resilient crops held at ICRISAT, Hyderabad on 15.02.20

Aman Verma

- Verma A, Thawait LK, Mahatma MK, Sushmita, Rathnakumar AL, Singh AL(2019) Enhancement of Zn and Fe availability of Peanut by reduction of Phytic acid content using processing techniques. Presented in International conference on Innovations in plant and animal sciences for sustainable agriculture and rural development. Held at Rajasthan Agriculture

Research Institute (SKNAU), Jaipur, India during 7-9 December, 2019, p 251.

Harish G

- Harish G, Thirumalaisamy PP, Ram Dutta R, Savaliya SD (2019) Improved storage practices for managing *Caryedon serratus* in groundnut. 3rd global meet on science and technology for ensuring food and nutritional security (GMSC 2019) 01-03, December 2019. Pp. 134

K.K. Pal

- Pal KK and Dey R (2019). Fulfilling the mission of drought and salinity tolerance in crop plants by harnessing the diversity of extreme halophilic microorganisms. AMI-2019 Annual Conference and International Symposium on 'Microbial Technologies in Sustainable Development of

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Energy, Environment, Agriculture and Health” during November 15-18, 2019 at Central University of Haryana, Mahendragarh

MK Mahatma

- Raval SS, Mahatma MK, Chakraborty Rathod KV, Tomar RS, Nogiya R, Bishi SK, Singh AL, Golakiya BA (2019) Transcriptomics of contrasting groundnut genotypes under varying temperature regimes. Presented in Food and Nutritional Conclave held at MPKV, Rahuri during February 25-27, 2019 p50-51.
- Mahatma MK, Thawait LK, Verma A, Sushmita, Rathnakumar AL, Singh AL (2019) Fortification of iron and zinc in groundnut by seed soaking treatment. Presented in National Conference on “Integrative Plant Biochemistry and Biotechnology” held at ICAR- Indian Institute of Rice, Hyderabad during 08-09. November, 2019 p73.

Narendra Kumar

- Kumar N, Ajay BC, Rathnakumar A, Radhakrishnan T, Jadon KS, MK Mahatma MK, Kona P, Chikani BM (2019). Genetic variability analysis for yield, quality traits and foliar disease resistance in groundnut. Presented in 13th

“International Conference on Development of Drylands (ICDD), Converting Dryland Areas from Grey to Green” held at CAZRI, Jodhpur, India from February 11-14, 2019 pp. T-5b/P-15: 178.

Praveen Kona

- Praveen Kona, Mahatma MK, Gangadhar K, Narendra Kumar, Ajay BC, Rathnakumar AL, Radhakrishnan T, Dagla MC, Lokesh Kumar, Gor HK (2019) Confectionery traits evaluation in advanced breeding lines (ABLs) of groundnut. 4th International Conference on Agriculture and Animal Husbandary. University of Hyderabad, August 28-30, p58.

Ram A Jat

- Jat RA, Choudhary RR, Reddy KK (2019) Residue management through minimum tillage in groundnut-wheat cropping system in Saurashtra region of Gujarat. Presented in International Conference on crop residue management held at Gyan Bhawan, Patna during 14-15 October, 2019 p51.

Thirumalaisamy PP

- Thirumalaisamy PP, Dutta, Harish G, Meena HN, Padvi, RD (2019). An insight of Alternaria leaf blight of peanut in India. In: XIX International Plant Protection Congress

(IPCC2019) during November 10-14, 2019 at ICRISAT, Hyderabad; p217

- Attended AICRPG workshop held at Visakhapatnam from 25 to 27th May, 2019.
- Attended 'Recent Advances of Bioinformatics in Agricultural Research: A Practical Perspective' conducted from December 12-21, 2019 at ICAR-IASRI, New Delhi.

Lectures Delivered

KK Pal

- Delivered invited lecture on 'Role of PGPR in Integrated Disease Management' on 13-11-2019 during a Five days training programme on 'Bio-rational approaches for plant disease management' organized by Department of Plant Pathology, College of Agriculture, JAU, Junagadh during November 11-15, 2019 under Institutional Development Plan (IDP) of NAHEP, ICAR.
- Invited Speaker at 60th Annual Conference of AMI and International Symposium on 'Microbial Technologies in Sustainable Development of Energy, Environment, Agriculture and Health’ held at Central University of Haryana, Mahendragarh from 15-18 November, 2019, and delivered an invited talk on

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'Fulfilling the mission of drought and salinity tolerance in crop plants by harnessing the diversity of extreme halophilic microorganisms' on 16-11-19

- Delivered invited lecture on "Application of endophytes for sustainable and climate smart agriculture" on 25-11-2019 in a 21 days winter school on 'Advance Technologies for Biofertilizers and Biopesticides Production for Profitable and Sustainable Agriculture', during 8 to 28 November, 2019 at Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan
- Delivered a talk on 'Microbial Technologies for enhancing profitability of groundnut production system' in Industry Interface Meeting 2019 held at ICAR-DGR Junagadh on 28-12-2019.

MK Mahatma

- Delivered Lead lecture on "Current status of food and nutritional security and food safety" in National seminar on "Biochemical and Molecular Biology Intervention for Nutritional Security and Food Safety" held during 12-13 December, 2019 at Nvsari Agricultural University, Navsari.

Narendra Kumar

- Delivered a lecture on "Basic principles of seed production in groundnut" on 21.09.2019 in modal training course in advance management practices in groundnut from September 19-26 at SKRAU, Bikaner.
- Presented seed production achievements of 2018-19 in the Joint Annual Group Meeting of National Seed Project (Crops) and XIVth ICAR Seed project meeting during 7-9 April, 2019 at HAU, Hisar.
- Delivered a training lecture cum exposé visit on quality seed production to participants from KVK, Bhavnagar on dated 30.01.2019.
- Delivered a training lecture cum exposé visit on quality seed production to participants from KVK, Kodinar on dated 5th February 2019.
- Delivered a training lecture on groundnut cultivation practices in Gujarat at Alidra, Junagadh on dated 30.04.2019.
- Delivered lecture on quality seed production of groundnut in Kisan Divas programme on 23rd December 2019 at ICAR-DGR, Junagadh
- Delivered lecture and exposé visit of 15 farmers from Farmers Welfare and Agriculture

Development, Mandisor on dated 27.11.2019.

- Delivered lecture and exposé visit of 35 farmers from Farmers training centre, Deesa on dated 28.11.2019.
- Delivered lecture and exposé visit of 50 farmers from Farmers Welfare and Agriculture Development, Ratlam on dated 18.12.2019.
- Delivered lecture and exposé visit of 12 farmers from Agriculture Development Block, Depalpura, Indore on dated 20.12.2019.
- Delivered lecture and exposé visit of 50 farmers from Agriculture Development Block, Indore on dated 30.12.2019.

R Dey

- Delivered invited lecture on "Role of PGPR in Sustainable Agriculture" on 25-11-2019 in a 21 days winter school on "Advance Technologies for Biofertilizers and Biopesticides Production for Profitable and Sustainable Agriculture", during 8 to 28 November, 2019 at Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan
- Attended ICAR-DGR Industry Interface Meeting 2019 held at DGR Junagadh on 28-12-2019.

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Meetings attended

Radhakrishnan T

- Attended the discussion on the Establishment of Regional Stations with the DDG (CS) at KrishiBhavan, New Delhi. on 30.04.19
- Organized the AICRPG workshop at Visakhapatnam during 25 to 27 May, 19
- Attended the brainstorming session on National Mission of Edible Oil (NMEO) on 01.06.19
- Attend Interface meeting between DAC & FW New Delhi, ICAR and State Government at Sachivalaya, Gandhinagar on 21.06.19
- Attended the Foundation Day Celebration of ICAR at New Delhi on 15.07.19
- Participated in the interactive meeting at Subject Matter Division at ICAR, New Delhi on 18.07.19
- Attended the review committee meeting on the recognition of RK University (constituted by the Gov. of Gujarat) at Anand Agricultural University, Anand, Gujarat during 25 to 27 July, 19
- Attend the seed review meeting called by the Director General, ICAR, New Delhi on 23.08.19
- Attended a meeting with the Director General, ICAR at Ahmedabad on 23.09.19

- Attended the CVRC meeting held at KrishiBhawan, New Delhi on 04.10.19
- Chaired a session in the Regional Expert Consultation on Gene Editing in Agriculture and its Regulation, held at ICRISAT, Hyderabad on 10.10.19
- Attended Review Meeting of AICRP on 30.10.19
- Had a meeting with the District Administration at West Mednipur regarding the land allotted to DGR for establishing the regional station of the ICAR-DGR on 19.11.19
- Attended the review meeting of the Seed Hubs at KVK, Neempeeth on 24.01.20
- Attended the meeting of land selection committee at Bikaner on 01.01.20

AL Singh

- The “Global Micronutrient Summit 2019” jointly organized by International zinc Association, UK/USA and FAI, at Hotel “The Leela Palace” New Delhi, from 5-6 Sept 2019 and shared my experiences on micronutrient research with the August gathering.

Aman Verma

- Attended AICRP-G, Annual groundnut workshop at Andhra University, Vizag,

Andhra Pradesh from 25th - 27th May 2019.

Gangadhara K

- Attended AICRP-G Annual groundnut workshop from 25-27th May 2019 at Andhra University, Vishakhapatnam, Andhra Pradesh

KK Pal

- Attended 21st IMC meeting of ICAR-DGR Junagadh on 27 April 2019 as member
- Attended 14th IMC meeting of ICAR-NBAIM, Mau on 11 July 2019, as member of IMC of NBAIM, Mau
- Attended meeting convened by Hon'ble Minister of State for Agriculture and Farmers' Welfare Shri Kailash Chaudhuri at NASC Complex, N. Delhi on 13-7-2019
- Attended Annual Review Workshop for Network project on AMAAS held at NASC complex, N. Delhi from 29-30 August, 2019
- Visited N. Delhi on 30-10-2019 to attend review meeting of NFSM(OS&OP) held on 30th October 2019 at KrishiBhavan, convened by DAC, Ministry of Agriculture and Farmers Welfare.
- Visited CCSRI, Mandvi on 7 November, 2019 to conduct survey, monitor and evaluate the performance of the trials/OFTs on endophytes for

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alleviation of salinity stress and also to evaluate the performance of CAM transited groundnut genotypes for salinity tolerance

- Participated in the DPC meeting for promotion from Scientist to Senior Scale Scientist on 22-11-2019 at ICAR-NBAIM, Mau as DG nominee

Narendra Kumar

- Attended XIVth Annual Review Meeting of ICAR Seed Project- “Seed Production in Agricultural Crops” held 7-9 April, 2019 at HAU, Hisar.
- Attended monitoring of breeder seed production and AICRP-G trials in the zone-I (Bikaner, Jodhpur and Durgapura) from 18-24 September 2019.
- Attended and assisted in organizing Annual Groundnut Workshop from May 25-27, 2019 at Andhra University, Visakhapatnam.

RR Choudhary

- Attended AICRP-G, Annual groundnut workshop at Andhra University, Vizag, Andhra Pradesh from 25th - 27th May 2019.

Sushmita

URS Awareness Training on ISO 9001:2015 at ICAR-DGR, Junagadh on 25 Feb 2019.

Awards/Recognition

Aman Verma

- Received Young Woman Scientist award in International Conference on “Innovations in Plant and Animal Sciences for Sustainable Agriculture and Rural Development” (IPASSARD 2019) dated December 07-09, 2019 organized by Rajasthan Agricultural Research Institute, SKNAU, Jobner, Rajasthan



and National Agriculture Development Co-operative Ltd. (NADCL), under Ministry of Cooperatives, Srinagar (J&K).

Narendra Kumar

- Young Scientist Award-2019 for outstanding contribution and recognition in the field of plant breeding by Agriculture Technology Development Society (ATDS).



Praveen Kona

- Received “Best oral presentation award” in ‘4th International conference on Agriculture and Animal Husbandry’ scheduled during 28-30th August, 2019 at School of Life Sciences, University of Hyderabad, Hyderabad.



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Staff List-2019 / General Information / Finance & Accounts

As on (01.01.2019)

S.L.	Name of employees	Designation
1	Dr. T. Radhakrishnan	Director
2	Dr. A.L. Singh	Principal Scientist, Plant Physiology
3	Dr. A.L. Rathnakumar	Principal Scientist, Plant Breeding
4	Dr. S.K. Bera	Principal Scientist, Cytogenetics
5	Dr. K.K. Pal	Principal Scientist, Agricultural Microbiology
6	Dr. Rinku Dey	Principal Scientist, Agricultural Microbiology
7	Dr. Ram Dutta	Principal Scientist, Plant Pathology
8	Dr. R.A. Jat	Senior Scientist, Agronomy
9	Dr. M.K. Mahatma	Senior Scientist, Plant Biochemistry
10	Dr. P.P. Thirumalaisamy	Sr. Scientist, Plant Pathology
11	Dr. Harish G.	Scientist (Senior Scale), Agricultural Entomology
12	Dr. Narendra Kumar	Scientist (Senior Scale), Plant Breeding
13	Dr. Ajay B.C.	Scientist (Senior Scale), Plant Breeding
14	Sh. M.V. Nataraja	Scientist (Senior Scale), Agricultural Entomology
15	Dr. G. Narayan	Scientist (Senior Scale), Agricultural Extension
16	Dr. K. Gangadhara	Scientist, Plant Breeding
17	Dr. Sangh Chandramohan	Scientist, Agricultural Biotechnology
18	Dr. Kiran Kumar Reddy	Scientist, Soil Science
19	Dr. Sushmita	Scientist, Plant Physiology
20	Dr. Kona Praveen	Scientist, Plant Breeding
21	Sh. Ananth Kurella	Scientist, Plant Pathology
22	Sh. Rupak Jena	Scientist, Nematology
23	Dr. Aman Verma	Scientist, Plant Biochemistry
24	Dr. Raja Ram Choudhary	Scientist, Agronomy
25	Ms. Kirti Rani	Scientist, Plant Breeding
26	Dr. D.L. Parmar	Chief Technical Officer
27	Sh. N.R. Ghetia	Chief Technical Officer
28	Sh. P.K. Bhalodia	Chief Technical Officer
29	Sh. P.V. Zala	Chief Technical Officer
30	Sh. P.R. Naik	Assistant Chief Technical Officer (Death on 10.11.19)
31	Dr. J.R. Dobaria	Chief Technical Officer
32	Dr. M.V. Gedia	Assistant Chief Technical Officer
33	Sh. Ranvir Singh	Assistant Chief Technical Officer
34	Dr. S.D. Savaliya	Assistant Chief Technical Officer
35	Mrs. V.S. Chaudhari	Assistant Chief Technical Officer

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36	Sh. B.M. Chikani	Assistant Chief Technical Officer
37	Sh. D.R. Bhatt	Assistant Chief Technical Officer
38	Sh. R.D. Padvi	Technical Officer
39	Sh. H.V. Patel	Technical Officer
40	Sh. C.B. Patel	Technical Officer
41	Sh. N.M. Safi	TO (Driver)
42	Sh. B.M. Solanki	Sr. Technical Assistant (Tractor Driver)
43	Sh. Lokesh Kumar	Sr. Technical Assistant
44	Sh. Pitabas Das	Technical Assistant
45	Sh. Indraraj Meena	Administrative Officer,
46	Sh. Amit Kumar	Finance & Account Officer,
47	Sh. R.T. Thakar	Assistant Administrative Officer
48	Mrs. Rossma Joseph	Personal Secretary
49	Sh. Y.S. Kariya	Personal Assistant
50	Sh. L.V. Tilwani	Personal Assistant
51	Mrs. SanthaVenugolan	Assistant
52	Mrs. M.N. Vaghasia	Assistant
53	Sh. M.B. Kher	Security Supervisor
54	Sh. C.G. Makawan	Assistant
55	Sh. P.N. Solanki	Upper Division Clerk
56	Sh. D.M. Sachaniya	Skilled Support Staff
57	Sh. M.B. Shaikh	Skilled Support Staff
58	Sh. J.G. Agrawat	Skilled Support Staff
59	Sh. K.T. Kapadia	Skilled Support Staff
60	Sh. V.N. Kodiatar	Skilled Support Staff
61	Sh. R.P. Sondarwa	Skilled Support Staff
62	Sh. V.M. Chawada	Skilled Support Staff
63	Sh. G.S. Mori	Skilled Support Staff
64	Mrs. D.S. Sarvaiya	Skilled Support Staff
65	Sh. P.M. Solanki	Skilled Support Staff
66	Sh. N.G. Vadher	Skilled Support Staff
67	Sh. B.J. Dabhi	Skilled Support Staff
68	Sh. C.G. Moradia	Skilled Support Staff
69	Sh. D.A. Makwana	Skilled Support Staff
70	Sh. Jay R. Purohit	Skilled Support Staff

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1. Staff position as on (01.04.2019 to 31.03.2020)

Category of	Sanctioned Strength as on 01.01.2019	Filled As on 01.01.19	Vacant As on 01.01.19	Filled As on 31.12.19	Vacant As on 31.12.19
Scientific	39+01RMP	24+01	15	21+01	18
Technical	39	19	20	17	22
Admn.	17	11	06	10	07
SSS	15	15	00	15	00
Total	110+1 RMP	69+01	41	63+01	47

2. DPC/Promotion/probation/MACP

1.	DPC Held on 15.07.2019 for Scientist Staff	04 employees
2.	DPC Probation Held on 16.09.2019 for Scientist Staff	02 employees
3.	DPC Held on 20.07.2019 for Technical Staff	02 employees
4.	DPC Held on 11.06.2019 for Technical Staff	01 employees
5.	DPC Held on 01.04.2019 for Admn. Staff	01 employees
6.	MACP Held on 10.06.2019 for Admn. Staff	03 employees

3. Institute Management Committee

1.	IMC meeting Held on 27.04.2019
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4. Retirement

1.	Shri N.R.Ghetia, CTO, 31.08.2019
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5. Transfer

1.	Dr. A.L. Rathnakumar Pr. Scientist, ICAR-DGR, Junagadh to IIOR, Hyderabad
2.	Dr. R.A. Jat, Sr. Scientist, ICAR-DGR, Junagadh to IISWC Dehradun
3.	Dr. G. Narayan Scientist, ICAR-DGR, Junagadh to NIVEDI Bangalore

6. Institute Joint Staff Council

1.	Chairman:- Director, ICAR-DGR, Junagadh-362 001, Gujarat
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Members: Staff side

1.	Shri Y.S. Karia, Secretary-IJSC and Member CJSC
2.	Smt. M.N.Vaghasia, Member
3.	Shri R.D. Padavi, member
4.	Shri P. Dash, Member
5.	Shri Jay Purohit, Member
6.	Shri C.G. Moradia, Member

Members:- Office side

1.	Dr. R. Day, Pr. Scientist, DGR, Junagadh
2.	FAO, DGR, Junagadh
3.	AO, DGR, Junagadh

7. Contractual Staff

1	RA	02	6	Technical Assistant	01
2	SRF	02	7	High Skilled worker	01
3	JRF	02	8	Skilled Helper	02
4	YP-2	01	9	Security Staff -Ex. Army	24
5	YP-1	13			

Finance and Accounts

Budget DGR Main Unit (Rs. in lakhs)

(April 2019 - December 2019)

Budget Head	Allocation	Total Expenditure
Establishment charges	856.00	834.78
Wages	92.50	92.25
Administrative Expenses	248.30	238.37
Pension	147.37	103.63
T.A.	25.33	23.86
Research and Operational	191.23	199.36
Expenses	1.86	0.92
HRD	176.49	111.78
Works	12.22	13.70
Equipment	4.42	0.35
Furniture	0.58	0.00
IT	0.00	0.00
Books	1.77	0.00
Vehicles	20.73	18.67
Other	22.50	0.00
Miscellaneous	7.50	0.00
TSP	103.75	100.00
TOTAL (Rs. in lakhs)	1912.55	1737.67

AICRP-G (Rs. in Lakhs)

Budget Head	Allocation (2020)	Total Expenditure
Pay & Allowance	846.86	598.19
TA	16.93	16.93
Recurring Contingency &	185.59	136.25
Need Based Research	44.49	41.05
TSP	7.50	0.00
TOTAL (Rs. in lakhs)	1101.37	792.42

