ICAR-DGR ANNUAL REPORT 2016 - 17

भाकृअनुप
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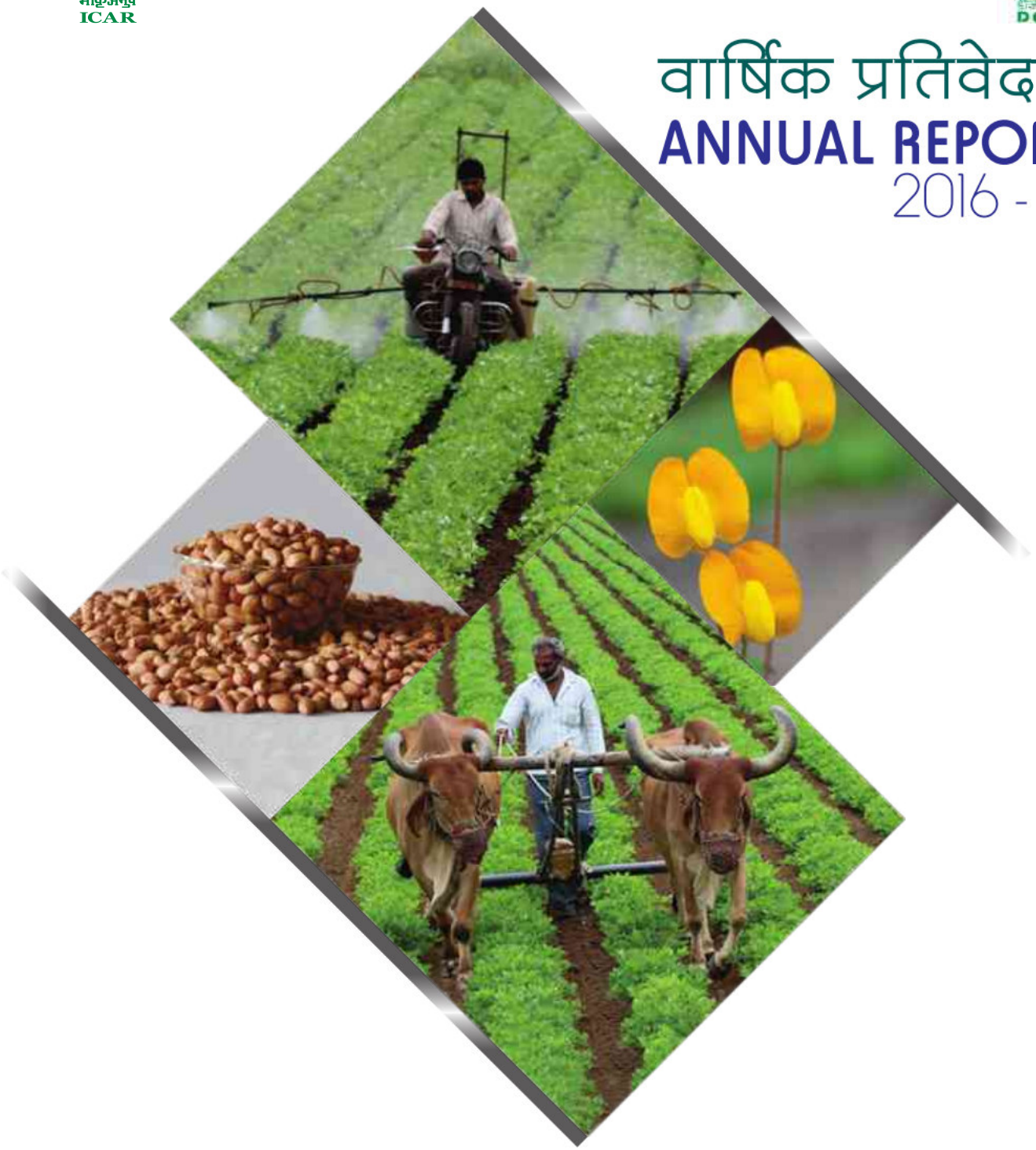

भाकृअनुप–मूँगफली अनुसंधान निदेशालय

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

ICAR-Directorate of Groundnut Research

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

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Preface

With pleasure, I present the annual report of the ICAR-DGR for the year 2016-17. The last crop season registered record production for oilseeds and pulses. The groundnut production also has been posted at 8.47 million tonnes. The Directorate has conducted 518 field level demonstrations (FLDs) and 40 training for improving the adoption rate of improved technologies. Quality seed being the most critical input in groundnut cultivation, we have produced 13952.63 quintals of breeder seed of 43 groundnut varieties cultivated in different states. For improving the livelihood of tribal farmers, we have implemented the tribal sub plan programme in 7 states benefiting 1250 farmers. Groundnut is gaining prominence as a food crop. In this context, groundnut and allied industries have diverse requirements. To understand and address those issues, the ICAR-DGR organised an Industries Interface meeting this Directorate on 31st January, 2017. To update farmers of the new technologies and developments a 'Groundnut farmer fair-cum-exhibition' was organized by ICAR-DGR on 1st October, 2016.

During 2016-17, the DGR scientists published 44 research articles, 5 book chapters, and presented 24 papers in conferences and symposia.

Utilization of the grants was to the tune of Rs. 434.93 lakhs under head 'Plan' and Rs. 1020.52 lakhs under the head 'Non-plan' for DGR and Rs. 798.81 lakhs for AICRP-Groundnut.

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

(Radhakrishnan T)

Contents

Executive Summary

Crop Improvement

- Nine thousand one hundred and twenty-nine (9129) groundnut accessions conserved in medium term cold storage (4±1°C; 30% RH) module.
- 109 accessions in six sections viz. *Arachis* (44), *Caulorhizae* (1), *rectoides* (7), *Heteranthae* (5), *Procumbentes* (8) *and Rhizomatosae* (38) were maintained in the field gene bank 109 accessions in six sections of Arachiswere maintained in the field gene bank.
- High yielding lines PBS 15022 and PBS 15044 were proposed for multilocation trials through AICRP-G.
- Among the germplasm lines screened under drought stress genotypes NRCG 404 and NRCG 12755 had high pod yield.
- Nine new advanced high yielding reeding lines (five of Spanish and four of Virginia habit group) were developed during kharif 2016.
- Eight mapping populations were developed, five for tolerance to stem rot, two for seed coat resistance to in-vitro seed colonization and one for foliar disease resistance.
- Segregating materials of 42 different crosses from four segregating generations (F_3 and F_4) were supplied to ten AICRP-G centres for kharif 2017.
- Advanced breeding line PBS22040 recorded a score <3 on 1-9 scale and found resistant to Alternaria leaf blight.
- Seven accessions (NRCGs' 11923, 12124, 11906, 8974, 5195, 11888, 12163) recorded oil content (more than 52%) and six accessions (11981, 11960, 11979, 414, 11875, 12128) recorded ≥30% protein content.
- Two accessions, ICGV 05057 and ICG 3053 which recorded less than 10% stem rot disease incidence were identified as promising.
- During drought stress, the BcZAT12 transgenic lines in T_2 generation showed significant higher level of relative water content, superoxide dismutase, catalase, glutathione peroxidise, ascorbate peroxidase, glutathione reductase activity, while significant lower level of hydrogen peroxide and malondialdehyde content was recorded when compared to untransformed wild type plants. Among studied
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- Five markers, one (IPAHM 103)reported linked and four novel EST-SSRs (DGR 308, DGR 508, DGR 800 and DGR 2409) were found to be associated with LLS and rust resistance.
- Two breeding lines (18-6 and 22-6) and seven breeding lines (17-12, 15-5, 15-17, 15-1, 18-5, 15-3, 15-13, 15-2) were found resistant (with less than 20% mortality) and moderately resistant (with less than 30% mortality), espectively for stem rot disease over three seasons
- Interspecific derivatives NRCGCS lines 40, 254, 292, 330, 404, 445, and 446 (belongs to Spanish bunch) were found short duration with early days to 50% flowering, high BY, HI and percent maturity than Chico.
- Fatty acid analysis over two seasons (kharif 2015 and kharif 2016)confirmed that 11 lines contain ~80% oleic acid. Oil content of these high oleate lines ranged from 52- 56% while pod yield were at per check.
- Six advanced breeding lines have been proposed for multilocation trials under AICRP-G during kharif 2017.
- A fresh elite Spanish bunch germplasm (NRCGCS281) with hundred kernel weight of 80 g has been registered at NBPGR. NRCGCS281 matures in 115 days and contains 50% oil.

Crop Protection

- VarietiesTirupati3 and Kadiri3 were found promising for resistance to stem rot.
- T.virideDharwad,T. virensand T. harzianum T170 achieved maximum inhibition of stem rot
- OrganicformulationsDGROF1 and DGROF3 gave maximum inhibition of stem rot.
- Raised bed (with three rows) recorded minimum stem rot as compared to farmers practice.
- Module-M10 and Module-M5 were best for reducing stem rot and collar rot, respectively.
- Storage of pods upto 8 months at room temperature (28±2 °C) in high density polythene bags (160 micron thickness, HDPE bags) has lesser A. flavus infection and aflatoxin contamination compared to pods stored in jute gunny bags, interwoven bags and ploythene lined gunny bags. In addition to this, devoid of bruchid and Corcyra infestations were recorded in pods/kernels stored in HDPE bags.
- Roasting of groundnut kernels at 120 °C for 10-15 minutes or at 140 °C for 6-8 minutes has reduced aflatoxin initial load from the 100 ppb to 12-22 ppb. This information provides way for minimizing aflatoxin load in the contaminated groundnut kernels.
- Yellow sticky traps were more efficient in trapping leafhopper and blue sticky traps were suitable for trapping thrips
- Maize and bajra planted at 2:1 ratio with groundnut found effective in reducing thrips and leafhopper population on groundnut
- Neem and castor oils @ 5% stored in blue plastic drum and galvanized bins were undamaged upto six months of storage
- Constitutive level of cinnamic and salicylic acid was higher in alternaria and late leaf spot resistant genotypes.
- Higher constitutive and induced activities of phenyl alanine ammonia lyase and tyrosine ammonia lyase enzyme were observed in alternariaand leaf spot resistant genotypes.
- TCA cycle compound increased in leaf spot genotypes after infection.

Crop Production

- Application of 100% RDF + 5 t/ha FYM + BF in groundnut and 75% RDF in wheat gave significantly highest pod and haulm yield of groundnut during kharif season. While application of 75% RDF + 5 t/ha FYM + biofertilizer in groundnut and 100% RDF in wheat gave significantly highest grain yield of wheat in kharif season.
- Among the organic modules, application of FYM @ 5t/ha + enriched compost @ 1429 kg/ha + growth stimulant + bio-multi-nutrient solubilizer gave significantly highest pod and haulm yield of groundnut during summer.
- The sowing of crop in paired rows at 45/10 x 10 cm spacing gave significantly highest pod yield while highest haulm yield was found with sowing at 45/20 x 10 cm spacing. Application of PGPR through seed treatment + two foliar spray of Amritpani at 25 and 45 DAS gave significantly highest pod and haulm yield of groundnut.
- Application of FYM was found most congenial for solubilization and mobilization of soil phosphorus followed by compost, citric acid and PGPR in groundnut - wheat cropping system.
- Combination of FYM and PSB 2 (i.e., BM 8) were found promising for enhanced growth, yield and nutrient acquisition by the plants in summer groundnut.
- Low to medium index of available soil phosphorus was observed in soils of Bikaner region under groundnut based cropping systems.
- The higher pod yield was recorded at 2 dSm^{-1}(84%) as compared to 6 dSm^{-1}saline irrigation water.
- The higher pod yield was recorded under straw mulch (79%) and under polythene mulch (62%) as compared to without mulch (control)
- Interaction effect of salinity X mulching revealed that pod yield under polythene mulch and straw mulch was recorded 342 and 491%, higher at 6 dSm^{-1}, respectively as compared to control.

Basic Sciences

- Early and sustained induction of heat shock proteins in tolerant as compared to susceptible genotypes may be an indicator of temperature shock stress tolerance in groundnut.
- Temperature stress in groundnut negatively affects oil content and enhances the protein content.
- The application of DAPG-producing fluorescent pseudomonads (identified for having antifungal activities against the major soil-borne fungal pathogens) reduced the plant mortality due to stem rot from 74% to 21-38% in different treatments.
- Four groundnut rhizobacterial isolates were identified for Zn and K solubilization.
- Leaf epiphytic bacterial isolates antagonistic to Alternaria and late leaf spot pathogen were identified.
- Eighteen new insecticidal bacilli (Bacillus thuringiensis, Bacillus licheniformis, Bacillus sp., Brevibacillusbrevis, Bacillus amyloliquefaciens, Bacillus cereus, Bacillus tequilensis, etc.), insecticidal to white grub have been isolated with upto 100% mortality.
- Application of endophytes like Bacillus firmus J22, Bacillus subtilis SEN51 and Pseudomonas pseudoalcaligenes SEN29 significantly prevented the loss of yield of groundnut by 15-25% as compared to uninoculated control
- Endophytes have also been found to possess plant growth promoting traits and enhanced pod yield of groundnut (TG37A) by application of Pseudomonas pseudoalcaligenes SEN29 (20.9%), and Bacillus firmus J22 (14.2%) during kharif 2016.
- Application of Bacillus firmus J22 alleviated salinity and reduced the yield loss to the tune of 22%.

Social Sciences

- The field survey conducted in kharif 2016 revealed that Dharwad district groundnut growers had medium to high RUM behaviour in land management, nutrient management and weeds management components. In Tumkuru district low level of resource use management behaviour found highly in cropping systems, soil-moisture, insect pests and diseases management components.

कार्यकारी सारांश

फसल सुधार

- जीन बैंक में मूँगफली के 9129 वंशक्रमों को ठंडे तापमान (4±1° सेल्सीयस) एवं 30% सापेक्ष आर्द्रता पर संरक्षित किया गया ।
- प्रक्षेत्र जीन बैंक में मँगफली के 6 अनुभागों के 109 वंशक्रमों को संरक्षित किया गया जिसमें *Arachis* (44), *Caulorhizae* (1), *Erectoides* (7), *Heteranthae* (5), *Procumbentes* (8) and *Rhizomatosae* (38) वंशक्रम शामिल है ।
- जीनोटाइप पीबीएस 15022 एवं पीबीएस 15044 को एआईसीआरपीजी के अंतर्गत विभिन्न स्थानों पर परीक्षण के लिये प्रस्तावित किया गया है ।
- मूँगफली वंशक्रमों का सूखे की परिस्थिति में परीक्षण किया गया जिनमें से एनआरसीजी 404 एवं एनआरसीजी 12755 में अधिक फलियों की उपज प्राप्त हुई ।
- नौ अधिक उपज देने वाली नई प्रजनक लाइने विकसित की गई जिनमें पांच स्पेनिश एवं चार विर्जिनिया समूह की है ।
- आठ मेपिंग लाइने विकसित की गई जिनमें से पांच लाइने तना गलन रोग सहनशीलता के लिये, दो लाइने बीज के आवरण में फफूंद प्रतिरोधकता के लिये एवं एक लाइन तना गलन रोग के प्रतिरोधकता के लिये है ।
- अग्रिम प्रजनक लाइन पीबीएस 22040 में अल्टरनेरिया पर्णचित्ती रोग प्रतिरोधकता पाई गई जिसमें रोग के लिये 1-9 के पैमाने पर<3 स्कोर देखा गया ।
- अग्रिम प्रजनक लाइनों पीबीएस 12171, 1 2189, 12190, 12191 एवं 12192 को ताजा बीज सुषुप्ता के लिये पहचाना गया ।
- सात वंशक्रमों; एनआरसीजी 11923, 12124, 11906, 8974, 5195, 11888 एवं 12163 में 52% से अधिक तेल तथा छह वंशक्रमों; एनआरसीजी 11981, 11960, 11979, 414, 11875 एवं 12128 में 30% प्रोटीन की मात्रा पाई गई ।
- दो वंशक्रमों, आइसीजीवी 05057 तथा आइसीजी 3053 में तना विगलन रोग 10% से कम देखा गया ।
- सूखे की स्थिति में BcZAT12 ट्रांसजेनिक टी 3 लाइन में अपेक्षाकृत जल की मात्रा, सुपर ओक्साइड डिसम्युटेज, केटालेज, ग्लूटाथयोन परओक्सिडेज, एस्कारबेट परओक्सिडेज, ग्लूटाथयोन रीडक्टेज एंजाइम की क्रियाशीलता सार्थक रूप से अधिक पाई गई । जबकि हाइड्रोजन परोक्साइड एवं मेलोनडाई एल्डिहाइड की मात्रा बिना ट्रांसफोर्म किये गये पौधों से कम थी । मूँगफली में पेग एवं फलियाँ बनते समय परओक्सीडिज एवं एस्कोरबेट परओक्सीडिजएंजाइल की क्रियाशीलता अन्य एंटीओक्सीडेंट एंजाइम की अपेक्षा अधिक पाई गई ।
- पछेती पत्ती धब्बा एवं रस्ट रोग प्रतिरोधकता के लिये पांच मार्कर पहचाने गये जिसमें से एक 0IPAHM 103 रोग प्रतिरोधकता से जुडा हुआ तथा चार इएसएसआर (डीजीआर 308, 508, 800 एवं 02409) सहायक थे ।
- तीन ऋतुओं में दो प्रजनक लाइने (18-6 एवं 22-6) तना विगलन रोग के लिये प्रतिरोधी पाई गई जिनमें पौधों की मृत्यु-दर 20% से कम थी तथा पांच प्रजनक लाइनों (17-22, 15-5, 15-17, 15-1, 18-5, 15-3, 15-13, 15-2) को मध्यम तना विगलन प्रतिरोधी पाया गया जिनमें पौधों की मृत्यु-दर 30% से कम थी ।
- मूँगफली की अंतर्प्रजातीय व्युत्पन्नों; एनआरसीजी 40, 254, 292, 330, 404, 445 एवं 446 (स्पेनिश गुच्छा) को कम समय में पकने वाली तथा जल्दी 50 प्रतिशत फुल आने वाली लाइनों के रूप में पहचाना गया इनमें चिको की अपेक्षा अधिक जैविक उपज तथा कटाई मानक प्राप्त हुआ ।
- दो ऋतुओं (खरीफ-2015 एवं खरीफ-2016) वसीय अम्लों के विश्लेषण से ज्ञात हुआ कि मूँगफली की ग्यारह लाइनों में लगभग 80% ओलिक अम्ल है तथा इनमें 52- 56% तक तेल कि मात्रा पाई गई । जबकि फली की उपज चेक के बराबर थी ।
- स्पेनिश गुच्छा वंशक्रम की एक अभिजात लाइन (एनआरसीजी 281) में 100 दानों का वजन 80 ग्राम पाया गया जिसे एनबिपीजीआर में पंजीकृत कराया गया । यह लाइन 115 दिनों में पक जाती है तथा दानों में 50% तेल पाया जाता है ।
- पछेती पत्ती धब्बा एवं रस्ट रोग प्रतिरोधकता के लिये पांच मार्कर पहचाने गये जिसमें से एक 0IPAHM 103 रोग प्रतिरोधकता से जुडा हुआ तथा चार इएसएसआर (डीजीआर 308, 508, 800 एवं 02409) सहायक थे ।
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- जैविक यौगिक डीजीआर-ओएफ 1 एवं डीजीआर-ओएफ 3 से सर्वाधिक नियंत्रण हुआ ।
- रेज्ड बेड (तीन लाइन) में किसानों की बुवाई की विधि की अपेक्षा कम तना विगलन रोग देखा गया ।
- मोड्यूल-एम 10 एवं मोड्युल-एम 5 में क्रमश: तना विगलन एवं कोलारविगलन सबसे कम देखा गया ।
- आठ महीने तक कमरे के तापमान (28±2° सेल्सियस) पर अधिक घनत्व वाले पोलीथीन बैग में मूँगफली का भण्डारण करने पर जूट के गनी बैग में भण्डारण की अपेक्षा कम एस्परजलिस फ्लेवस एवं एफ्लाटॉक्सिन का संक्रमण देखा गया । इसके अतिरिक्त ब्रुचीड तथा कोरसिरा का संक्रमण भी अधिक घनत्व वाले पोलीथीन बैग में नहीं देखा गया ।
- मूँगफली को 120° सेल्सियस पर 10-15 मिनट अथवा 140° सेल्सियस पर 6-8 मिनट तक भूनने से एफ्लाटॉक्सिन 100 पीपीबी से घटकर 12-22 पीपीबी रह जाता है । अत: इस तकनीक से संक्रमित दानों में एफ्लाटॉक्सिन को कम किया जा सकता है ।
- नाईट्रोजन: फोस्फोरस: पोटाश 37.5:70.0:0.0 की दर में उपयोग लेने पर थ्रिप्स की संख्या कम देखी गई ।
- पीले चिपचिपे जाल पत्ती होप्पर तथा नीले चिपचिपे जाल थ्रिप्स को फँसाने में ज्यादा प्रभावी है ।
- मक्का एवं बाजरा को मूँगफली के साथ 2:1 अनुपात में उगाने पर पत्ती होप्पर एवं थ्रिप्स की संख्या में प्रभावी रुप से कमी देखी गई ।
- मूँगफली को नीम तथा अरंडी के तेल (5% की दर से) से उपचारित करके नीले प्लास्टिकके डिब्बे एवं टिन के डिब्बे में छह महीने तक भण्डारण कीटों के प्रकोप से सुरक्षित रखा जा सकता है ।
- अल्टूनेरिया एवं पत्ति धब्बा रोग प्रतिरोधकजीनोटाइप में संक्रमण से पूर्व सिन्नेमिक एवं सेलिसिलिक अम्ल की मात्रा अधिक पाई गई ।
- अल्टूनेरिया एवं पत्ति धब्बा रोग प्रतिरोधकजीनोटाइप में संक्रमण से पूर्व एवं बाद फिनाइलएलानिन अमोनिया लायेज एवं टाइरोसिन अमोनिया लायेग एन्जाइम की क्रियाशीलता अधिक पाई गई ।
- टीसीए चक्र उत्पादों की मात्रा में पत्ति धब्बा रोग के समय बढोतरी देखी गई ।

फसल उत्पादन

- खरीफ में 100% अनुशंसित उर्वरक की मात्रा के साथ 5 टन गोबर की खाद एवं जैव-उर्वरक देने तथा गेंहूँ में 75% अनुशंसित उर्वरक देने से सर्वाधिक फलियाँ एवं पुआल की उपज प्राप्त हुई । जबकि मूँगफली में 75% अनुशंसित उर्वरक मात्रा के साथ 5 टन गोबर की खाद एवं जैव-उर्वरक देने तथा गेंहूँ में 100% अनुशंसित उर्वरक देने से सर्वाधिक अनाज का उत्पादन हुआ ।
- विभिन्न जैविक मॉड्यूलमें से गोबर की खाद 5 टन/हैक्टर + एनरिच्ड कम्पोस्ट 1429 कि.ग्रा./हैक्टर + वृद्धि उत्तेजक + जैव बहु पोषक तत्व के प्रयोग से ग्रीष्म में सर्वाधिक फलियाँ एवं पुआल की उपज प्राप्त हुई ।
- फसल की बुवाई युग्मित पंक्तियों में 45/10 x 10 सेमी की दुरी पर करने से सर्वाधिक फलियाँ प्राप्त हुई जबकि 45/20 x 10 सेमी की दूरी पर करने से सर्वाधिक पुआल की उपज प्राप्त हुई । पीजीपीआर से बीजोपचार + अमृतपानी के दो बार पर्ण छिडकाव (बुवाई के 25 दिन बाद) के प्रयोग से सर्वाधिक फलियाँ एवं पुआल की उपज प्राप्त हुई ।
- मूँगफली-गेंहूँ फसल पद्धति में मृदा में फास्फरस की धुलनशीलता एवं गतिशीलता बढाने के लिए गोबर की खाद सबसे उपयुक्त है उसके बाद कम्पोस्ट, साइट्रिक अम्ल एवं पीजीपीआर है ।
- गोबर की खाद एवं पीएसबी 2 के संयुक्त उपयोग से ग्रीष्म मूँगफली की वृद्धि एवं उपज में बढोतरी देजी गई साथ ही साथ पौषक तत्वों की उपलब्धता भी बढी ।
- बीकानेर क्षेत्र में मूँगफली उगाने वाली मृदा के परिक्षण में निम्न से मध्यम प्राप्य फॉस्फोरस देखा गया । उपयोग से ग्रीष्म मूँगफली की वृद्धि एवं उपज में बढोतरी देजी गई साथ ही साथ पौषक तत्वों की उपलब्धता भी बढी ।
- बीकानेर क्षेत्र में मूँगफली उगाने वाली मृदा के परिक्षण में निम्न से मध्यम प्राप्य फास्फोरस देखा गया ।
- लवणीय पानी की सिंचाई में, 2 डीएसएम-1 लवणीयता वाले पानी की सिंचाई से 6 डीएसएम-1 की अपेक्षा अधिक फलियाँ की उपज प्राप्त हुई ।
- भूसे की पलवार एवं पोलिथिन की पलवार लगाने से बिना पलवार के मूँगफली की अपेक्षा अधिक फलियाँ की उपज प्राप्त हुई ।
- लवणीयता x पलवार परस्पर प्रभाव के अन्तर्गत 6 डीएसएम-1 लवणीयता वाले पानी की सिंचाई से भूसे की पलवार एवं पोलिथिन की पलवार वाली मूँगफली में कंट्रोल की अपेक्षा अधिक फलियों की उपज प्राप्त हुई ।

- मूँगफली की अंर्तप्रजातीय व्युत्पन्नों; एनआरसीजी 40, 254, 292, 330, 404, 445 एवं 446 (स्पेनिश गुच्छा) को कम समय में पकने वाली तथा जल्दी 50 प्रतिशत फुल आने वाली लाइनों के रूप में पहचाना गया इनमें चिको की अपेक्षा अधिक जैविक उपज तथा कटाई मानक प्राप्त हुआ ।

फसल संरक्षण

- तिरुपति 3 तथा कादिरी 3 किस्में तना विगलन रोग के प्रतिरोधी पाई गई ।
- ट्राइकोडरमा विरडी धारवाड, ट्राइकोडरमा वाइरेन्स एवं ट्राइकोडरमा हरजियानम टी 170 से तना विगलन का सर्वाधिक नियंत्रण हुआ ।
- जैविक यौगिक डीजीआर-ओएफ 1 एवं डीजीआर-ओएफ 3 से सर्वाधिक नियंत्रण हुआ ।
- रेजड बेड (तीन लाइन) में किसानों की बुवाई की विधि की अपेक्षा कम तना विगलन रोग देखा गया ।
- मोड्यूल-एम 10 एवं मोड्युल-एम 5 में क्रमश: तना विगलन एवं कोलारविगलन सबसे कम देखा गया ।
- आठ महीने तक कमरे के तापमान (28±2° सेल्सियस) पर अधिक घनत्व वाले पोलीथीन बैग में मूँगफली का भण्डारण करने पर जूट के गनी बैग में भण्डारण की अपेक्षा कम एस्परजलिस फ्लेवस एवं एफ्लाटॉक्सिन का संक्रमण देखा गया । इसके अतिरिक्त ब्रुचीड तथा कोरसिरा का संक्रमण भी अधिक घनत्व वाले पोलीथीन बैग में नहीं देखा गया ।
- मूँगफली को 120° सेल्सियस पर 10-15 मिनट अथवा 140° सेल्सियस पर 6-8 मिनट तक भूनने से एफ्लाटॉक्सिन 100 पीपीबी से घटकर 12-22 पीपीबी रह जाता है । अत: इस तकनीक से संक्रमित दानों में एफ्लाटॉक्सिन को कम किया जा सकता है ।
- नाईट्रोजन: फोस्फोरस: पोटाश 37.5:70.0:0.0 की दर में उपयोग लेने पर थ्रिप्स की संख्या कम देखी गई ।
- पीले चिपचिपेजाल पत्ती होप्पर तथा नीले चिपचिपेजाल थ्रिप्स को फँसाने में ज्यादा प्रभावी है ।
- मक्का एवं बाजरा को मूँगफली के साथ 2:1 अनुपात में उगाने पर पत्ती होप्पर एवं थ्रिप्स की संख्या में प्रभावी रुप से कमी देखी गई ।
- मूँगफली को नीम तथा अरंडी के तेल (5% की दर से) से उपचारित करके नीले प्लास्टिकके डिब्बे एवं टिन के डिब्बे में छह महीने तक भण्डारण कीटों के प्रकोप से सुरक्षित रखा जा सकता है ।
- अल्टूनेरिया एवं पत्ति धब्बा रोग प्रतिरोधकजीनोटाइप में संक्रमण से पूर्व सिन्नेमिक एवं सेलिसिलिक अम्ल की मात्रा पाई गई ।
- अल्टूनेरिया एवं पत्ति धब्बा रोग प्रतिरोधक जीनोटाइप में संक्रमण से पूर्व एवं बाद फिनाइलएलानिन अमोनिया लायेज एवं टाइरोसिन अमोनिया लायेग एन्जाइम की क्रियाशीलता अधिक पाई गई ।
- टीसीए चक्र उत्पादों की मात्रा में पत्ति धब्बा रोग के समय बढोतरी देखी गई ।

फसल उत्पादन

- खरीफ में 100% अनुशंसित उर्वरक की मात्रा के साथ 5 टन गोबर की खाद एवं जैव-उर्वरक देने तथा गेंहूँ में 75% अनुशंसित उर्वरक देने से सर्वाधिक फलियाँ एवं पुआल की उपज प्राप्त हुई । जबकि मूँगफली में 75% अनुशंसित उर्वरक मात्रा के साथ 5 टन गोबर की खाद एवं जैव-उर्वरक देने तथच गेंहूँ में 100% अनुशंसित उर्वरक देने से गेंहूँ सर्वाधिक अनाज का उत्पादन हुआ ।
- विभिन्न जैविक मॉड्यूलमें से गोबर की खाद 5 टन/हैक्टर + एनरिच्ड कम्पोस्ट 1429 कि.ग्रा./हैक्टर + वृद्धि उत्तेजक + जैव बहु पोषक तत्व के प्रयोग से ग्रीष्म में सर्वाधिक फलियाँ एवं पुआल की उपज प्राप्त हुई ।
- फसल की बुवाई युग्मित पंक्तियों में 45/10 x 10 सेमी की दुरी पर करने से सर्वाधिक फलियाँ प्राप्त हुई जबकि 45/20 x 10 सेमी की दूरी पर करने से सर्वाधिक पुआल की उपज प्राप्त हुई । पीजीपीआर से बीजोपचार + अमृतपानी के दो बार पर्ण छिडकाव (बुवाई के 25 दिन बाद) के प्रयोग से सर्वाधिक फलियाँ एवं पुआल की उपज प्राप्त हुई ।
- मूँगफली-गेंहूँ फसल पद्धति में मृदा में फास्फरस की घुलनशीलता एवं गतिशीलता बढाने के लिए गोबर की खाद सबसे उपयुक्त है उसके बाद कम्पोस्ट, साइट्रिक अम्ल एवं पीजीपीआर है ।
- गोबर की खाद एवं पीएसबी 2 के संयुक्त उपयोग से ग्रीष्म मूँगफली की वृद्धि एवं उपज में बढोतरी देजी गई साथ ही साथ पौषक तत्वों की उपलब्धता भी बढी ।
- बीकानेर क्षेत्र में मूँगफली उगाने वाली मृदा के परिक्षण में निम्न से मध्यम प्राप्य फास्फोरस देखा गया ।

फसल संरक्षण

- तिरुपति 3 तथा कादिरी 3 किस्में तना विगलन रोग के प्रतिरोधी पाई गई ।
- ट्राइकोडरमा विरडी धारवाड, ट्राइकोडरमा वाइरेन्स एवं ट्राइकोडरमा हरजियानम टी 170 से तना विगलन का सर्वाधिक नियंत्रण हुआ ।

मूलभूत विज्ञान

- दानों में अधिक आयरन एवं जिंक वाले मिनिकोर वंशक्रमों की पहचान की गई।
- मूँगफली में लवणीयता की स्थिति में सुपर ऑक्साइड डिसम्युटेज, केटालेज, एवं परओक्सिडेज एंजाइमों की क्रियाशीलता में वृद्धि देखी गई।
- मूँगफली की तापमान सहनशील जीनोटाइप में संवेदनशील जीनोटाइप की अपेक्षा हिट सोक प्रोटीन का जल्दी एवं निरंतर प्रेरण देखा गया जोकि तापमान की सहनशीलता के लिये उत्तरदायी हो सकता है।
- तापमान तनाव के कारण मूँगफली में तेल में कमी एवं प्रोटीन में वृद्धि देखी गई।
- डीएपीजी–उत्पन्न करने वाले फ्लूरोसेंट स्यूडोमोनास (जोकि मृदा जनित कवक रोगजनकों के लिए कवकरोधी है) के प्रयोग से पौधों कि मृत्यु में 74% कि अपेक्षा 21-38% तक कमी हुई।
- मूँगफली के चार राइजो बेक्टेरियल आइसोलेट्स को जिंक एवं पोटाश की धुलनशीलता के लिए पहचाना गया।
- पत्तियों के एफिफाइटिक बेक्टेरियल आइसोलेट्स को अल्टरनेरिया एवं पछेती पत्ति धब्बा रोगनाशकों के विरोधी के रुप में पहचाना गया।
- सफेद गिडार के नियंत्रण के लिये अठारह नये बेसिल्ली कीटनाशी (*Becilulus thuringiensis, Becillus licheniforms, Bacillus sp., Brevibacillusbrevis, Bacillus amyloliquefaciens, Bacillus cereus, Bacillus tequilensis,* etc.) पृथक किये गये जिनकी मृत्युदर 100 प्रतिशत थी।
- एंडोफाइट्स की पौधों की वृद्धि को बढाने के गुणों के कारण खरीफ–2016 में एंडोफाइट्स *Pseudomonas, pseudoalcaligenes* SEN 29 एवं *Bacillus firmus* J22 के उपयोग से मूँगफली की टीजी 37 ए किस्म में फलियों की उपज में क्रमश: 20.9 प्रतिशत एवं 14.2 प्रतिशत वृद्धि हुई।

सामाजिक विज्ञान

- खरीफ–2016 के दौरान के सर्वेक्षण से पता चला कि धारवाड जिले के मूँगफली उगाने वाले किसानों का मृदा प्रबंधन, पोषक तत्व प्रबंधन एवं खरपतवार प्रबंधन मध्यम से अधिक तक था। तुमकुर जिले किसानों का संसाधन उपयोग प्रबंधन विशेषकर फसल प्रणाली, मृदा नमी तथा कीट व्याधियों के नियंत्रण के लिये कम था।

1 Genetic improvement of groundnut

Breeding for tolerance to abiotic stress in groundnut

Hybridization, selection and generation of advancement in segregating generations

Ten fresh crosses were attempted in kharif 2016 to enhance earliness and tolerance to drought stress and yield attributes. In kharif 2016 the probable hybrid pods from ten crosses attempted in kharif 2015 were raised and F_1 hybrids were harvested as single plants. Nine crosses in F_3 generation were raised in Anantapur under rainfed conditions and approximately 80 single plant progenies (spp) were selected. 104 single plant progenies from 9 different crosses in F_4 generation and 129 single plant progenies from F_5 generation were raised under rainfed conditions at Anantapur during kharif 2016 and 46 single plant progenies were selected. In addition, selections in five crosses developed for confectionery traits yielded 60 promising genotypes. Seeds of two advanced breeding lines PBS 15022 and PBS 15044 were multiplied for AICRPG trials.

Screening of genotypes for drought/water stress

Twenty-eight genotypes were screened during kharif season of 2016 under rainfed conditions at Anantapur without any supplemental irrigation. Genotypes used in the experiment consisted of twelve mutant lines derived from TG 37A (KKP 1 to KKP 12), fourteen advanced breeding materials (PBS series) and two check varieties (VRI GN 6 and K 6). Analysis of variance indicated significant genotypic differences for SCMR, relative water content (RWC), pod yield per plant, haulm yield per plant and harvest index. Genotypes PBS 15028, PBS 15029 and PBS 30055 had high pod and haulm yield when compared to local check K6 under drought stress.

Screening Spanish DSN for drought tolerance at Anantapur

Spanish DSN (drought screening nursery) consisting of 113 genotypes along with four checks (K6, M13, ICGS 76 and ICGS 44) were screened for drought tolerance under two treatments involving with and without protective irrigation using Augmented design. Analysis of variance indicated significant differences among test genotypes for days to 50% flowering (DFF), SCMR, pod yield per plant and harvest index under rainfed conditions. Whereas under protective irrigated conditions significant differences were observed for DFF, pod yield per plant and harvest index. Under rainfed conditions genotypes PBS 15030, PBS 15041, Jun 28, PBS 15044, PBS 15014, PBS 15018 had high pod yield and harvest index when compared to local check K6 under drought stress.

Screening Virginia DSN for drought tolerance at Anantapur

Virginia DSN (drought screening nursery) consisting of 170 genotypes along with four checks (K6, M13, ICGS 76 and ICGS 44) were screened for drought tolerance under two treatments involving with and without protective irrigation using Augmented design. Analysis of variance indicated significant differences among test genotypes and checks varieties for SCMR, RWC, pod yield per plant, haulm yield per plant and harvest index under rainfed and protective irrigated conditions. Among the genotypes studied,PBS 25085, PBS 25063, PBS 21099, PBS 26055, PBS 25063 and PBS 25077 had high pod yield and harvest index when compared to best check K6.

Promising genotypes identified under drought situations of Anantapur

Screening of inter-specific derivatives for drought tolerance

A set of 171 inter-specific derivatives were screened for drought tolerance along with four checks (K6, M13, ICGS 76 and ICGS 44) under two treatments involving with and without protective irrigation using augmented design. Analysis of variance indicated significant differences among test genotypes and check varieties for SCMR, RWC, pod yield per plant, haulm yield per plant and harvest index under both rainfed and protective irrigated conditions. Among the genotypes studied 19 genotypes had high pod yield and 24 genotypes had high harvest index when compared to check K6.

Screening of germplasm accessions identified based on SLA and SCMR for drought/water stress

Thirty genotypes were screened during rabi season of 2015 under rainfed conditions at Anantapur without any supplemental irrigation. Analysis of variance (Table 10a) indicated significant genotypic differences for haulm yield per plant, pod yield per plant and harvest index. Among the genotypes screened only genotypes NRCG 404 had high pod yield per plant and high harvest index compared to all other genotypes.

Screening of germplasm accessions for tolerance to drought/water stress

An experiment involving 186 germplasm accessions along with cultivars such as K6, K9, Dharani, Haritandra, Vemana, TG 37A, Vemana, SP250A, M13, ICGV 86590 and ICGV 86031 was conducted during rabi season of 2015 under rainfed conditions at Anantapur without any supplemental irrigation. Analysis of variance indicated significant genotypic differences for haulm yield per plant, pod yield per plant and harvest index. Few superior germplasm accessions with high pod yield per plant and harvest index are presented in Table 11b. Genotype NRCG 12755 had high pod yield per plant whereas genotype CS166 had high harvest index.

Mutagenesis of variety TPG 41

For enhancing the O/L ratio in groundnut, variety TPG 41 were EMS mutagenized with different treatment combinations and total of 138 individual plants were harvested from the M_2 generation of TPG 41 mutagenized population.

Evaluation of groundnut germplasm for maturity related traits.

During summer-2016, 124 groundnut genotypes were evaluated in augmented design with 5 checks and genotypes Dh 101, Dh 86, J 11, TAG 24 and TG 26 had more number of pegs and mature pods when harvested at 95DAS.

Breeding for resistance to major diseases and insect pests in groundnut

Hybridization

Ten crosses were effected in kharif 2016 to develop improved varieties resistant / tolerant of foliar diseases, stem rot, Alternaria leaf blight, collar rot, leaf spot and rust, Spodoptera and sucking pest. The number of harvested crossed pods varied from 33(CS 74 × Dh 86) to 211 (TG 37A × CS 319). The mean success rate (%) of the hybridization programme was 26.45, which ranged from 6.9 to 47.8%.

Identification of hybrids

Thirteen different crosses were raised in summer 2016 to identify F.'s effected for developing resistant/tolerant genotypes to foliar diseases, stem rot and insect-pests of groundnut. A total 60 single plants have been identified as hybrids in all the eleven crosses. A maximum number (17) F.'s have been identified in the cross TG37A × CS319 followed by eight hybrids in the crosses GG7 × RHRG06083. Two crosses were rejected due to appearance of parental-type.

Advancement of different filial generations

The breeding materials generated earlier were advanced to next higher filial generation. Progenies of 63 crosses wereadvanced to different filial generations (F_2-F_6) in kharif 2016, among them 40 crosses in early generations (up to F_3) and 23 in advanced generations. At the time of harvest ten crosses were rejected due to large proportion of poor recombinants and absence of desirable trait of interest in the recombinants. In F_6 generation, individual plant progenies of 14 crosses were raised to identify high yielding stable genotypes, among these crosses seven were rejected and from the remaining seven crosses nine new advanced high yielding stable breeding lines were identified and given nomenclature according to objective and their botanical group.

Selection in segregating generation

Development and generation advancement of mapping populations

Eight mapping populations were advanced to next filial generation in kharif 2016 to get sufficient seed for screening according to their objectives. Under this projecta total eight mapping populations were developed with different objectives. Five mapping populations (GG 20 × CS 19 (340), GG 20 × CS 75 (272), GG 20 × CS 83 (216), GG 20 × CS 19 (126) & GG 20 × GG 16 (303)}developed for resistance/tolerance of stem rot and two populations (GG 20 × J 11 (138) and ICGV 00350 × J 11 (374)} developed for seed coat resistance to A. flavusand one population (JL 24 × VG 9816 (291)}developed for the study of foliar disease diseases resistance.

Yield evaluation of advanced breeding lines

Summer 2016: A total 28 Spanish advanced breeding lines with four checks (TAG 24, TG 37A, Dh86 and TPG 41) were evaluated in RBD with three replications for yield and its other traits during summer 2016. The results revealed that none of the genotype significantly surpass the best check for pods/plant, pod and kernel yield (kg/ha) and SOT (%). One genotype PBS-12207 recorded higher pods/plant, pod and kernel yield over the best checks but statistically not significant.

Kharif 2016

First year evaluation: A total eleven genotypes of Spanish bunch along with checks viz. TG37A, JL501 were evaluated in five rows of 5m length for yield and its component traits in RBD with three replications. The differences due to genotypes were highly significant for pods/plant, pod yield (kg/ha) and shelling outturn (%). The results revealed that none of the Spanish bunch genotype significantly surpass the best check for no. of pods/plant, pod and kernel yield (kg/ha), shelling outturn (%)but one genotypes PBS12209 for was found at par with best check variety JL501 (69%) for shelling outturn (73%).

Yield evaluation trials

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

Development of new advanced breeding lines

A total nine new advanced high yielding breeding lines were developed from advanced materials during kharif 2016, of which five lines belongs to Spanish bunch (PBS 12223, PBS 12224, PBS12225, PBS 12226, PBS 12227) and four lines belongs to Virginia bunch habit group (PBS22134, PBS22135, PBS 22136, PBS22137).

Multiplication and maintenance of breeding materials

Summer 2016: A total of 19 new advanced breeding lines developed during kharif 2015, of which eight lines of Spanish and 11 lines of Virginia group were mass multiplied to get sufficient seed for further evaluation and screening against different biotic stresses. Besides these, 18 advanced breeding lines of Spanish and Virginia bunch, 38 groundnut genotypes found resistance/tolerance to different biotic stresses were also mass multiplied to get sufficient seed for conducting yield trials and screening for resistance to different biotic stresses.

Kharif 2016: A total of 19 new advanced breeding lines, 68 maintenance breeding lines (Spanish bunch-36, Virginia bunch-32) and 119 groundnut genotypes found resistance/ tolerance to different biotic stresses were also mass multiplied to get sufficient seed for conducting yield trials and screening for resistance to different biotic stresses.

Multiplication and status of AICRP-G lines

During kharif 2016, seed of three elitebreeding lines (PBS 12196, PBS 12200 and PBS 12201) were mass multiplied to get sufficient seed required for AICRP-G yield evaluation trials and seed of one elite breeding line PBS 22080 was also multiplied to get sufficient seed for AVT if it promoted in AVT for kharif2017 but it was dropped in IVT-II (Virginia) in kharif2016. Elite breeding line PBS12196 was proposed for testing under AICRP-G trials in kharif 2017.

Distribution of breeding materials to different AICRP-G centres

The breeding material of 42 different crosses from four segregating generations (F_2 and F_3) was selected in kharif2016 and supplied to ten AICRP-G centres to effect location specific selections for different biotic stresses for kharif 2017.

List of segregating materials supplied to different AICRP-G centers for *kharif* 2017

SN	Name of crosses	Purpose of crosses	AICRP-G Centre
Segregating generation: F4			
1	TG 37 A × ALR 1	High yield and foliar diseases resistance	Tindivanam
2	GG 7 × GPBD 4	High yield and foliar diseases resistance	Vyara
3	GG 2 × RHRG 06083	High yield and foliar diseases resistance	Vyara
4	GG 2 × ICG 1697(NCAc 17090)	High yield and foliar diseases resistance	Vyara& Udaipur
5	JL 776 × KDG 128	High yield multiple tolerance of FDR,	
		Spodoptera, LM, jassid, and thrips	Jalgaon
6	GG 20 × CS 319	High yield with stem rot resistance	Jalgaon
7	TG 37A × CS 319	High yield with stem rot resistance	Jalgaon, Udaipur
8	GG 20 × CS 319	High yield with stem rot resistance	Bikaner
9	TG 37 A × CS 319	High yield with stem rot resistance	Udaipur
10	VRI 2 × Kadiri 9	High yield and foliar diseases resistance	Vridhachalam/ Kadiri
11	Kadiri 9 × VRI 2	High yield and foliar diseases resistance	Vridhachalam/ Kadiri
12	BAU13 × CS196	High yield and foliar diseases resistance	Gwalior
13	CS 281 × CS196	High yield and foliar diseases resistance	Gwalior
14	GPBD 4 × CS 196	High yield and foliar diseases resistance	Tindivanam
15	GJG 17 × GPBD 4 (BC1F4)	High yield and foliar diseases resistance	Jalgaon/Raichur
Segregating generation: F5			
1	TAG 24 × CS 349	Resistance to Alternaria leaf blight	Vyara
2	GG20 × JCG 88	HY, wider adap and tol. to A. flavus	Durgapura
3	CTMG 6 × BG 2	HY and tolerance to Spodoptera	Gwalior
4	GG 20 × NRCG 357	High yield and wide adaptation	Bikaner
5	TG 37A × NRCG 357	High yield and wide adaptation	Udaipur
6	CS 319 × GG 20	High yield with stem rot resistance	Kadiri
7	GG 20 × CS 319	High yield with stem rot resistance	Kadiri
8	BAU13 × CS196	High yield and foliar diseases resistance	Gwalior
9	CS 281 × CS196	High yield and foliar diseases resistance	Gwalior
10	GG 20 × GBPD 4	High yield and foliar diseases resistance	Bikaner
11	GG 20 × CS 196	High yield and foliar diseases resistance	Bikaner
12	GPBD 4 × CS 196	High yield and foliar diseases resistance	Udaipur
Segregating generation: F6			
1	GG 20 × CS 19	High yield with stem rot resistance	Bikaner/Jalgaon
2	J 11 × GG 20	Seed coat resistance to A. flavus	Durgapura
3	ICGV 00350 × JSP 39	Resistance to stem rot	Tindivanam / Vridhachalam
4	RHRG 06083 × ICGV 86031	High yield and multiple tolerance of insect pest and PBND resistant	Jalgaon/Raichur
5	BAU13 × CS196	High yield and foliar diseases resistance	Bikaner / Durgapura
6	CS 281 × CS196	High yield and foliar diseases resistance	Bikaner
7	GG 20 × GBPD4	High yield and foliar diseases resistance	Udaipur
8	GG 20 × CS 196	High yield and foliar diseases resistance	Udaipur
9	GPBD 4 × CS 196	High yield and foliar diseases resistance	Raichur
10	TG 37 A × CS 85	High yield with stem rot resistance	Jalgaon
11	GJG 17 × GPBD 4	High yield and foliar diseases resistance	Tindivanam
Segregating generation: F7			
1	GG 20 × J 11	Seed coat resistance to A. flavus	Durgapura
2	ICGV 00350 × J 11	Seed coat resistance to A. flavus	Durgapura
3	TG 37A × Kadiri 3	High yield and resistant to PBND	Raichur
4	Dh86 × Girnar1	High yield & tolerance to sucking pest	Raichur

Screening of genotypes for resistance/tolerance of collar rot

A total 43 advanced breeding lines along with two tolerant genotypes OG 52-1 and J11 were screened in replicated trial for resistance/tolerance to collar rot at CSWRI ARC, Bikaner during kharif 2015 and 2016. Data were recorded on plant mortality up to 45 DAS. The collar rot incidence 44.5 and 22.9% in 2015 and 2016 respectively. Results revealed that five genotypes PBS 12191, PBS 12192, PBS 22092, PBS22097 and PBS22100 recorded average less than 10% disease incidence in all the replications while tolerant genotype OG52-1 (9.0 & 6.7%) and J11(8.7 & 5.5%) also having disease incidence less than 10% in both the year. Therefore, these genotypes have been found tolerant to collar rot in field condition.

Screening of advanced breeding lines for foliar disease resistance

Summer 2016: A total 34 Spanish dvanced breeding lines were screened in summer-2016 for resistant to Alternaria leaf blight with resistant check viz., NRCSCS 349, NRCSCS74 and NRCSCS186 (4.7, 4.0 and 4.0 respectively disease score on 1-9 scale).The experiment was conducted under field condition with infector row in RBD with three replications. Maximum disease pressure was observed in genotype PBS12209, PBS12211 and PBS12211 (score 7.0 on 1-9 scale). PBS22040 found resistant to Alternaria leaf blight having a disease score <3 on 1-9 scale. An advanced breeding line PBS12213, PBS12199, PBS12195 recorded equal disease score as resistant genotype. In another experiment of comprising 82 Virginia advanced breeding lines screened in summer-2016 for resistant to Alternaria leaf spot with same resistant check viz., NRCSCS349, NRCSCS74 and NRCSCS186. Maximum disease pressure was observed in genotype PBS-22092 (score 8 on 1-9 scale). An 18 advanced breeding lines PBS22049, PBS22050, PBS22057, PBS22058, PBS23003, PBS23019, PBS23031, PBS22080, PBS22088, PBS22091, PBS22093, PBS22102, PBS22089, PBS22103, PBS22117, PBS22118, PBS22120, PBS22121 recorded less than 6 disease score and found to be tolerant genotype. These genotypes can be tested one or more year for confirm their resistance across the season.

Kharif 2016: A total 75 genotypes along with resistant check viz., GPBD 4 (high yielding leaf spot and rust resistant variety) were screened in replicated trial using infector row technique for resistance of foliar diseases (early, late leaf spot and rust) during kharif, 2016. The maximum disease pressure for early leaf spot (ELS), late leaf spot (LLS) and rust was 7.7, 6.3 and 2.0 respectively on modified 1-9 point scale.In general, in kharif season, the disease incidence of ELS was higher than LLS and rust incidence was almost absent in all the genotypes.
For early leaf spot, none of the genotypes showed resistance score ≤3 on 1-9 scale. Disease incidence of LLS and rust incidence was not high enough for distinguishing genotypes based disease score. To confirm disease resistance of genotypes, it needs to be screen under high disease pressure for at least three year.

Screening of advanced breeding lines for resistance/tolerance of sucking pests

Eighty-two Virginia bunch and 28 Spanish bunch genotypes were screened for resistance to sucking-pests such as, leafhoppers and thrips at 30 DAS during summer-2016. None of the genotypes were significantly differing with respect to both the mean leafhopper and thrips populations at 30 days after sowing (DAS). Due to low insect pressure during crop season conclusive results could not be drawn.

Screening of advanced breeding lines for resistance/tolerance of iron chlorosis

A total 115 genotypes including advanced breeding lines, interspecific derivatives and cultivars were screened for tolerance of iron chlorosis for summer-2016. The experiment was conducted under natural field condition in RBD with three replications. The genotypes showing interveinal chlorosis in their top five leaves are rated for visual chlorotic rating (VCR) score on 1-5 scale at various growth stages.The average highest 5 score of iron chlorosis was observed in many genotype and well known iron tolerant our own source PBS 22040 recorded 3.0 and ICGV 86031 recorded score 4.0 score on 1-5 scale. Among the screened genotypes, three genotypes viz., PBS 222050, PBS 12169, PBS 12190, PBS 12204, PBS 12198 recorded an average score ≤ 3.0 on 1-5 scale. Hence, these genotypes have been identified as tolerant to iron chlorosis and could be used as a new source of iron tolerant genotype.

Iron chlorosis tolerant genotypes

Screening of advanced breeding lines for fresh seed dormancy

A total 31 genotypes along with cultivars TG37A, Dh86 and TPG41 and fresh seed dormant genotype PBS12171 were screened for fresh seed dormancy in summer-2016. The experiment was conducted in RBD with three replications in single row of each genotype in 2m row length. The dormancy was measured in intensity (per cent of seed not germinated 10 days after harvest) and duration (number of days taken to attend 50% of germinated seeds). The intensity of dormancy ranged from 0 to 88%. The results revealed that following genotypes have more than 30 days fresh seed dormancy duration PBS 12171, PBS12187, PBS12189, PBS12190, PBS 12191 and PBS 12192. Advanced breeding lines PBS 12169, PBS 12200, PBS 12200B, PBS 12201 and PBS 12206 have 21 days fresh seed dormancy. The genotypes PBS 12171, PBS 12187, PBS 12189, PBS12190, PBS12191 and PBS 12192 have also recorded more than 30 days fresh seed dormancy duration in summer 2014 and 2015. Hence, these genotypes have been identified as new sources of fresh seed dormancy in Spanish bunch genetic stock.

Genetic variation for fresh seed dormancy in Spanish bunch genotypes

Enhancement and management of groundnut genetic resources

Conservation of working collection

Nine thousand one hundred and twenty-nine (9129) groundnut accessions have been maintained in the medium term cold storage (4±1°C; 30% RH) module. The accessions comprises of 1180 Virginia Runner; 1206 Virginia Bunch; 3198 Spanish Bunch; 1260 Valencia and 2285 intermediates/other types

Field maintenance of Wild Arachis germplasm

A total of 109 accessions in six sections viz.Arachis(44), Caulorhizae(1), Erectoides (7), Heteranthae (5), Procumbentes (8) and Rhizomatosae (38) were maintained in the field gene bank. Seeds from annual species of section Arachis were harvested and conserved. The plants of six amphidiploid derivatives (Synthetic Groundnut) obtained from ICRISAT have been established the field for further use in crop improvement programme.

Distribution of germplasm accessions

In summer, 314 germplasm accessions including wild relatives of groundnut were supplied to 21 indenters for use in the crop improvement programme. These germplasm were supplied to the scientists of DGR (208), State Agricultural Universities (76) and AICRP-G (30) to identify promising lines for WUE, diseases and nematode tolerance, large seeded types and to use in crossing programmes. In kharif, a total of 315 germplasm accessions including wild relatives of groundnut were supplied to 10 indenters for use in the crop improvement programme. These germplasm were supplied to the scientists of DGR (15) and State Agricultural Universities (298) to identify promising lines for WUE, diseases and nematode tolerance, large seeded types and to use in hybridisation programmes.

Multiplication of elite germplasm accessions

For seed enhancement, distribution and conservation, 645 accessions; WUE (177); South American collections (60; ARG; FST); general (42); high oil, high protein, low oil (10 accessions); DUS reference varieties (8); stem rot tolerant lines (348) have been multiplied in summer 2016.

One thousand four hundred and seventy-one accessions (1471) have been rejuvenated and multiplied during kharif 2016. This comprised 189 composite collection of water use efficiency of ICAR-DGR; 177 water use efficient lines developed under ACIAR- ICRISAT-ICAR received from ICRISAT; 200 released varieties; 140 accessions belonging to South American collections; 720 accessions for rejuvenation and 45 accessions with unique morphological features.

Morphological characterization

Characterisation of accessions supplied under Consortium Research Platform on Agro-Biodiversity project of ICAR

492 diverse accessions received under CRP-AB project were sown for multiplication and characterisation for 15 qualitative and 12 quantitative traits with two checks GG 2 and GG 20. Of these 5 accessions did not germinate and in 19 accessions there was no pod set. The results of 468 accessions including checks are briefly summarised below.

Pod yield per plant ranged from 1.0 g to 17.0 g and five accessions recorded the high yield namely ECs' 0557443 (17.0 g), 0557321 (8.8 g), 0557765 (7.0 g), 509768(6.5g) and 0557324 (6.0g). For Hundred Seed Mass two accessions exhibited more than 50.0 g [(EC 509781, 51.9g); (EC509999, 50.0g)] while in 15 accessions it was >40 g. In 4 accessions it was <20.0 g; 200 accessions had 100-seed mass between 20-30g and 241 accessions were between 30-40g per 100-seeds.

For shelling outturn, three accessions recorded <40-50%; 37 accessions with 50-60% shelling; 256 accessions had between 60-70% shelling and 208 accessions recorded a shelling of 70-80%. The mean value for this trait was 68.6%.

Maturity duration varied between 101-115 days. The earliest being EC 509733 and the late being EC 509787.

Based on Principal Component Analysis revealed that the variation in the data could be assigned to six PCs'. The first two PCs could explain only 54.9% of the total variation in the population for the traits studied and the cumulative variation accounted by all the six PCs were 67% only indicating substantial role of environment on the traits studied. Eigen value was more than unity in five out of six vectors.

In PC1 the traits contributed for the variation based on the PC score were mostly the vegetative traits viz. dry fodder yield (0.88), haulm yield (0.86), number of secondary branches (0.65) and length of main axis (0.44). Among important yield related traits, variation due to pod yield was insignificant (0.09), whereas contribution of seed (0.55) and pod length (0.43) for the total variation was substantial.

In kharif 2016, a total of 1002 germplasm accessions received from NBPGR, New Delhi, have been characterized at this directorate for 28 specified traits. Out of these, 45 accessions did not germinate and in 39 accessions there was no pod formation. For pod yield, seven accessions, IC 0496438 (32.5 g), IC 0497639 (30.5 g), IC 0497734 (40.0 g), IC 0444572 (22.2 g), IC 0508915 (21.8 g), EC 557994 (21.3 g) and IC 0496544 (210.3g) were found high yielding. Four accessions were found having bold seeds (≥ 40g/10kernel) viz. IC 0496412 (48.0 g), IC 0497825 (44.0 g), EC 0557368 (44.0 g) and IC 0495730 (44.0 g). Shelling outturn was high (≥ 74%) in seven accessions {IC 0495721 (76.4%), IC 0495738 (76.3%), IC 0495803 (75.5%), IC 0495806 (75.3%), IC 0495875 (75.0%), IC 0444387(75.0%) and IC 0495647 (74.4%)}.

Maturity duration in early types, EC 0558105 (106 d), IC 0495611, (106 d), IC 0495699 (106 d), EC 0558106 (107 d), EC 0558125 (107 d), IC 0495820 (107 d) and IC 0495825(107 d) was around 107 days. Three seeded pods were very high in seven accessions namely IC 0495721 (76.4%), IC 0495738 (76.3%), IC 0495803 (75.5%), IC 0495806 (75.3%), IC 0495875 (75.0%), IC 0444387(75.0%) and IC 0495647 (74.4%).

Characterization of interspecific derivatives

Seventeeninterspecific derivativesmostly of A.cardenasii, A.duranensisandA. stenosperma. Data on 17 qualitative 28 quantitative descriptor traits were recorded at appropriate growth stages of the crop. Days to initiation of flowering ranged from 17-24d; days to 50% flowering was between 20-27d; number of mature pods were between 6-16 per plant; pod yield in these derivatives ranged from 4.9 g (VG 0438) to 12.0 g (VG 0411) per plant. Hundred Seed Mass ranged from 27.8g (VG 1002) to 39.9g (VG 0420). The shelling outturn was in the range of 61.8% (VG 09405) to 70.7% (VG 09406).

Characterization of six candidate varieties as per DUS test guidelines under PPV & FRA

Six candidate varieties have been received from PPV & FRA, New Delhi for DUS characterisation during kharif 2016 viz. Western Vardan, Desi Mungfali 2, Hara Mungfali, Desi Mungfali Lal, Desi Lal and Desi Chiniya. These candidate varieties have been sown along with eight reference varieties as per DUS test guidelines. The reference varieties utilized for DUS testing were: Spanish Bunch: GG 2 and SG 84 Valencia: Kopergaon 3 and Gangapuri; Virginia Bunch: GG 20 and BAU 13; and Virginia Runner: Punjab 1 and Somnath. Observations on 13 qualitative and 5 quantitative descriptor traits have been recorded.

Screening for low temperature and high tolerance under field conditions

The low temperatures (<18°C) at sowing of groundnut crop in summer/spring in northern India results in slow seedling emergence and poor plant stand. Delay in seedling emergence extends crop duration beyond 120 days, exposing the crop to high temperatures at reproductive phase and pod damage due to early onset of monsoon rains. Identification and incorporation of cold tolerance is therefore an important groundnut breeding objective.

Hence, to assess the low temperature tolerance at germination195 released varieties and 184 mini-core accessions were screened under lab conditions during summer 2014. Of these 36 released varieties and 25 mini-core accessions which were identified as low temperature tolerant based on good (>90%) germination under lab conditions were planted in the field under three different sowing dates viz. early (19 Jan 2016); normal (3 Feb 2016) and late (16 March 2016) to evaluate effect of low and high temperature on germination and reproductive traits besides yield in comparison with normal (3 Feb 2016) sown conditions. Early sown crop was harvested on 25 May 2016 and normal sown was harvested on 26 May 2016. Late sown crop harvested was on 23 June 2016. This experiment has been repeated for the second year.

In 2016, the temperature was in the range of 10° to 30°C during the week followed by sowing. Subsequently, in February (15°C-31°C); March (20°C-37°C); April (22°C-38°C) and May (26°C-40°C) the effect of low temperature could not be ascertained on germination and reproductive traits. However, the temperature exceeded 40°C for only 14 days.

Among the 25 germplasm accessions evaluated, maturity duration in different dates of sowing ranged from 100-111d in early sown crop; 102-112 d in normal sown crop; and genotypes were harvested uniformly at 100 DAS (June 23rd) in late sown crop. Pod yield per plant under early sown condition was 11.5 g (NRCG 14341); normal sown condition the pod yield recorded was 2.8 g (NRCG 14403); late sown condition 2.1 g (NRCG 14328). Pod yield advantage/gain when sown early and late separately in these germplasm was also assessed in comparison with normal sown crop. In early sown crop, out of 25 accessions, 14 accessions recorded high yields than when sown under normal sowing date. Of these 9 accessions had 30% more yield over normal date of sowing. The top six entries under this situation were NRCGs 14339, 14374, 14413, 14453, 14341 and 14492. Under late sown condition the yield reduction were very high which ranged from 21%-325%. Only two accessions, NRCGs 14492 (27.8%) and 14454 (8.3%) recorded higher yields over normal sown crop. One accession NRCG 14492 was identified promising under both under early and late sown conditions based on pod yield, emergence, days to maturity. Among the 36 released varieties evaluated, maturity duration in different dates of sowing ranged from 100-110d in early sown crop; 102-110d in normal sown crop; and genotypes were harvested sown crop. Among the 36 released varieties evaluated, in early sown crop, 14 varieties exhibited higher yields than when sown under normal sowing date. Pod yield advantage/gain when sown early and late separately in these varieties was also assessed in comparison with normal sown crop. Of these five varieties (GPBD 4, Kopergaon3, ALR2, TAG 24, and TG 17 had recorded 1.5 times higher yields over those of normal sown crop. Seven other varieties, JL 220, Dh 86, Kisan, OG 52-1, Tirupati4, GJG 9, and GG 8 exhibited 30% more yields over those of the normally planted crop. Under late sown conditions the yield reduction in these accessions ranged from 17%-350% over the normally planted crop. Yield advantage observed in eight varieties under late sown conditions over normal sown crop were MH 2 (64%), TAG 24 (50.0%), GG 8 (50.0%), Dh 86 (33.8%), TG 26 (18.1%), Kop 3 (17.3%), OG 52-1 (16.1%), and JGN 3 (4.0%).

Analysis of quality (oil, protein) of 317 working collection accessions

317 accessions of working collection have been evaluated for oil, and protein in kharif 2016. The oil content in 317 general accessions ranged from 43.3%-54.7%; protein content ranged from 23.7%-37.1%. Out of 317 accessions, 105 accessions had oil content more than 50%; and 23 accessions had oil content more than 52%. Of these 7 accessions (NRCGs' 11923, 12124, 11906, 8974, 5195, 11888, 12163) recorded oil content more than the benchmark variety TMV 10 which was so far the highest oil containing genotype i.e. 52.8%. Six accessions (11981, 11960, 11979, 414, 11875, 12128) recorded more than 35% protein content.

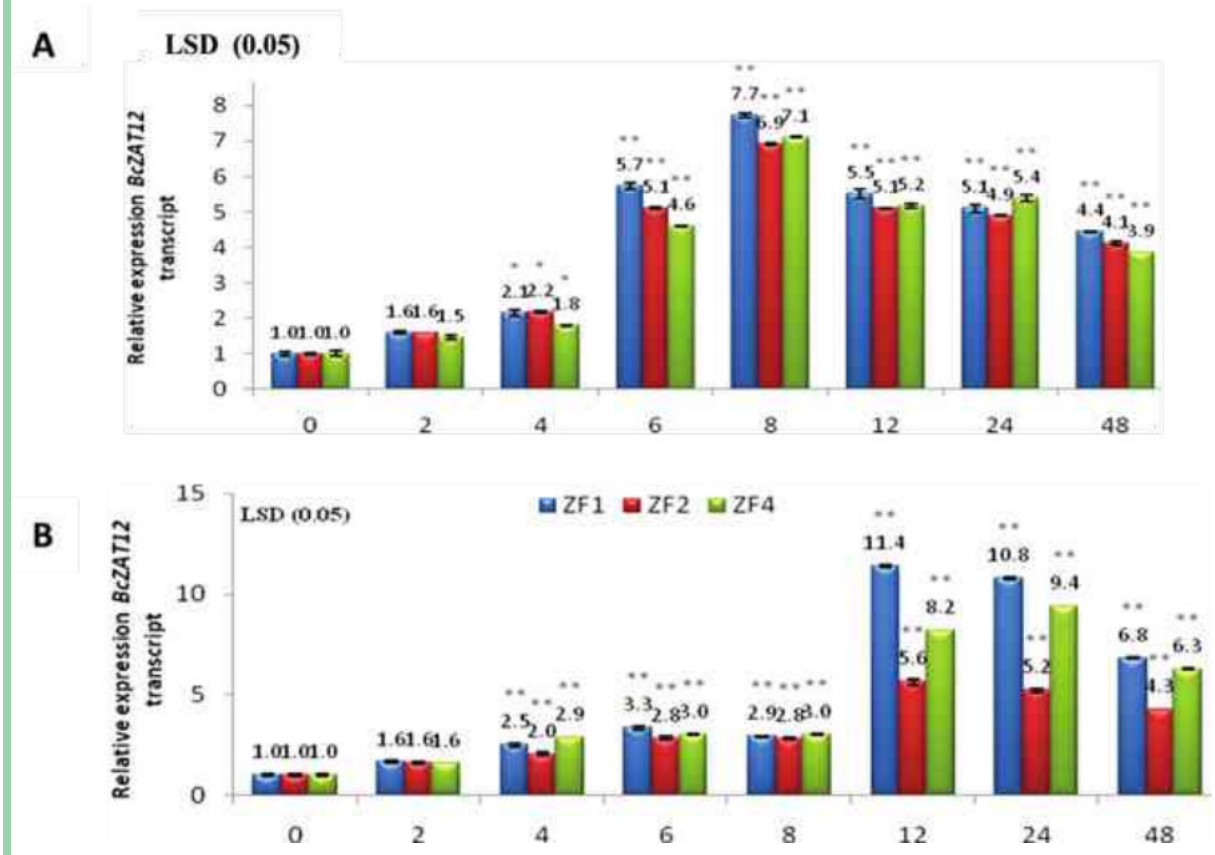
Screening for resistance to stem rot under sick plot conditions

In summer 2016, a total of 319 genotypes GG 20 mutants; AICRP-G genotypes; advanced breeding linesandinterspecificderivatives were screened for resistance to stem rot under sick plot conditions. Altogether 29 genotypes were found promising with <20% stem rot incidence. In kharif 2016, a total of 288 genotypes viz. GG 20 mutants; AICRP-G genotypes; advanced breeding linesandinterspecificderivatives were screened for resistance to stem rot under sick plot conditions. The disease incidence ranged from 0 to 100%. One genotype was found to be free of the disease (ISK 2016-1) and two (ICGV 05057; ICG 3053) recorded less than 10% disease incidence.

Biotechnological approaches to the characterization and genetic enhancement of groundnut

Real-Time PCR (qPCR) analysis of transgene expression in ZAT12 transgenic plants exposed to drought and salinity stresses

Quantitative real-time PCR using BcZAT12 gene-specific primers was carried out to confirm expression of the heterologous BcZAT12 gene (driven by Lea promoter) in the leaves of three transgenic events (ZF1, ZF2 and ZF4), and differential expression of the transgene was observed at various time points during both drought and salinity stresses. In this study, 2 $\Delta\Delta$CT method was used for quantitative estimation of transgene expression (Livak and Schmittgen, 2001). Within two h of drought (20% PEG) and salinity (200 mMNaCl) stress imposition, BcZAT12 gene expression increased more than 1.6-fold.



Quantitative (Real-Time) PCR analysis of expression patterns of BcZAT12transgene in the leaf tissue of three transgenic events at different time points (hr) and in response to PEG induced drought stress (A) and NaCl induced salinity stress (B). Data represent mean of three replicates. Bars denote fold expression as compared to the expression level at 0th h ± SD. * and ** indicate a significant difference from that of WT at P<0.05 and <0.01, respectively, by Student's t test.

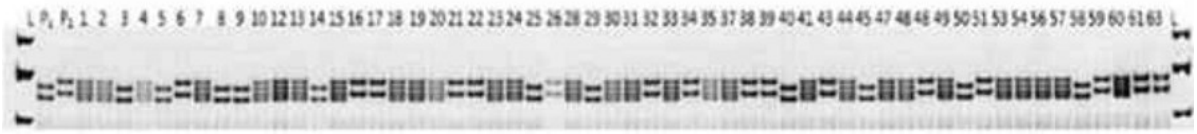
However, under drought stress, consistent increases in transgene expression were recorded from the 4th h, and the maximum was recorded at the 12th h (>5 fold in ZF2 to 11.4-fold in ZF1) compared to the start of the stress imposition. Under salinity stress, transgene expression reached a maximum at the 8th h (6.9 in ZF1 to 7.7 fold in ZF1), and a gradual declining trend was recorded subsequently until the 48th h.
RT-PCR analysis demonstrated earlier showed elevated level of BcZAT12 gene expression in the representative plants from the transgenic lines (from each of the twelve T3 transgenic events) at 7% soil moisture deficit stress. Furthermore, Real Time PCR shows a tightly regulated expression of concerned transgene in all transgenics due to the stress.
Functional analysis of BcZAT12 transgenic events under progressive soil moisture deficit stress under glasshouse conditions
To evaluate drought stress tolerance of BcZAT12 T lines, dry down experiment was carried out in lysimeter at reproductive stage (flowering and pegging stage). During drought stress experiment key physio-biochemical parameters like ROS scavenging enzyme activity, RWC, stress metabolites like proline, H2O2 and malondialdehyde content were measured at flowering (45DAS), pegging stage (60DAS) and pod formation (70DAS) stage after stress imposition.
In drought stress treatment (DS) both T lines and WT showed severe wilting and dehydration patches at pod formation stage (70DAS) which corresponds to 30 days of progressive soil moisture deficit stress (drought) stress, hence these plants were re-watered (200 ml water) at an interval of 24 hours for recovery of plant up to 3 days. The severity of wilting was more pronounced in WT as compared to transgenic plants. At recovery T lines recovered easily while, 50% WT plants failed to recover.

Phenotypes of
WT (GG 20) and eight independent T lines (ZF1-7, ZF10) under well-watered and drought stressed condition at pod formation stage days after 30 days of stress imposition.

Characterization of these transgenic lines were undertaken to assess their tolerance and performance under glasshouse conditions. Key biochemical parameters like activity of antioxidants enzymes, content of stress metabolites and growth related parameters were evaluated. The transgenics lines showed lower accumulation of MDA and H2O2 compared to the WT plants. The specific activity of CAT, POD, APX, GR and AsA content were significantly higher in T lines compared to WT plants under drought stress conditions at all reproductive growth stages. Thus the transgenic lines reduced oxidative damage as well as maintaining the ROS status, suggests better membrane integrity of groundnut plants and a stronger water status arising by the contribution of BcZAT12 gene in the transgenic groundnut. Photosynthetic parameter measured in terms of chlorophyll colour index and relative water content; growth parameters like root length, root fresh and dry weight, shoot fresh and dry weight, and pod weight also improved in T lines suggesting better photosynthetic rate. Significant correlations were obtained between transgene expression and improved physio-biochemical traits of transgenics under progressive soil moisture deficit stress- inducible function of Lea promoter.

F2 phenotyping and genotyping (using SSR markers) for the foliar-fungal diseases

The F2 mapping population comprising of 1700 individuals was developed for LLS and rust resistance by crossing GJG17 (Susceptible) and GPBD 4 (Resistant). About 1000 confirmed F2 for the cross GJG17 x GPBD4, were sown under natural conditions and phenotyping data was recorded for rust and LLS diseases usingmodified 9-point scale. First 328 F2 lines were used for genotyping with SSR markers. Genotyping was done with the set of 55 polymorphic SSR markers, of which 9 are reported linked markers to LLS and rust and remaining 46 are novel EST based SSR markers developed in this lab.



Genotyping of first 63 F2 lines with DGR-48 marker (L- Ladder, P1-GJG 17 and P2-GPBD4)

To develop RIL mapping population, generation advancement has been carried out using single seed descent (SSD) method. In rabi 2016 a total of (1319) F5 lines was sown and around 1100 F6 seeds were obtained which will be sown in summer 2017 to obtained F7 lines (Table 1). In addition to genotyping, Bulk Segregant Analysis (BSA) was performed with available 55 polymorphic SSR markers to obtain putatively associated markers to LLS and rust resistance. Five markers, one (IPAHM 103) reported linked and four novel EST-SSRs (DGR 308, DGR 508, DGR 800 and DGR 2409) were found to be associated with LLS and rust resistance.

Current status of mapping population

Cross	No of confirmed F1's (using markers)	No of F2's	Polymorphic	Remarks markers	Current generation
GJG17 x GPBD4	90	1500	55	Resistance to foliar-fungal diseases	F_6 (seed)
GJG22 x ICGV 86590	97	850	10	Resistance to foliar-fungal diseases	F_5 (seed)

Utilization of wild Arachis gene pools for improvement of groundnut

Evaluation of RILs for tolerance to drought

Genotype having higher yield under irrigated conditions and less reduction of yield under imposed water-deficit stress conditions are suitable for both drought and irrigated conditions. Based on the results of experiment conducted during summer 2015, selected 14 RILs developed from a cross between ICG4747 and TMV 2 NLM were evaluated under both drought and irrigated conditions during summer 2016. Experiment was sown in RBD with three replications. Each genotype was sown in one line of five-meter length. Although all 14 RILs were found with less yield reduction under drought over check but five RILs (5-2,5-13, 5-16, 3-4 and 5-8) recorded significantly less yield reduction over check and pod yield per plant of these RILs were at per with check. While RIL1-5 recorded significantly higher pod yield over check and yield reduction was at per with check. Drought tolerance of these 14 RILs will be further confirmed at Regional Research Station, Anantapur.

Evaluation of RILs for tolerance to drought

Screening of segregating progenies for resistance to stem rot

Breeding lines (F5), 232 in numbers developed from a cross between GG 20 x CS 19 were screened under artificially inoculated field conditions and observation on mortality were recorded on 15 days after inoculation and expressed in percentage. Two lines (18-6 and 22-6) and seven lines (17-12, 15-5, 15-17, 15-1, 18-5, 15-3, 15-13, 15-2) were found resistant (with less than 20% mortality) and moderately resistant (with less than 30% mortality), respectively. Resistance for stem rot disease of these lines were further confirmed in kharif 2016 and were found consistent.

Screening of segregating progenies for resistance to stem rot

Screening of interspecific breeding lines for resistance to stem rot

Selected 40 Interspecific pre-breeding lines developed from a cross between J11 and Arachispusilla were screened for resistance to stem rot under artificially inoculated conditions in net-house. Mortality percent ranged from 71 to 100 in these 40 pre-breeding lines and found highly susceptible to sclerotial stem rot.

Screening of groundnut genotypes for resistance to stem rot in screening block

Hybridization

A total of six cross were attempted, using J11 as female and six different wild species as male parent during kharif 2015 and probable cross pods were sown in field during kharif 2016. Four hybrids from cross J11 x A. stenosperma (NRCG14863), two hybrids from J11 x A. valida (NRCG14871) and one hybrid from the cross J11 x A. sylvestris (NRCG 14868) were identified. No hybrids were identified in rest three crosses J11 x A. matiensis (NRCG11855), J11 xA. kretschmeri (NRCG14853) and J11 xA. diogoi (NRCG11781)

Three fresh crosses were attempted under field conditions during kharif 2016. Interspecific hybrids (J11 x A. diogoi, J11 x A. pussila and J11 x A. duranensis) were used as female and TG37A as male parents to improve resistance to stem rot in TG37A. Probable cross pods from three crosses were harvested for further use.

Initial yield evaluation trial

Advanced breeding lines, sixty in numbers bred from a cross between GG20 x CS19 for improving resistance to stem rot in GG20 were evaluated during kharif 2016. These lines were sown in one line of four meter bed in augmented design with four blocks following recommended crop management practices. The check TG37A recorded highest pod yield/line among the four checks used, while 13 genotypes recorded significantly higher pod yield/line than TG37A. Of which two lines recorded significantly higher pod yield/line over two seasons (kharif 2015 and kharif 2016). These two lines will be further tested under advance yield trails.

Selection of Interspecific derivatives for earliness

A total of 584 interspecific derivatives were sown in one line on four-meter bed following recommended crop management practices during kharif 2016. Observation on days to 50% flowering, biological yield (BY), harvest index (HI) and percent maturity were recorded. BY, HI and percent maturity were recorded at 90 days after germination from each line. Seventy genotypes (45 Spanish bunch and 25 Virginia bunch) flowered early (22 days after germination) than Chico. Days to fifty percent flowering ranged from 16 to 20 days after germination in these 70 lines. NRCGCS lines 40, 254, 292, 330, 404, 445, and 446 (belongs to Spanish bunch) were found short duration with early days to 50% flowering, high BY, HI and percent maturity than Chico.

Advancement of Recombinant Inbred Lines

Two hundred and sixty-eight RILs of a cross between GG20 x CS19, developed for mapping QTLs for resistance to stem rot were advanced from F5 to F6 generation during kharif 2016. Six RILs recorded less than 30% mortality in both F5 and F6 generations under artificially inoculated conditions. 13 RILs recorded higher pod yield than GG20. One RIL recorded higher pod yield along with less than 20% mortality over two generations (F5 and F6 generation).

Hundred and ninety-three RILs of a cross between GG20 x NRCGCS319, developed for mapping QTLs for resistance to stem rot were advanced from F4 to F5 generation during kharif 2016. Thirteen RILs recorded higher pod yield than GG20. Phenotyping for resistance to stem rot is in progress during summer 2017.

Hundred and eighteen RILs of a cross between JL24 x NRCGCS85, developed for mapping QTL for resistance to PBND were

advanced from F4 to F5 generation during kharif 2016. Fourteen RILs recorded higher pod yield than JL24. Phenotyping for resistance to PBND is in progress during rabi 2017.

Two hundred sixty-five RILs of a cross between JL24 x NRCGCS86, developed for mapping QTL for resistance to PBND were advanced from F4 to F5 generation during kharif 2016. Phenotyping of resistance to PBND is in progress during rabi 2017.

Groundnut genotypes with high oleic acid content

Breeding lines, 202 in number were developed from two crosses (ICGV6100 xSunoleic95R and ICGV5141 xSunoleic95R) through MAS and MABC approaches. Based on fatty acid analysis selected 18 high oleate breeding lines were evaluated in RBD with three replications during kharif 2016. Each line was sown in one line of four meter bed following recommended crop management practices. Fatty acid analysis over two seasons (kharif 2015 and kharif 2016) confirmed that 11 lines contain ~80% oleic acid. Oil content of these high oleate lines ranged from 52-56% while pod yield were at per check. Besides 7 lines with high (~60%) oil content, 6 lines with high (~28%) protein content, 3 lines with less (45%) oil content and 25 lines with higher pod yield were identified. Besides 71 BC1F7, 97 BC2F6 and 129 BC3F5 lines of a cross ICGV6100 xSunoleic95R were developed and phenotyping for oil content as well as oleic acid content is in progress.

Mapping/validation of QTLs responsible for oil content

Mapping populations between two crosses ICGV 06188 xICGV 07229 and ICGV 098432 x ICGV 07166 were developed for mapping/validation of QTL for oil content. Phenotyping of 293 F8 lines of cross ICGV 06188xICGV 07229 and 739 F8 lines of cross ICGV 098432 x ICGV 07166 has been completed. Genotyping of these population is in progress.

Seed multiplication of advanced breeding lines for AICRP-G testing

Seeds of six advanced breeding lines were multiplied for AICRP-G testing. These six lines will be freshly proposed for testing during kharif 2017.

Elite germplasm registered

A fresh elite Spanish bunch germplasm (NRCGCS281) with hundred kernel weight of 80 g has been registered at NBPGR. NRCGCS281 matures in 115 days and contains 50% oil.

Sharing of Pre-breeding lines

Pre-breeding lines have been supplied to following center of NARS/ CGIAR centers during kharif 2016

- ICRISAT
- JAU, Junagadh, RAS, Raichur, BCKV, Mohonpur, MPAUT, Udaipur, BAU, Kanke, BSKKV, Shirgaon, TNAU, Aliyarnagar
- Various sections of ICAR-DGR

2 Groundnut pests and diseases-emerging problems and their management

Development of management module for soil borne diseases of groundnut

Screening of cultivated varieties for resistance to stem rot

The experiment was conducted during summer 2016 and kharif 2016. Altogether, 53 cultivated varieties were screened for resistance to stem rot disease during summer-2016, the minimum (5.1%) stem rot was recorded with variety Tirupati 3 followed by Tirupati 2 (7.0%) being at par with R 8808 (7.3%). However, the maximum (29.1%) disease was recorded with JL 42. However, the maximum (1037 kg/ha) pod yield was recordedwith ICGV 86590 followed by ICGS76 (905.6 kg/ha). However, the minimum pod yield of 248.1 kg/ha was recorded with ICGS (FDRS)-4 followed by Tirupati3 (314.8 kg/ha). During kharif-2016, 24 cultivated varieties were screened for resistance to stem rot disease, 24 cultivated varieties were screened for resistance to stem rot disease, where minimum (10%) stem rot was recorded with variety Kadiri 3 followed by LGN 2 (12%) being at par with JSP 19 (12%). However, the maximum (30%) disease was recorded with ICGV86031. Whereas, the maximum (983 kg/ha) pod yield was recorded with JSP19followed by Kadiri 3 (933 kg/ha). The collar rot was recorded in very negligible amount maximum being 5% in ICGV 86235.

Screening of cultivated varieties for resistance to stem rot

Evaluation of bio-control agent for growth promotion of groundnut and management stem rot

The field bio efficacy of seven *Trichoderma spp.* isolates, namely *Trichoderma harzianum* S1, *T. koningiopsis*, *T. bravicompactum*, *T. longibrachiiatum*, *T. virens*, *T. harzianum*-T-170 isolate and *T. harzianum* Dharwad isolate was tested for management of *Sclerotium rolfsii* during summer 2016, and all seven *Trichoderma* and one PGPR during kharif2016.

- During summer 2016, the maximum (62.7%) inhibition of stem rot was achieved by *T.viride* Dharwad followed by *T. longibrachiatum*(47.8%) against control. However, *T. virens* could inhibit only 33.7% over control. Whereas, maximum (1347 kg/ha) pod yield was supported by *T. koningiopsis* followed by *T.virens*(1297 kg/ha), which 27% and 23% increase over control, respectively. The maximum (3389 kg/ha) fodder yield was supported by T. harzianumS1 followed by *T.koningiopsis*(3361 kg/ha), which 24% and 23% increase over control, respectively.
- During kharif-2016, maximum (47%) inhibition of stem rot was achieved by *T. virens* being at par with *T. harzianum* T170 (47%) followed by *T. koningiopsis* (38%) against control. However, *T. brevicompactum* could inhibit only 34% over control. However, maximum (1978 kg/ha) pod yield was supported by *T. harzianum*-T-170, which was followed by *T.konigiopsis* (1971 kg/ha). Further, the maximum (7167 kg/ha) fodder yield was supported by *Trichoderma* Dharwad isolate followed by *T.virens*(7028 kg/ha).

Close view of sick plot

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

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

- During summer 2016,the maximum inhibition (46%) of stem rot was recorded in treatment of DGROF3 i.e. spraying at 30, 45 and 60 DAS (Days after sowing) followed by DGROF1 (42%) i.e. spraying at 30 and 60 DAS + soil application at 45 and 75 DAS, over farmers' practice. The DGROF3 supported maximum pod yield of 1375 kg/ha also followed by DGROF2 (1308 kg/ha). However, maximum fodder yield of 3396 kg/ha was supported by DGROF1 followed by DGROF2 (3063 kg/ha).
- During kharif 2016, the maximum inhibition (43%) of stem rot was recorded in treatment of DGROF1 i.e. spraying at 30 and 60 DAS + soil application at 45 and 75 DAS, over farmers' practice being significantly at par with DGROF2, DGROF3 followed by DGROF4 i.e. spraying at 30, 45 and 60 DAS (Days after sowing. Whereas, DGROF4 supported maximum pod yield of 1439 kg/ha followed by DGROF2 (1354 kg/ha) being significantly at par with DGROF1 and DGROF3. However, maximum fodder yield of 3396 kg/ha was supported by DGROF1 (7740 kg/ha) followed by DGROF4 (7734 kg/ha).

Effect of ridge, raised and flat bed for management of soil borne diseases

The experiment was conducted during summer and kharif 2016 with four treatments namely on ridge bed (single row), raised bed (two rows side by side), raised bed (with three rows), flatbed (with four rows) against farmers' practice as control (without seed treatment) on flatbed (with four rows).

- The minimum (8.3%) stem rot was recorded in treatment with raised bed (with three rows) as compared to farmers' practice, the control. It was noted that maximum (16.1%) stem rot was recorded in the treatment of farmers' practice with flatbed system followed by 13.4% in the treatment on ridge bed with single row. The maximum stem rot on ridge bed (with single row) could be attributed to the availability of more moisture content for the longer period during summer-2016.
- During kharif2016, the minimum (7%) stem rot was recorded in treatment with raised bed (with three rows) as compared to farmers' practice, the control. It was noted that maximum (15%) stem rot was recorded in the treatment which was on ridge bed (with single row). The maximum stem rot on ridge bed (with single row) could be attributed to the availability of more moisture content for the longer period. The appearance of collar rot was not different in treatments which ranged from 4-5% from one to another treatment.

Testing of different modules for stem rot and collar rot disease

Altogether, 9 modules were identified and tested for soil borne diseases with farmers' practice and absolute control during summer 2016 and kharif2016. During summer 2016, there was only one set of experiment for stem rot, whereas during kharif 2016, there were two sets of experiment, one for stem rot and another for collar rot.

Effect of modules on stem rot and yield during summer 2016

Stem rot: The maximum (45%) inhibition of stem rot was achieved by Module-M10i.e. Deep summer ploughing with mould board plough+ seed of variety TG 37A + seed treatment with *Trichoderma* @ 10 g/kg of seed + soil application of Trichoderma @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS,followed by Module M-16 (42%) i.e. Deep summer ploughing with mould board plough+ seed of variety TG 37A + seed treatment with *Trichoderma* @ 10g/kg of seed + soil application of *Trichoderma* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS being at par with M-11 (42%) 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 @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS over farmers' practice. However, Module-M4 i.e. Deep summer ploughing with mould board plough+ seed of variety TG 37A + seed treatment with *Trichoderma* @ 10g/kg of seed + soil application of *Trichoderma* @ 4 kg/ ha enriched in FYM first at the time of sowing, received maximum stem rot (8% inhibition) over farmers' practice.

Pod yield:The maximum pod (1350 kg/ha) was supported by Module M17 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* @ 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 M15 (1344 kg/ha) i.e. deep summer ploughing with mold board plough+ seed of variety TG 37A+ seed treatment with PGPR @625g/ for per ha of seed + soil application of *Trichoderma* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS.

Fodder yield: The maximum fodder (3778 kg/ha) yield was supported by Module-M17 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* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS followed by Module-M11 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* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS over farmers' practice, which supported fodder yield of 3528 kg/ha.

Effect of modules on stem rot and yield during kharif 2016

Stem rot: The maximum (22%) inhibition of stem rot was achieved by Module M-10 i.e. Deep summer ploughing with mould board plough+ seed of variety GG 20 + seed treatment with *Trichoderma* @ 10 g/kg of seed + soil application of *Trichoderma* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS, followed by Module-M15 (17%)i.e. Deep summer ploughing with mould board plough+ seed of variety GG 20+ seed treatment with PGPR @625g/ for per ha of seed + soil application of *Trichoderma* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS over farmers' practice. However, Module-M3 received maximum stem rot (13%) over farmers' practice.

Pod yield: The maximum pod (1792 kg/ha) yield was supported by Module M-11 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 *Trichoderma* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS followed by Module-M17 (1605 kg/ha) i.e. Deep summer ploughing with mould board plough+ seed of variety GG 20+ seed treatment with tebuconazole @ 1.5 g/kg of seed + soil application of *Trichoderma* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS, being increase of 15% and 3% respectively over farmers practice.

Fodder yield: The maximum fodder yield (6333 kg/ha) was supported by Module M-10 i.e. Deep summer ploughing with mould board plough+ seed of variety GG 20 + seed treatment with *Trichoderma* @ 10 g/kg of seed + soil application of *Trichoderma* @ 4 kg/ ha enriched in FYM first at the time of sowing, second at 35 DAS, followed by Module-M15 (6250 kg/ha)i.e. Deep summer ploughing with mold board plough+ seed of variety GG20+ seed treatment with PGPR @625g/ for per ha of seed + soil application of Trichoderma @ 4 kg/ ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS, which 16 and 15% increase over farmers' practice.

Effect of modules on collar rot and yield during kharif 2016

Collar rot: The maximum inhibition (35%) of collar rot was achieved by Module M-5 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 Trichoderma @ 4 kg/ha enriched in FYM at the time of sowing, followed by M16 (32%) i.e. Deep summer ploughing with mould board plough+ seed of variety GG20 + seed treatment with *Trichoderma* @ 10g/kg of seed + soil application of *Trichoderma* @ 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.

Pod yield: The maximum pod (2121 kg/ha) yield was supported by Module M-5 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 *Trichoderma* @ 4 kg/ha enriched in FYM at the time of sowing, followed by M-9 (2108 kg/ha) i.e. Deep summer ploughing with mould board plough – Soil application of *Trichoderma* @ 4 kg/ha enriched in FYM + seed of variety GG20 +

Seed treatment with PGPR @625g/for per ha of seed+ Soil application of *Trichoderma* @ 4 kg/ha enriched in FYM at 35 days after sowing (DAS), which 53 and 52% respectively, over the farmers' practice.

Fodder yield

The maximum fodder (8389 kg/ha) yield was supported by Module M-11 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 *Trichoderma* @ 4 kg/ha enriched in FYM first at the time of sowing, second at 35 DAS being 20% over the farmers' practice. However, the yield was reduced in other treatments in comparison to farmers' practice. This reduced yield could be attributed to high density of weeds during productive stage of crop season.

Management of aflatoxin contamination in groundnut

Effect of different storage bags on aflatoxin contamination

By and large, groundnut pods and kernels are stored in jute gunny bags for easy handling, low cost and easy availability of the gunny bags. Storage of groundnut pods and kernels in jute gunny bag has serious concerns resulting from the infestation by bruchid beetle (Caryedon serratus), rice moth (Corcyra cephalonica), flour beetle (Tribolium sp.) and buildup of aflatoxin contamination in the stored produce due to growth of Aspergillus flavus. The need of an alternate method of storage is imminent in the light of the problems faced by groundnut growers and exporters in storing groundnut in jute gunny bags. Different kind of storage bags viz., woven plastic bag, woven plastic bag with polythene lined (60 µ), polythene bag (60 µ), high density polyethylene bags (160µ), jute gunny bag and jute gunny bag with polythene lined (60 µ) were evaluated in order to prevent damage of pods/kernels from storage insect pests and from aflatoxin contamination.

For the safe storage, initially pods were cleaned. During the process of cleaning; shrivelled, discoloured, decayed, pest infested pods as well as plant debris and soil particles adhering on the pods are removed and the healthy pods are to be separated out. The healthy pods are dried to below 7% moisture content before packing. Cleaned dry pods @ 15 kg per bag were placed in each bag in four replications.

Evaluation of storage bags

S No.	Treatments	Pod damage by storage pests (%)	Aflatoxin contamination (ppb)	Germination (%)
1	Woven plastic bag	43 - 67	*	*
2	Woven plastic bag with polythene lined (60 µ)	23 - 29	2.5 - 13.8	44 - 57
3	Polythene bag (60 µ)	32 - 38	1.0 - 22.2	32 - 49
4	High density polyethylene bags (160µ)	0 - 2	0.0 - 1.7	68 - 83
5	Jute gunny bag	72 - 91	*	*
6	Jute gunny bag with polythene lined (60 µ)	24 - 31	0.0 – 27.3	36 - 51

*Pod damage more than 40% were not subjected for analysis of aflatoxin contamination and germination percentage

Pods stored upto 8 months at room temperature (28±2 °C) in high density polythene bags (160-micron thickness, HDPE bags) has lesser A. flavus infection and aflatoxin contamination compared to pods stored in jute gunny bags, interwoven bags and polythene lined gunny bags. In addition to this, devoid of bruchid infestation was recorded in pods/kernels stored in HDPE bags. Effect of roasting and blanching on aflatoxin contamination

Groundnut kernels were spiked with 100 ppb aflatoxin and subjected for roasting at different temperature and time as mentioned in table. Two varieties, GG 20 and TG 37A were used in the experiment. Groundnut kernels roasted at 30 to 90 °C were detected with same concentration of aflatoxin spiked on the raw kernels.

Whereas, roasting of groundnut kernels at 120°C for 10-15 minutes or at 140°C for 6-8 minutes has reduced aflatoxin initial load from the 100 ppb to 12-22 ppb.

Effect of roasting of groundnut kernels and aflatoxin reduction

Treatment		Aflatoxin contamination (ppb)				
Aflatoxin (100ppb) loaded kernels (GG 20)	Duration (min.)	B1	B2	G1	G2	Total
Raw groundnut spiked	--	43.5	11.5	42.5	9.0	106.5
Roastedat 60°C	30	44.0	8.0	41.0	10.5	103.5
	60	38.0	8.0	39.0	8.5	93.5
	90	41.0	8.5	36.0	7.5	93.0
	120	37.0	11.5	37.5	9.5	95.5
Roastedat 90°C	30	41.0	11.0	36.0	10.5	98.5
	60	42.0	8.5	39.0	11.5	101.0
	90	25.5	6.5	24.0	7.0	63.0
Roastedat 120°C	10	11.0	1.5	7.5	2.0	22.0
	15	10.0	2.5	4.5	1.5	18.5
Roastedat 140°C	6	8.5	1.5	6.0	1.0	17.0
	8	6.5	1.0	4.0	0.5	12.0

Effect of roasting of groundnut kernels and aflatoxin reduction

Treatment		Aflatoxin contamination (ppb)				
Aflatoxin (100ppb) loaded kernels (TG 37A)	Duration (min.)	B1	B2	G1	G2	Total
Raw groundnut spiked	--	44.5	11.0	41.0	11.0	107.5
Roasted at 60°C	30	39.0	9.0	43.5	11.5	103.0
	60	41.5	11.0	37.0	9.5	99.0
	90	39.0	10.5	39.5	10.5	99.5
	120	38.0	9.5	39.5	11.5	98.5
Roasted at 90°C	30	43.0	9.0	39.0	9.5	100.5
	60	40.0	11.5	37.0	10.0	98.5
	90	22.5	8.5	29.0	5.0	65.0
Roasted at 120°C	10	11.0	2.0	6.0	2.0	21.0
	15	9.5	2.0	5.5	1.0	18.0
Roasted at 140°C	6	9.5	1.5	4.0	1.0	16.0
	8	7.5	1.5	4.0	1.0	14.0

In both the varieties, roasting of groundnut kernels at 120°C or above for few minutes started degradation of the aflatoxin. This information provides way for minimizing aflatoxin load in the contaminated groundnut kernels.

Management of insect-pests of groundnut

Effect of nitrogen and potassium fertilization on the incidence of sucking pests (Rabi-Summer, 2015)

An experiment was carried in summer, 2015 to determine the effect of nitrogen and potassium fertilization on the incidence of sucking pests of groundnut. The populations of sucking pest viz., thrips, aphids and hoppers were recorded. Treatment-4 (NPK @ 37.5:70.0:0.0) was observed with significantly lower population (3.1 thrips per square). Highest pod yield (2911.4 kg/ha) was observed in Treatment-8 (NPK @ 50.0:70.0:30.0).

Experimental field view

Effect of trap colour and height on sucking pest incidence (Rabi-summer, 2015)

An experiment was carried in summer, 2015 to determine the effect trap colour and height on trapping efficiency for sucking pests of groundnut. Observations were recorded in two types of trap colours (yellow and blue), four directions (East, West, South and North), three heights (15, 45 and 75 cm from ground level) and in four cultivars (TG 37A, GG2, TAG24 and GJG31). Yellow coloured sticky traps were more efficient in trapping leafhopper while blue sticky traps were for thrips.

Influence of inter-crops on population dynamics of groundnut insect-pests (Kharif, 2016)

Six intercrops viz., pigeon pea, cotton, bajra, maize, sesame, and castor were tried as intercrop with groundnut to determine their impact on population dynamics of groundnut insect-pests. Pigeon pea, cotton, sesame and castor were planted in ratio of 3:1 while maize and bajra were planted at 2:1 ratio with groundnut. The population recorded with sticky traps revealed that the population of thrips and aphids were comparatively lower in crop combination of groundnut with Bajra.

Castor damage by Spodopteralitura

Evaluation of storage bins and botanical oils on infestation of bruchids

Two botanical oils (neem and castor oils @ 50 ml/kg pods) and two storage containers (blue plastic drum and galvanized bins) were evaluated for their efficacy against bruchids. After 4-months of storage, neem oil treated pods stored in blue plastic drums were found with lowest damage (2.8%) and weight loss (2.6%) in pods followed by castor oil treated pods stored in blue plastic drum (14.3 and 13.5%, respectively). Either oil treatment or storage container has no detrimental effect on seed germination after six months of storage where germination was around 90 per cent.

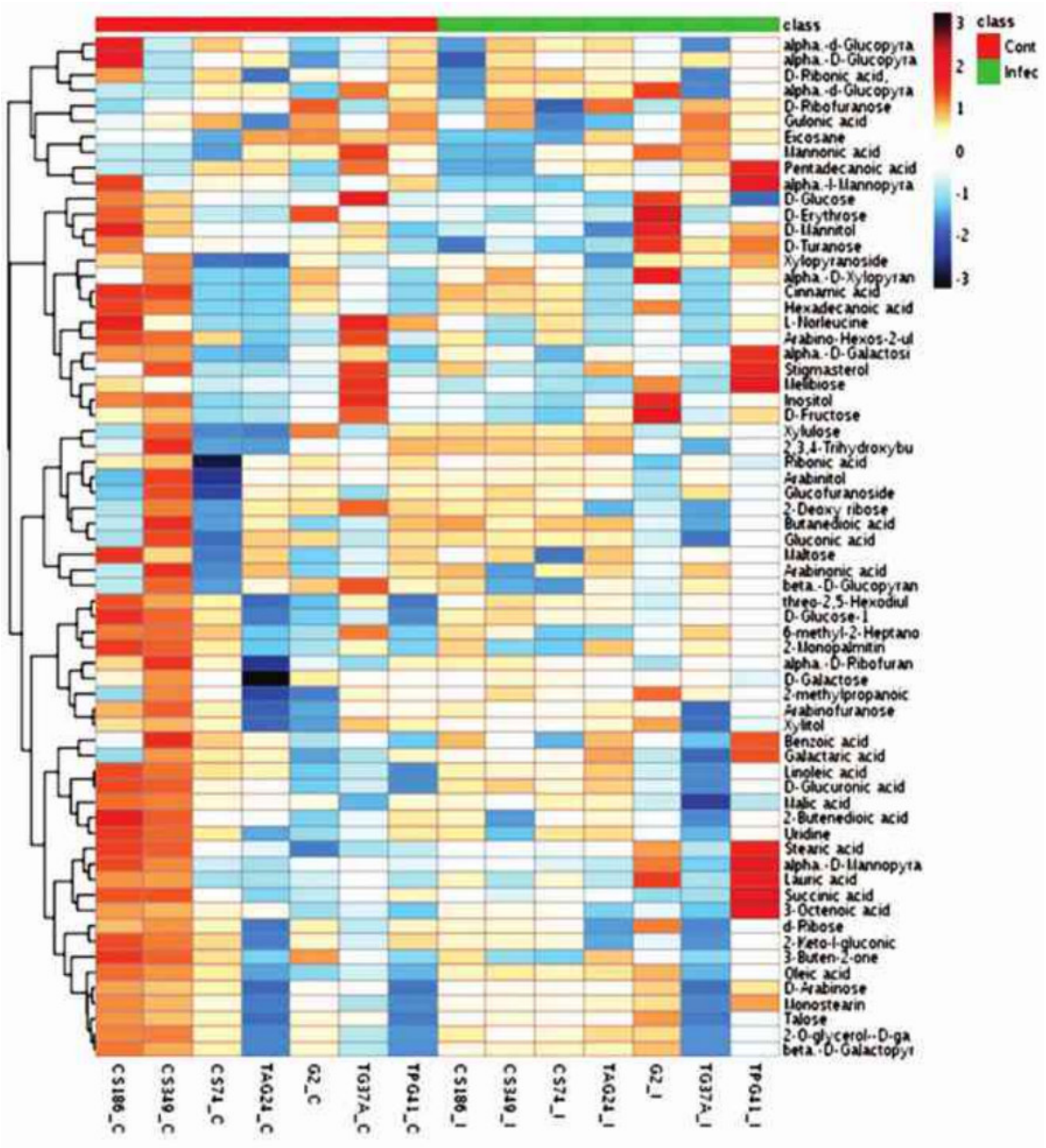
Influence of fungal pathogens on metabolomes of groundnut

Changes in untargeted and targeted metabolites in groundnut genotypes during Alternaria leaf blight

To understand resistance mechanism, Alternaria leaf blight resistant (GPBD 4, CS 74, CS 186 and CS 349) and susceptible (GG 2, JAL 42 and TPG41) genotypes were analysed for untargeted metabolites, sugar, phenol and organic acid profiles along with some defense related enzymes. Leaves were collected from both control and infected plants at 5 days after infection (d.a.i.). Untargeted metabolites were analysed by GC-MS and identified using NIST library.Sugars, amino acids, organic acids, fatty acids, phenolics and sterols were identified from the leaf of groundnut. Malic acid, 2-Butendioic acid (fumaric acid), 2-deoxy ribose, D-glucopyranose, glucose, norleucine were observed higher in control plants while, xylulose, lauric acid, oleic acid, monostearin and xylopyronoside were found higher after infection. While, after infection, succinic acid, malic acid, fumaric acid, 2-deoxy ribose, linoleic acid, uridine decreased.

Sugars and phenolics were extracted in 80% alcohol and 80% methanol respectively and analysed by Ion chromatography. After infection with pathogen, myo-inositol content was increased in susceptible genotypes while decreased in resistant genotypes. Similarly, glucose and fructose content was also found higher in susceptible genotypes at 5 d.a.i. Constitutive level of cinnamic and salicylic acid was higher in resistant genotypes than that of susceptible genotypes. Interestingly, salicylic acid was not observed in control and infected leaves (5 d.a.i.) of TPG 41(susceptible genotypes).

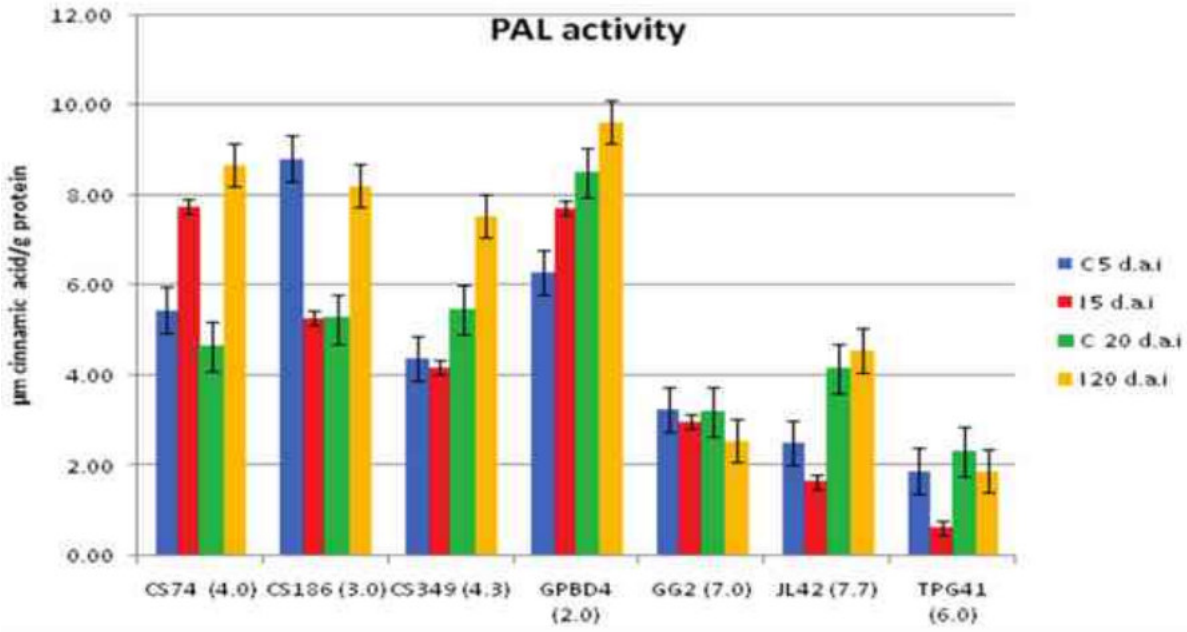
TCA cycle product i.e. oxaloacetate, succinic acid, malic acid and citric acid were separated by Ion chromatograph. Succinic acid was appreciably decreased in resistant genotypes after infection while increased in susceptible genotypes. Moreover, constitutive level of succinic acid was higher in resistant genotypes than that of susceptible genotypes. Malic acid decreased in all genotypes after infection.



Heat map showing abundance of metabolite in control and infected leaves of groundnut genotypes after Alternaria infection.

Changes in defense related enzymes in groundnut genotypes during Alternaria leaf blight

Higher activity of phenyl alanine ammonia lyase enzyme was observed in resistant genotypes at 5 d.a.i. than that of susceptible genotypes. Both constitutive and induced higher activities of tyrosine ammonia lyase enzyme were observed in resistant genotypes. Activities of polyphenol oxidase and peroxidase enzymes were higher in non- infected leaves of resistant genotypes.



Changes in phenylalanine ammonia lyase activity in groundnut genotypes. Where, C: control and I: infected; number in parentheses indicate disease score.

Identification of untargeted metabolites during Groundnut-Cercosporidium personatum interaction

Various metabolites were extracted, derivatized and identified using GC-MS from resistant and susceptible genotypes during Groundnut-Cercosporidium personatum interaction. About 70 to 140 metabolites were identified from different genotypes that include sugars, amino acids, fatty acids, phenolics, organic acids and sterols. Cinnamic acid, Linoleic acid and mannitol were observed higher in resistant genotypes than that of the susceptible genotypes. Linoleic acid may provide more substrate for lipoxygenase enzyme which plays important role in HR induction. While in susceptible genotypes, sterols (stigmasterol and beta-sitosterol) were observed higher. Increased content of stigmasterol after pathogen attack attenuate pathogen-induced expression of the defense regulator thus promotes plant susceptibility.

Changes in phenyl propanoid pathway enzymes during Groundnut-Cercosporidium personatum interaction

Higher activities of phenyl alanine ammonia lyase, tyrosine ammonia lyase and peroxidase were observed in resistant genotypes than that of susceptible genotypes. Higher activities of these enzymes may be correlated with higher content of various phenolics in resistant genotypes.

Estimation of TCA cycle products (organic acids) during Groundnut-Cercosporidium personatum interaction

TCA cycle compounds i.e. malic and citric acid was observed higher in susceptible genotypes. These compounds increased after infection in all genotypes. Thus higher content of these TCA cycle products implies higher respiration rate and higher catabolism during pathogen infection.

Services

Oil, protein and moisture content of 5000 groundnut samples from different section of DGR and 300 samples from different AICRP-G centers were measured by NIR spectroscopy.

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

Development of technologies for enhancing resource use efficiency in groundnut-based cropping systems

Integrated nutrient management studies in groundnut-wheat cropping system

A field experiment was conducted during 2016-17 to validate the effects of integrated nutrient management practices on system productivity of groundnut-wheat cropping system. The experiment was laid out in randomized block design with 12 treatments, replicated thrice. The treatments comprised T1, Absolute control (no fertilizers and organic manures); T2, 50% recommended dose of fertilizers (RDF) in groundnut and 100% RDF in wheat; T3, 75% RDF in groundnut and 75% RDF in wheat; T4, 100% RDF in groundnut and100% RDF in wheat; T5, 75% RDF+5 t FYM/ha in groundnut and 75% RDF in wheat; T6, 75% RDF+2.5 t FYM/ha in groundnut and 100% RDF in wheat; T7, 75% RDF+2.5 t GM/ha(Cassia tora) in groundnut and 75% RDF in wheat; T8, 50% RDF+5 t GM/ha (Cassia tora) in groundnut and100% RDF in wheat; T9, 100% RDF+biofertilizers(BF) in groundnut and 100% RDF+BF in wheat; T10, 100% RDF+ 5 t FYM/ha+BF in groundnut and 75% RDF in wheat; T11, 75% RDF+5 t FYM/ha + BF in groundnut and 100% RDF in wheat; and T12, farmers' practice (DAP @100 kg/ha in groundnut and wheat each), respectively.

The results indicated that application of 100% RDF+5 t/ha FYM+BF in groundnut and 75% RDF in wheat was effective to give significantly highest pod and haulm yield of groundnut over farmers' practice and control during kharif season. While application of 75% RDF+5 t/ha FYM+biofertilizer in groundnut and 100% RDF in wheat gave significantly highest grain yield of wheat over control during rabi season. Application of 50% RDF+ Cassia tora green manuring @5 t/ha in groundnut and 100% RDF in wheat gave significantly highest straw yield of wheat over control.

Effect of organic manures, growth promoters and nutrient solubilizers on summer groundnut

A field experiment was conducted during summer, 2016 to validate the effects of different organic plant nutrient sources, growth promoters, and nutrient solubilizers in groundnut at ICAR-DGR research farm, Junagadh. The treatments were: recommended dose of fertilizers (T1), FYM @ 10 t/ha (T2), neem cake @1634 kg/ha (T3), enriched compost @ 2858 kg/ha (T4), FYM @ 5 kg/ha +enriched compost 1429 kg/ha (T5), T5+plant growth stimulant (T6), T6+plant growth promoters (T7), T7+ nutrient solubilizer (T8), recommended dose of fertilizers+Amrit pani (T9). The experiment was laid out in randomized block design with four replications.

The analysis of data revealed that significantly highest pod and haulm yield was obtained with RDF over application of neem cake @1634 kg/ha and enriched compost @2858 kg/ha. However, among the organic modules application of FYM @5t/ha+enriched compost @1429 kg/ha+growth stimulant+bio-multi-nutrient solubilizer gave significantly highest pod and haulm yield over application of neem cake @1634 kg/ha and enriched compost @2858 kg/ha. Foliar spray of Amrit pani slightly improved pod and haulm yield over RDF alone.

Response of groundnut to crop geometries and growth promoting substances

A field experiment was conducted during kharif 2016 to identify suitable crop geometry in groundnut (variety TG 37 A) to facilitate mechanical interculturing to reduce cost on weed control and enhance productivity, and know response of groundnut to growth promoting substances. The experiment was laid out in split plot design with three replications. Five treatments of crop geometries viz., 30x10 cm, 45x10 cm, 45/10x10 cm, 45/15x10 cm, and 45/20x20 cm spacing were tested in main plots, while four treatments of growth promoting substances viz., control, plant growth promoting Rhizobia (PGPR), Amrit pani, and PGPR+Amrit pani were tested in sub plots.

The sowing of crop in paired rows at 45/10 x 10 cm spacing gave significantly highest pod yield while highest haulm yield was found with sowing inn paired rows at 45/20 x 10 cm spacing over sowing at 45 x 10 cm spacing. Among the plant growth promoters, application of PGPR through seed treatment + foliar spray of Amrit Pani gave significantly highest pod and haulm yield over control.

Development of conservation agriculture technologies for groundnut–basedcropping system(s)

Developing Conservation Agriculture technology for groundnut-wheat cropping system.

A field experiment was conducted during 2012-13 to 2015-16 to know the effects of conservation agriculture on soil health, productivity, and profitability of groundnut based cropping systems in black calcareous soils. Three tillage practices viz. conventional tillage, minimum tillage and zero tillage were assigned in main plots, while three residue management practices viz. no residue application, wheat stubble retention, and wheat stubble retention+Cassia toramulch were allotted in sub-plots. The experiment was laid out in split plot design with three replications. The experiment was conducted on permanent raised beds due to the problem of waterlogging in the experimental field occasionally.

Pooled results (three years):

Conventional tillage and minimum tillage being at par gave significantly higher pod yield over that with zero tillage. However, minimum tillage and zero tillage being at pat gave significantly higher haulm yield over that with conventional tillage. Highest net returns and BCR in groundnut was obtained with minimum tillage. In wheat, grain yield, net returns and BCR was higher with minimum tillage and zero tillage compared to conventional tillage but differences were not significant. GPEY was significantly higher with minimum tillage over conventional tillage and zero tillage.

Retention of wheat residues gave significantly higher pod yield over no mulch, while wheat residues+Cassia tora mulch gave significantly higher pod yield over both no mulch and retention of wheat residues. Similarly, retention of wheat residues, and wheat residues + Cassia tora mulch being at par gave significantly higher haulm yield over no mulch. Wheat residues+Cassia tora mulch gave significantly higher net returns and BCR over no mulch. Wheat grain yield

was not significantly affected by residue and mulching practices. Net returns in wheat were significantly lower with wheat residues+Cassia tora mulch compared to no mulch due to extra cost involved. Retention of wheat residues, and wheat residues+Cassia tora mulch being at par gave significantly higher GPEY over no mulch.

The changes in different soil phosphorus (P) pools (viz., inorganic-P, organic-P and residual-P) were found non-significant among different tillage and crop residues recycling levels. However, the residual soil phosphorus which is generally considered as most stable and highly recalcitrant soil-P pool was significantly altered among tillage levels with highest under minimum tillage followed by zero tillage and least under normal tillage. Further, these management practices considerably altered the soil phosphorus pools. In general, the inorganic (5 to 27%) and residual soil phosphorus (25 to 58%) were decreased whereas the organic soil phosphorus (16 to 38%) was increased among different treatments as compared to the initial soil levels. Overall the contribution of these soil-P pools in total soil phosphorus was decreased by 2to 10% in inorganic and residual soil-P and about 12% increase was observed in organic soil-P after two years of crop rotations.

Management of soil and irrigation water salinity in groundnut

Evaluation of released varieties of groundnut in summer&kharif season in saline black clay soil

Groundnut was taken in summer2015 and 2016 to test the eight released varieties namely dh86, dh101, GPBD5, GG7,JL501, K9, TKG19A and TPG 41 under Spanish group in the saline environment having salinity levels of 0.5, 2, 4 and 6 dS m-1. The five meter rows length of each variety and seven/eight supplementary irrigations were given. It was observed that the pod and haulm yields of all the varieties were at par up to the irrigation of saline water of 2 dS m-1 but significant difference was recorded at a water salinity of 4 dS m-1 in comparison to water salinity of 0.5 dS m-1 (control). Further, the significant difference in pod yield was also recorded within the varieties and significantly higher pod yield was recorded in dh86 and lowest pod yield in K9 during both years. Almost similar trend was observed for other yield contributing characters under saline environment.

The same experiment was taken in kharif2015 and 2016 at similar site of field to evaluate the similar set of varieties under similar level of salinity but four supplementary saline irrigations were given in first year and one in second years season in place of seven/eight irrigations during summer season. In this season observed that pod and haulm yields of all the varieties were at par up to the irrigation of saline water of 4 dS m-1 but significant difference was recorded at a water salinity of 6dS m-1 in comparison to water salinity of 0.5 dS m-1 (control). Further, the significant difference in pod yield was also recorded within the varieties and significantly higher pod yield was recorded in GG7 and lowest in TPG41 in both years under Spanish group during kharif season.

Effect of different mulching on groundnut yield under different salinity stress

The experiment was conducted during summer 2016 to ameliorate the effect of salinity with application of different mulches under different salinity levels. The treatment consisted of four levels of salinity (0.5, 2, 4 and 6 dS m-1) in main plot, three levels of mulching [without mulch (control), polythene mulch and straw mulch] in sub plot. The results revealed that significantly higher pod yield was recorded with the application of 2 dS m-1saline irrigation water but significant reduction was recorded at 6 dS m-1as compare to other treatments. The 84% higher pod yield was recorded at 2 dS m-1as compared to 6 dS m-1saline irrigation water. The haulm yield of groundnut was also showed non-significant results up to 2dS m-1as compared to fresh irrigation water (i.e., control) and significant reduction was recorded at 4 dS m-1onwards. Further, significant differences were also recorded among different mulches. The pod yield was recorded in order of that under straw mulch (79%) > polythene mulch (62%) higher as compared to control but haulm yield increased almost equal under both type of mulching (34%) over control. Although, interaction effect of salinity x mulching revealed that as the level of saline irrigation water increases pod and haulm yield of groundnut significantly increase under polythene mulch and straw mulch as compare to without mulch. The pod and haulm yield under polythene mulch and straw mulch was recorded 342 & 81 and 491 & 77%, higher at highest salinity level (6 dSm-1) respectively.

Studies on dynamics of soil phosphorus under various management practices in groundnut cultivation

Mobilization of soil phosphorus as influenced by nutrient management in groundnut-wheat cropping systems

Rabi-Summer 2015-16: Wheat crop (cv. GW 496) was grown in calcareous vertisols having four different phosphorus (P) gradients viz., native soil phosphorus, 50% RDP, 100% RDP and 150% RDP as main plots. Four different phosphorus solubilizers namely citric acid @ 2.5kg ha-1, FYM @ 1% w/w, compost @ 1% w/w and PGPR consortia with one control (i.e., no P-solubilizer) were applied in sub-plots during rabi2015-16. The yield and yield attributes of wheat (viz., grain yield, biomass yield, ear head/m2, test weight, grains per ear-head etc.) were significantly altered among different soil phosphorus gradients and phosphorus solubilizers. Similarly, organic carbon, available phosphorus in soil and phosphorus, sodium and potassium content in plant parts were also significantly differed among these treatments. Use of farm yard manure was found most effective for mobilization of soil phosphorus followed by compost in terms of plant growth, yield, soil nutrient availability and nutrient uptake by the plants. The interaction

effect of P-gradients and P-solubilizers found non- significant on all these parameters.

Kharif 2016: Groundnut crop (cv. TG 37A) was grown in sequence to wheat crop having similar set of treatments during kharif 2016.The growth and yield attributes of groundnut like biomass accumulation, number of branches, plant height, HPW, HKW and pod yield of groundnut etc. were considerably differed among different soil phosphorus gradients as well as phosphate solubilizers. The highest groundnut yield was observed with higher dose of phosphorus application compared to the lower levels. Similarly, application of FYM was proved as the most effective soil phosphorus solubilizer followed by compost, citric acid and PGPR in terms of growth and yield of groundnut.

Solubilization and exploitation of soil phosphorus in groundnut production using phosphate solubilising microorganisms

Groundnut crop (cv. TG 37 A) was grown using three source of phosphorus viz., native soil phosphorus, FYM @ 10t ha-1 and 50 kg P2O5 in main plots and four different phosphate solubilizing bacteria (PSB) in sub plots during summer 2016. Generally non-significant results were obtained except pod yield and available soil phosphorus. The available soil phosphorus was significantly affected among different PSB with highest under PSB 2 (i.e., BM 8). Similarly pod yield was significantly affected by interaction of P sources and PSB with highest in use of FYM and PSB 2. Combination of FYM and PSB 2 was found promising for enhanced growth, yield and nutrient acquisition by the plants.

Characterization and availability of soil phosphorus under groundnut cultivation in Bikaner (Rajasthan)

Soil samples (113 Nos.) were collected from different groundnut based cropping systems including groundnut–gram, groundnut – mustard, groundnut – wheat, groundnut – fallow etc. covering Bikaner, Kolayat, Sri Dungargadh and Nokha tehsils. The available soil phosphorus in these soils ranged from 8 to 32 mg/kg depending upon the land use and cropping systems. Generally, soils of these districts were ranged from low to medium in availability of soil phosphorus.

Response of kharif groundnut to differential supply of phosphatic fertilizers in calcareous soil

Groundnut crop (cv. TG 37A) was grown with 0, 30, 40 and 50 kg P2O5 ha-1 applied differentially during kharif2016. Application of phosphatic fertilizer has inconsistent response in terms of growth and yield attributes of groundnut. Irrespective of the doses of P- fertilizers, the highest values of these parameters were observed with basal application of phosphatic fertilizers followed by 50% application as basal and 50% at 30-40 DAS using water soluble grade fertilizers and least under 50% as basal and 50% as side dressing at 30-40 DAS.

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

Iron and zinc bio-fortification in groundnut

Screening groundnut cultivars for high Zn and Fe contents in seed

The analysis of Zn and Fe contents in seeds of 190 groundnut cultivars along with many other nutrients showed a wide range in the Zn and Fe concentration in seed. From these 13 groundnut cultivars with more than 55 ppm Zn in their seed and 10 cultivars with high Fe were identified.

Screening groundnut varieties for high micronutrient density in seeds

Fe biofortification in groundnut through seed dressing of iron sources

Five iron sources (FeSO4, FeCl3, Ferric Citrate, FeEDDHA, Fe-EDTA) were applied as a seed dressing on 12 groundnut cultivars to see the effect of these on pod yield and Fe content in seed produce. Out of these only iron sulphate and FeEDDHA increased yield, but the Fe contents in seed of these produce increase due to iron sulphate, FeCl3 and FeEDDHA with a lot of differences observed among the cultivars. On an average the Fe content in the control, FeSO4, FeCl3, Ferric Citrate, Fe-EDTA, FeEDDHA treatments were 76, 91, 86, 78, 77 and 81 ppmg Fe, respectively.

Zinc biofortification through various Zn-sources in groundnut

Five Zn sources (zinc sulphate, Zn EDTA, zinc chloride, zinc oxide and zinc acetate) applied as foliar spray during summer season, only zinc sulphate and zinc acetate increased the pod yield, but all of them arrested the growth, reduced haulm yield and increased shelling and 100 seed wt. In another experiment five commercial grade Zn sources (Shruti, Energy high Zn Swarna Hydrogel + zinc sulphate, and Monzin) were tried in the field using 10 groundnut cultivars during rainy season where these sources were found useful with varied responses.

than 55 ppm Zn in their seed and 10 cultivars with high Fe were identified. The nutrient analysis of seed sample of 20 groundnut cultivars, from the experiment, grown under influence of zinc sulphate and Zn-EDTA application (soil and foliar), indicated that both of these increased the Zn content in seed. On an average the Zn in seed of produce grown under control and with zinc sulphate and Zn-EDTA were 50, 58 and 55 ppm respectively though cultivars showed variations.

Thus application of Zn fertilizer is recommended to increase Zn content of groundnut seed.

Zinc biofortification in groundnut under rainfed cultivation

In an experiment 100 groundnut cultivars were grown under both rainfed and protected conditions during rainy season and application of Zn was studied for their enrichment under rainfed condition. Though the application of Zn controlled over growth, it slightly increased pod yield. The seed samples of these produce are being analyzed for Zn enrichments.

Zn and Fe biofortification in various seed-sizes groundnuts

The pod nutrition of various seeds size groundnut and Fe and Zn biofortification was studied in field with 50 genotypes varying in pod structure and sizes and grown at various combination with fertilizers (T1-control, T2-Samridhi an organic sources), T3-T2 + 2 kg Zn as Monzin,) where a large variation in the response depending upon the seed size was observed. Seed sample of these are being analyzed for Fe and Zn contents.

B and Zn interactions in relation to their content in seed

The interaction effect of B and Zn using treatments (ie. control, 1 kg ha-1 B, 1 kg ha-1 B + 2 kg ha-1 Zn), studied in field trials with 20 cultivars, showed synergistic effects and both of these micronutrients were important for pod development and high yields. The nutrient accumulation pattern in seed were governed by B. Thus, both of these elements are required for better partitioning of biomass and nutrients from haulm to seed.

Screening and mechanism of iron-deficiency chlorosis

In a screening plot 114 groundnut genotypes, comprising of advanced breeding lines of various sections were screened for their reaction to lime-induced iron-chlorosis (LICC), and identify the iron-efficient lines using visual chlorotic rating (VCR) during the cropping season and categorized under various classes. Of these thirteen were identified as Fe-efficient which showed tolerance of iron chlorosis.

Also 200 groundnut cultivars grown in two different experiment were screened for LICC,from where 24 were tolerant, several moderately tolerant, besides 8 were very sensitive. The iron chlorosis tolerant cultivars were: R8808, S230, Kadiri 7, 8, and 9, Tirupati 3, TG 42, Kadiri gold, HNG 69, M 145, M 197, M 522, GJG 22, Champawat, LGN 2, BG1, Mallika, RSB 87, RG 510, RG 425, DH4-3, ICGV87846.

Physiological studies in groundnut under water-deficit and salinity stresses

Physiological efficiencies among Indian groundnut cultivars

From the field grown 100 cultivars during kharif season, the photosynthesis (PN), transpiration (E), stomatal conductance (gs), chlorophyll fluorescence, SCMR and yields were studied where large variability was observed. The study identified several cultivars as high and lowin PN, Eand gs.

There was positive correlation between, PN and gs, PN and E,PN and number of pods, SCMR and pod yield, SCMR and WUE, haulm yield and plant height, haulm yield and pods, and a negative correlations between SCMR and plant height, SCMR and E, and E with WUE.

Elasticity among groundnut cultivars for their tolerance to various drought

36 recent groundnut cultivars were screened under protected (P), rainfed (RF) as well as exposed to mid-season

Measuring Chlorophyll fluorescence in groundnut under rainfed

(MSD, 50-70 DAS) and late season drought (LSD,70-90 DAS) under ROSand their elasticity of drought tolerance were worked out with several interesting results. Four year of study reveals that in Junagadh the rainfed crop faces 2-3 drought spell of various period causing yield losses from 5-50 % depending upon the cultivars. Though varietal differences were reported there was no yield reduction in the RF crop over a crop grown under protected irrigation during three of the four years however the LSD was most detrimental to crop hence should be avoided.

The cultivars with early flowering, high SCMR, low SLA, high yield and HI and early maturity showed escape mechanism and were considered as highly suitable for rainfed cultivation under drought situation.The cultivars Kadiri 7, RG 425, RG 510, RG 578, RG 559-3, GG 20, GG 16, GJG 22, CSMG 9510, M522, HNG 69, HNG 123 showed more than 1500 kg/ha pod yield under rainfed conditions. Interestingly the cultivars Pratap 1, RG 578, Kadiri 7 and GJG 22 performed well under both MSD and LSD. However, the cultivars Kadiri 7, and GJG 22 showed most elasticity and performed well under all the 4 situations.

Pod zone moisture contents influences yield, yield attributes and aflatoxin

A number of groundnut cultivars (24) exposed to various moisture content (on dry wt basis) in their pod zone (>19.6, 17.2-19.6, 15.0-17.1, 12.4-14.8, and <12.4 % moisture content) from 50 DAE in a microplot study through drip irrigation, though behaved differently, there were no pod yield losses till the soil moisture content in pod zone was >15.0 %, below which drastic reduction in pod yield were observed. There were variations in the other physiological parameters also.

There was a contrast differences in the aflatoxin in the seed of peanut grown at above and below 12.4 % soil moisture content in the pod zone. Out of 24 cultivars, 15, 14, 13 and 13, respectively grown at >19.6 %, 17.2-19.6%, 15.0-17.1 % and 12.4-14.8 %, moisture content showed < 4 ppb aflatoxin in their seed. But at pod zone moisture content below 12.4 %, 18 cultivars showed > 10 ppb aflatoxin and cultivars GG 2, GG 7, GG 8, AK 159, Girnar 3 and SG 99 showed < 10 ppb aflatoxin showing their better resistance.

Water requirement of groundnut cultivars

Twenty-four groundnut cultivars grown at 400, 500 and 600 mm of total water during cropping season showed on an average 220, 235 and 203 g/m2 yield, respectively. However, these behaved differently and at 500 mm 11 cultivars, at 400 mm 5 cultivars and only 3 cultivars at 600 mm showed >250 g/m2 pod yield. Interestingly the cultivars ICGV 00350, JGN 23 and RG 510 showed elasticity and performed well under all the three situations.

Influence of growth regulators on seed size

Three foliar spray of (40, 60 and 75 DAS) commercial growth regulators Lihocine (Chlormequate chloride), Planofix (Alpha Nepthyl Acetic acid), Chamatkar (Mepiquate chloride)Progibb (GA) and Herbozymes (extract ofsea weed Ascophyllum nodosum) increased seed size of two groundnut cultivars GG 7 and TG 37. However, there was varied response of these on growth, pod and fodder yields and shelling. The Lihocine and planofix arrested the over growth.

Understanding salinity stress tolerance mechanism and biochemical parameters

In a pot study, major oxidative stress tolerance were studied in 6 differentially salt-sensitive genotypes ('CS 240', 'NRCG 357', 'TMV 2', 'Girnar 1', 'TPG 41', 'Somnath') grown at 4 levels of salinity (0, 25, 50 and 100 mMNaCl).

Activity assay of major ROS-detoxifying enzymes and their relative transcript abundance through real-time qPCR technique revealed up-regulation of SOD, CAT and POD under salt stress, while no significant induction observed in GR and APX.

Screening for salinity tolerance

The field screening of 57 groundnut cultivars at two salinity levels (2 dS m-1 and 4 dS m-1), by recording germination, plant survival, and yield attributes identified five cultivars with lesser reduction in yield and showing comparatively high tolerance with reasonable pod yield at 4 dS m-1 salinity.

Impact of climate change on physiology and productivity of groundnut

Temporal expression of HSPs under high temperature stress

The basis of high temperature tolerance,in particular, the differential expression of heat shock proteins (HSPs), was studied in two relatively tolerant (ICGS 44 & GG 7) and two susceptible (DRG 1 & AK 159) groundnut genotypes (identified in our earlier experiments) by growing them in walk-in growth chamber under controlled conditions having mean day-night temperature 35/25 °C; mean relative humidity 40/60 % and day-night cycle of 13/11 hrs. The 30 days old plants were then exposed to high temperature stress i.e. 42 °C in the growth chamber for 0.5, 1.0 and 2 hrs and tender leaf tissues were collected for RNA isolation for gene expression analysis of HSPs (HSP 17, HSP 40, HSP 70 and HSP 80). Sample harvested at 0 hrs was considered as control. Gene expression analysis of HSPs revealed that imposition of short-term high temperature stress resulted alteration in expression of HSPs which is specific to genotypic and time specific; however the higher induction of small heat-shock proteins (HSPs), particularly HSP-17, in DRG 1 suggest it to be an indicator of heat stress sensitivity of groundnut genotypes.

Effect of temperature stress on kernel quality of groundnut

The effect of high temperature stress on quality of groundnut kernels was studied by creating differential temperature regime under field condition through staggered sowing at 20 days interval between each sowing date (D1:21st Jan, D2:10th Feb and D3:2nd Mar) using two relatively tolerant (ICGS 44 & GG 7) and two susceptible (DRG 1 & AK 159) genotypes. Harvesting was done for D1, D2 and D3 on 24th May, 06th June and 13th June respectively. The harvested kernels were evaluated for oil, protein and fatty acid composition.

Results showed that there were no changes in Oleic to Linoleic ratio (O/L) under differential temperature regime except in ICGS 44 where O/L reduced from 1.68 with increasing temperature. Similarly, due to high temperature, oil content decreased in both D1 and D3 in all genotypes except in heat tolerant ICGS 44, where it remained almost stable. Further the analysis indicated protein content increased under both high and low temperature, where as in ICGS 44, the alteration was negligible. Hence it is hypothesized that temperature stress

Experiment on effect of high temperature stress in groundnut

enhanced kernel quality in terms of protein content by the cost of reduction in oil content. This preliminary experiment, also suggest that the oil stability of groundnut oil is least affected with changing environmental temperature.

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

Application of DAPG-producing fluorescent *pseudomonads* for suppression of stem rot of groundnut (Kharif 2016)

Some fluorescent *pseudomonads* are known to produce 2, 4-diacetylphloroglucinol (2, 4-DAPG) which is antifungal and inhibits the soil-borne fungal pathogens. To make soils naturally suppressive to soil-borne fungal pathogens like *Sclerotium rolfsii* causing stem rot in groundnut, DAPG-producing fluorescent *pseudomonads*, highly antagonistic to *S. rolfsii*, were applied and evaluated with the susceptible cultivar GG20.

DAPG-producing fluorescent *pseudomonads* (12 in number) were evaluated for the development of suppressive soils as one of the management strategies for controlling soil-borne fungal pathogens like *Sclerotium rolfsii* causing stem rot of groundnut. The experiment was conducted in permanent plots with susceptible cultivar GG20 during kharif season of 2016. The results indicated that with the application of DAPG-producing fluorescent *pseudomonads*, the mortality was reduced from 74% in pathogen control to 21-38% in different treatments with DAPG-producing fluorescent *pseudomonads*. The mortality due to natural infection of *Sclerotium* rolfsii was 8%.

Besides suppression of plant pathogens by making soil naturally suppressive to pathogens, growth and yield of groundnut also improved significantly due to plant growth promoting activity of the fluorescent pseudomonads. Application of *Pseudomonas putida* DAPG 4; *P. putida* DAPG7; *P. fluorescens* FP46, *P. putida* FP133, *P. putida* FP86,etc.significantly improved the yield of cultivar GG20 by 13-21%. Besides, nutrient uptake has also been improved by these strains.

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

A total of 150 rhizobial isolates have been obtained from samples collected from different groundnut growing fields in the Saurashtra region. The nod+ and nif+ groundnut rhizobium isolates were processed for 16S sequencing. 16S rRNA sequence based approach was undertaken. Initial results of 16S rRNA sequence of groundnut nodulating bacteria indicated that besides traditional rhizobial genera, *Enterobacter clocae, Pantoeadispersa, Ochrobactrum*, etc. are also found to be nodulating groundnut.

Isolation, characterization and in vitro evaluation of leaf epiphytes of groundnut for biological control and other traits

Phyllosphere or epiphytic bacteria can be used as potential biological control agents for air-borne fungal pathogens. Leaf epiphytic bacteria were isolated from different groundnut genotypes, across different habit groups of groundnut (Valencia, Virginia and Spanish). Fifty-five morphologically different isolates of epiphytic bacteria were selected for studying their antifungal activities against

two major foliar pathogens of groundnut, i.e Alternaria and LLS pathogen. Out of the 55 bacterial epiphytes tested, 20 cultures showed antifungal activity against Alternaria, the inhibition zone ranged from 5 to 18 mm. Six isolates were promising in showing high degree of antifungal activity against Alternaria. The 55 bacterial epiphytes were also tested for their antifungal activities against LLS pathogen. Eleven epiphytes showed antifungal activities against LLS pathogen, the inhibition zones ranging from 7 to 12 mm. Seven of the epiphytes showed antifungal activities against both the pathogens.

Isolation and characterization of Zn and K solubilizing rhizobacteria

The activity was initiated with the screening of PGPR cultures available in the microbiology section for zinc solubilization using ZnO as the insoluble source. Three PGPR cultures showed Zn solubilization, zones ranging from 8 to 15 mm. Thirty PGPR isolates were screened for solubilization of Zn using zinc phosphate and zinc carbonate as sources of Zn. Five PGPR isolates showed solubilization of zinc phosphate and zinc carbonate – the solubilization zone for zinc phosphate ranged from 7 to 10 mm and for zinc carbonate from 8 to 14 mm. The PGPR cultures BHU-1, FP82, BM6, FP93 and Bacillus megaterium were efficient zinc solubilizers. Thirty PGPR cultures were screened for K solubilization. Sixteen PGPR cultures showed clear zones of K solubilization in petridishes, using potassium aluminosilicate as insoluble source of K. The zone of solubilization ranged from 11 to 22 mm, the maximum was with BHU-1. Consortium of compatible strains of Zn and K solubilizers will be developed and tested for enhancing Zn and K solubilization and uptake in groundnut.

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

Isolation and characterization of microbes insecticidal to Helicoverpa and Spodoptera

To provide alternate biocontrol agents other than Bt against *Helicoverpa armigera* (Hubner) and *Spodoptera litura* (Fabricus),47 and 53 non-Bt isolates were obtained from dead larvae of *Helicoverpa* and *Spodoptera*, respectively. Evaluation of seven non-Bt bacilli (LS1, LS2, LS4, LS5, LS6, LSH1, LSH2) in leaf bioassay for control of *Spodoptera* resulted in larval mortality of 0-33.3% as compared to 10% mortality obtained in control. Further evaluation of another two non-Bt isolates, LS13 and LS14, showed 100% mortality against Spodoptera

Evaluation of Bt and isolation of other insecticidal bacilli against white grubs

From the naturally dying population of white grubs at farmers' field, 18new isolates of insecticidal bacilli (*Bacillus thuringiensis, Bacillus licheniformis, Bacillus sp., Brevibacillus brevis, Bacillus amyloliquefaciens, Bacillus cereus, Bacillus tequilensis*, etc.) were isolated during kharif 2016 and bioassay showed upto 100% larvicidal activity and against white grubs against earlier identified *Bacillus thuringiensis* vartenebrionis HBN2.

Control

HBN2

Newly isolated Bacillus thuringiensis var. tenebrionis

Control

Larval bioassay with isolates of Bacillus thuringiensis vartenebrionis

Isolation and characterization of rhizobia tolerant to salinity and moisture deficit stress

From the nodule samples collected from groundnut growing areas of Bhuj affected by salinity, 57 isolates of groundnut-rhizobia were obtained, purified, characterized. All of the isolates can tolerate 5% of NaCl whereas 17 of them can grow upto 10% of NaCl, 5 could tolerate 15% of NaClin vitro. From the nodule samples collected from the severely drought-stressed groundnut cultivated at Junagadh, 47 isolates were characterized for nod and nif functions. Analysis of the 16S rRNAs sequence data of all the 24 nod+ isolates revealed that majority of the nod+ isolates belonged to the genus *Enterobacter* (*Enterobacter cloacae* and *Enterobacter sacchari*). Only six isolates (DTR11, SRG19, DTR21, DTR24, DTR34 and DTR47) showed similarity with the genus Rhizobium

Selection and identification of endophytes for alleviation of moisture-deficit and salinity stress in groundnut

(i)Alleviation of drought by application of endophytes:

Evaluation of physiological, biochemical and molecular basis of alleviation of drought revealed that endophyes of groundnut, under drought stress, modulated: (a) root growth and development; (b) stomatal opening and closing; (c) production of ROS scavenging enzymes like catalases (general scavenger) and fine tuners of ROS like POD, SOD, GR, etc.; (d) uptake of K; etc. Application of endophytic bacteria like *Bacillus firmus* J22, *Bacillus subtilis* SEN51 and *Pseudomonas pseudoalcaligenes* SEN29 significantly prevented the loss of yield of groundnut by 15-25% as compared to uninoculated control with the application of single irrigationwater at the time of sowing during summer 2016.

Raising groundnut (TG37A) crop with single supplementary irrigation during summer 2016 with the application of different endophytic bacteria

Evaluation of endophytic bacteria for alleviation of drought stress and for reducing the yield loss with cultivar TG37A, summer 2016

Treatments	PY (kg/ha)	HY (kg/ha)
Control	1318	3437
Pseudomonas mexicana REN47	1438	3957
Pseudomonas pseudoalcaligenes SEN29	1550	4323
Acinetobacter junii J20	1465	3797
Bacillus subtilis REN51	1567	4520
Bacillus firmus J22	1650	4193
CD (0.05)	**104**	**139**

In kharif season, evaluation of five endophytes (*Pseudomonas pseudoalcaligenes* SEN29, *Pseudomonas mexicana* REN47, *Acinetobacter junii* J20, *Bacillus firmus* J22 and *Bacillus subtilis* REN51) with cultivar TG37A enhanced yield of groundnut (TG37A) in most of the cases and acted as PGPR. Application of *Pseudomonas pseudoalcaligenes* SEN29, *Bacillus firmus* J22, etc. enhanced the pod and haulm yield of groundnut significantly.

Evaluation of endophytes for PGP-activity during kharif 2016 (cultivar TG37A)

Treatment	Pod yield (kg/ha)
Control	3148
Pseudomonas mexicana REN47	3327
Pseudomonas pseudoalcaligenes SEN29	3807
Acetinobacterjunii J20	3415
Bacillus subtilis REN51	3281
Bacillus firmus J22	3595
CD (0.05)	**185**

Upon inoculation, these endophytes have been found to alleviate the drought and salinity stress by significantly enhancing the production of ROS scavenging enzymes in groundnut besides significant enhancement in root growth and biomass, K uptake, and by reducing transpiration loss of water by modulating the stomatal aperture during daytime.

(i) Alleviation of salinity stress by application of endophytes

To understand the mechanisms of alleviation of salinity stress further, an experiment was conducted during summer 2016 with soil salinity of 4.0-4.5 with cultivar TG37A and four of its selections, which were tolerant to drought. It was found that when soil salinity approached around 4.0, the plant kept the stomata closed during entirety of the daytime. Monitoring the behavior in a 24h cycle indicated that the stomata regulated inversely. Besides, expression of Na-H transporters in root, there was expression of carboxylation and decarboxylation modules in salinity stressed groundnut. Application of endophytic bacteria like *Pseudomonas pseudoalcaligenes* SEN29, *Bacillus subtilis* REN51 *and Bacillus firmus* J22 modulated the expression further of all modules and alleviated the salinity stress. Reduction in yield by salinity was prevented by application of Bacillus firmus J22 to the tune of 22%.

5 Socio economic research and extension for groundnut in developments

Innovative approaches to bridging yield gaps in groundnut through technology dissemination and capacity building

Study on Resource Use Management (RUM) behaviour of groundnut growers of Karnataka

The survey was conducted during Kharif 2016 among three districts of Karnataka viz., Dharwad, Tumkuru and Chitradurga. Dharwad district is having higher yield level than the other two districts. Chitradurga district alone contributes about 23 per cent of groundnut production in Karnataka next to this district is Tumkuru.

In each district, to study the resource use management behaviours of farmers 50 farmers were randomly selected. Interview schedule was administered to know the extent of resource use management behaviours exists among them. The result is given in table no.1. The result revealed for Dharwad district is that most of the groundnut growers had medium to high RUM behaviour in land management, nutrient management and weeds management components. In Tumkuru district low level of resource use management behaviour found highly in cropping systems, soil-moisture, insect pests and diseases management components.

In Chitradurga district, farmer's awareness and adoptability of technologies regarding land, cropping systems, weed, and irrigation management systems is low. These results indicates that there need interventions in better cropping systems, weed and irrigation management systems for higher productivity and profitability.

Effect of organic manures, growth promoters and nutrient solubilizers on summer groundnut

Resource-Use-Management Behaviour of farmers of Dharwad, Tumkuru and Chitradurga district of Karnataka

Indicators of RUM Behaviour	Dharwad(50)			Tumkuru (50)			Chitradurga (50)		
	Low (%)	Med. (%)	High (%)	Low (%)	Med. (%)	High (%)	Low (%)	Med. (%)	High (%)
Land management	22	52	26	54	25	21	63	29	8
Cropping systems management	36	19	45	67	23	10	72	23	5
Seeds management	25	44	31	56	34	10	43	20	37
Soil-moisture management	32	45	23	66	25	9	26	53	21
Nutrients management	16	27	57	28	38	34	60	25	15
Weeds management	23	52	25	46	34	20	69	21	10
Insects pests management	45	36	19	74	15	11	54	30	16
Diseases management	52	24	24	67	29	4	41	32	27
Irrigation management	15	38	47	42	30	28	63	28	9

RUM Indicators Contributing to Groundnut Productivity in Karnataka

Indicators	Unstandardized coefficients			
	Groundnut productivity-Dharwad district		Groundnut productivity-Chitradurga district	
	Beta value	SE	Beta value	SE
Constant	-0.75	1021. 64	-81.65	55.8
Land management	10.19 NS	39.92	78.27**	0.83
Cropping systems Management	09.52 NS	33.91	6.91**	1.97
Seeds Management	11.34 NS	5.63	1.72NS	0.84
Soil-moisture management	12.93*	44.35	14.73*	3.30
Nutrients Management	62.70**	5.13	4.10**	3.32
Weeds management	8.21 **	51.45	5.14 *	6.72
Insect pests management	94.23**	15.97	0.15NS	2.97
Diseases management	12.09 NS	23.45	1.78**	1.50
Irrigation management	110.40**	21.33	11.07**	6.17

SE= Standard error

Visit of farmers

This year (2016-17), altogether 1485 visitors from various states viz. Gujarat, Madhya Pradesh, Karnataka, Odisha, New Delhi, Maharashtra, and Rajasthan visited this Directorate. It includes a total of 698 farmers from 7 different states, 763 students from four universities and 24 staff belonging to different agriculture universities and state departments. 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 unreached

Groundnut is an important oilseed crop in tribal areas not only to enrich the soil but also the life of tribal farmers in terms of income and nutritional security. Tribal mostly cultivate poor yielding groundnut varieties along with minor cereals and redgram as intercrops under rainfed conditions. Among them, groundnut cultivation as sub-system in their primitive farming is a non-profitable one with their poor knowledge on improved adoption practices and less efficient resource use management behaviour is common situation. 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. Generally the seed given to these farmers will be brought back and distributed to other beneficiaries in the next season.

Thus this process will be continued till having to establish groundnut as suitable livelihood crop among tribal farmers. There by economic growth of area will be improved. At the time of implementation, the specific objectives kept were:

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

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

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

IV. Developing community seed banks among tribal farmers.

V. Dissemination the farm mechanization technology there by reducing the labor cost.

Total budget used was Rs.189 lakhs and covered with 1250 tribal farm families.

Input distribution and training to tribal farmers at KVK Vyara, Gujarat

Mr.EreSaring, TSP beneficiary of Balek village, Arunachal Pradesh, who was trained at ICAR-DGR

6 Research Highlights of All India Coordinated Research Project on Groundnut

Crop Improvement

Germplasm enhancement

A Consortium Research Platform (CRP) on Agro-biodiversity has been approved by ICAR, for implementation in the XII Plan. CRP on Agro biodiversity is a national project on germplasm characterization and evaluation. The major objective of this project is that the germplasm conserved at NBPGR could be effectively linked with enhanced use of germplasm in the crop improvement programme in NARS. There are two components envisaged in this project viz., Component I (characterization, regeneration and documentation) and Component II (detailed evaluation). Of which ICAR-DGR is one of the partners identified for Component I. The project has been implemented through two AICRP-G centres: 1. ANGRAU, Kadiri and 2. TNAU, Vridhachalam despite AICRP-G.A total of 3002 accessions have been multiplied and characterized at two centres during kharif 2016.

A total of six thousand one hundred and forty-two germplasm accessions have been multiplied and maintained at 11 centres during kharif 2016. This included 60 wild accessions; 299 interspecific derivatives; exotic collection; 2076 Spanish bunch accessions; 26 Valencia accessions; 644 Virginia Bunch accessions; 271 Virginia Runner accessions; 2000 base collection accessions; and 1407 other germplasm accessions.

At Dharwad six high oleic lines (>65%) viz. Higholeic-112, Higholeic-132, Higholeic-153, Higholeic-161, Higholeic-162, and Higholeic-163 have been identified.

Interspecific hybridisation

At Vridhachalam centre, nine interspecific crosses made during rabi-summer 2015-16 between three cultivated groundnut varieties and three wild Arachisspecies viz. Arachis paraguariensis (resistant to early leaf spot and Spodoptera litura), Arachis benensis and Arachis diogoi(both resistant to late leaf spot) were made. Out of nine crosses, in two crosses the pod setting (%) was less than 10%; while in five other crosses the pod setting varied between 20% to 30.1%; and in two other crosses pod setting varied between 16.4% and 17.6%.

Sixteen fresh crosses were effected during kharif 2016, involving four foliar and fungal diseases susceptible groundnut varieties as ovule parents (VRI 2, TMV 12, JL 24 and K 6) and resistant amphidiploids and tetraploids as male parents.
The diploid wild species viz., Arachisdiogoi and Arachis benensis are potential sources of novel genes for the genetic improvement of cultivated groundnut owing to their higher level of resistance to late leaf spot and rust. The seeds obtained from the five crosses made (involving three cultivated types and two wild species, Arachis diogoi and Arachis benensis)during previous rabi-summer 2015-16 season were evaluated.
Five stable pre breeding lines viz., VG 0411, VG 0437, VG 0501, VG 0410 and VG 941 were found promising over the best check VRI Gn 6 at AVT stage of the centre.
Five stable pre-breeding lines viz., VG 0411, VG 0437, VG 0501, VG 0410 and VG 941 were found promising over the best check VRI Gn 6 at AVT stage of the centre.

Intra and Inter varietal crosses and elections

A total of 306 crosses Intra and Inter varietal crosses have been made during kharif and rabi-summer. 1392 crosses advanced to different filial generations; 25978 selections both single plants and progeny bulks were selected most which are early generation selections and the rest are in advanced generations

Varietal Evaluation

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.

Rabi-summer Initial Varietal Trial Stage I trials were allotted to 22 centers located in five agro-ecological zones of groundnut. Except for three centres (Modipuram, Bhubaneswar and Badachana) all the centres have reported the data; and kharif trials were allotted to 29 centresall of them have conducted and reported the trial data except for Bikaner centre. There were 13 entries (SB) in rabi-summer; and 21 entries, 13 of Spanish Bunch and eight Virginia types and seven large seeded were evaluated. Promotion to AVT or rejection of these entries will be decided after completion of second year trials in these centres. During rabi-summer 2015-16, Initial Varietal Trial Stage I and II (Pooled), was allotted to all the 24 centres of the five zones namely, Zone I, Zone II, Zone IIIa, Zone IIIb and Zone IV with 13 genotypes. None were found significantly superior over the respective best checks of the zones.

Four entries (ICGV 03042, ICGV 060424, ICGV 07222, ICGV 07240) were evaluated at AVT in zone IIIb in rabi-summer 2015-16; The mean yields of the other entry, ICGV 07240 over different stages of evaluation were 2789 kg and 1819 kg/ha which is 7 q higher over the check varieties over different stages of evaluation. Three test entries, ICGV 06424, ICGV 07222 and ICGV 07240 out-yielded the best check variety, ICGV 00350 (a variety released just in 2012) and over R 8808 (ZC) over different stages of evaluation with high levels of pod and kernel yields besides high oil content (>50%) proposed for identification.
In kharif 2016, out of 13 SB entries the genotype, JL 1085 which recorded 10% higher kernel yield over the best check is promoted to AVT. Out of the two test entries evaluated at AVT (SB) in kharif 2016, the genotype, TCGS 1157 exhibited yield superiority over different stages of testing with high levels of pod and kernel yields and possessed more than 20% higher kernel yields over the best check varieties of the zone proposed for identification.

Special Trial on Evaluation of Near Isogenic Lines

Twelve NILs developed through MABC approach for rust resistance and tolerance to LLS was evaluated at AVT-I at eight target locations. The rust disease pressure was sub-optimum for rust across the locations while for LLS the disease pressure was very high at Dharwad. Based on the yield superiority of NILs over their recurrent parents and rust disease score two NILs of ICGV 91114, namely ICGV 14421 (2230 kg of pod and 1599 kg of kernel per ha) and ICGV 13189 (2063 kg of pod and 1505 kg of kernel per ha); one of TAG 24 viz. ICGV 13207 (1990 kg of pod and 1467 kg of kernel per ha) were promoted to AVT-II.

Breeder Seed Production

For the year 2015-16, DAC indent for 7128.80q of groundnut breeder seeds was received for 40 varieties to be produced during kharif 2015. Based on the availability of nucleus/breeder seed of different varieties, a production target of 6925.80q was allocated for 38 groundnut varieties to 19 breeder seed producing centres/agencies. Against this allocation, however, a total of 2808.13q breeder seed could be produced during kharif 2015. To mitigate the shortfall, a compensatory programme was chalked out for rabi-summer 2015-16, through which a production of 7015.00q has been realised. Thus, an overall quantity of 9823.13q groundnut breeder seed has been produced during the year 2015-16.

During kharif 2016, DAC indents to the tune of 11376.23q of breeder seeds were received for 43 groundnut varieties. Based on the availability of nucleus/breeder seed stage I, a production target of 11318.23q was assigned for 42 groundnut varieties to 19 centres. During kharif 2016, a total quantity of 2929.63q breeder seed could be produced. To mitigate the short fall, a compensatory programme was undertaken during rabi-summer 2016-17 and the anticipated production is 11023.00q. Thus, the total production of groundnut breeder seeds during 2016-17 would be 13952.63 q.

Crop Protection

Altogether 21 trials, eleven during rabi-summer 2015-16, ten during kharif 2016 from pathology and entomology were conducted. The highlights of the research from trials are presented:

PATHOLOGY (RABI/ SUMMER)

Monitoring of major diseases of groundnut

Monitoring of major diseases at farmers' field and research stations was reported for summer 2015-16. The late leaf spot (1-9 scale) was reported from Vridhachalam. Early leaf spot (1-5 scale) at Aliyarnagar, Bhubaneswar and Dharwad. Rust (1-8 scale) from Dharwad. Alternaria leaf blight from Junagadh (2-5 scale). Collar rot (4.0-10.2%) at Vridhachalam and Bhubaneswar (3.0-7.4%). Root rot from Vridhachalam (2.6-7.5%). Dharwad and Kadiri reported stem rot with incidence of 16.5% and 6-14%, respectively. Dry rot was reported from Kadiri (12-20%). Pavagada recorded incidence of PBND (>18%). At Research Stations, Vridhachalam reported incidence of collar rot (13.6%), stem rot (5.8-12%), and severity of late leaf spot (4-9 scale). Kadiri reported incidence of dry root rot (18%) and PBND (6-13%).

Screening of IVT-I & AVT and other materials for resistance / tolerance to major diseases

Among genotypes screened,INS-I-2015-22 was reported to be resistant for Rust and Late Leaf Spot at Aliyarnagar and Bhubaneswar; for collar rot at Junagadh, Kadiri and Jalgaon; and for dry root rot at Kadiri. INS-I-2015-6 for resistance to Rust and Late Leaf Spot from Aliyarnagar and Bhubaneswar; for collar rot at Junagadh and Jalgaon. INS-I-2015-5 being resistant to collar rot at Bhubaneshwar, Dharwad, Jalgaon and Junagadh. INS I-2015-19 reported resistance for collar rot at Jalgaon and Junagadh.

Management of major foliar diseases

Treatment T4 was reported to be best amongst all the treatments with lowest incidence of foliar diseases and supporting high pod and haulm yield at Junagadh, Pavagada, Tirupati and Vridhachalam. Early leaf spot (7 PDI) was observed at Pavagada. Late leaf spot (2-31.11 PDI) at Tirupati, Pavagada and Vridhachalam. Rust (2-25.89 PDI) at Tirupati, Pavagada and Vridhachalam. Alternaria blight (1 PDI) at Pavagada and at Junagadh (24.06 PDI). Pod yield ranged from 1852 to 2298 kg/ha and haulm yield from 1117 to 4047kg/ha with ICBR ranging from 2.69-3.50.

Management of PBND through integration of different modules

The damage of thrips and PBND was reported to be lowest, supporting higher pod and haulm yield by adopting module II at Kadiri and Pavagada. At Kadiri, thrips damage was 33.2% and PBND was 4.7% supporting better pod (937 kg/ha) and haulm (1186 kg/ha) yield. At Pavagada, thrips damage was 24% and PBND of 7% supporting pod and haulm yield of 1156 kg/ha and 3120 kg/ha, respectively.

ENTOMOLOGY: RABI-SUMMER

Report on the insect – pests' situation

Incidence of sucking pests like thrips and leafhoppers was seen in all the centers. Whitefly incidence was noticed only in Junagadh and Vridhachalam, centers. Defoliators incidence was very negligible during rabi-summer, however Marucavitrata incidence was recorded from Vridhachalam.

Recording incidence of natural enemies

Natural enemies like Coccinellids, syrphids and Chrysoperla were recorded. General predators like spiders' incidence was also observed in AICRPG centers.

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

Spodoptera incidence started from 4th STD week. Whereas Helicoverpa incidence was noticed during 7th STD week Leafminer incidence is only reported from Jagtial. Sucking pest incidence was observed throughout the season.

Screening for resistance to insect pests

In Dharwad INS-I- 2014-2, INS-I- 2014-5, INS-I-2014- 7 and INS-I- 2014-20, AIS-2014-1, AIS-2014- 3, AIS-2015- 6 and AIS-2015- 9 were found promising by recording lowest damage by thrips. ICGV-07217 was found promising against leaf hopper, thrips and Spodoptera by recording lower damage score.

In Junagadh INS-I- 2015-1, INS-I- 2015-3, INS-I-2015- 6, INS-I- 2015-8, INS-I- 2015-2, AIS-I- 2015-9, INS-I- 2015-11, INS-I-2015-19 INS-I- 2014-7, INS-I- 2014-26, INS-I- 2014-6 and INS-I-2014- 29 these were the promising lines found for thrips. In Kadri INS 14- 8,9,10,13,14,19,22 and AIS-14- 2,6,9 showed resistance reaction against jassid leaf damage 12 genotypes INS-14- 4,10,17,23,26,27,28,30 and AIS-14- 1,2,5 were having resistance reaction against jassid.

PATHOLOGY (Kharif)

Monitoring of major diseases of groundnut

Monitoring of major diseases at farmers' field and research stations was reported for kharif 2016. At farmers' field, early leaf spot was reported from Pavagada (0-7) and Vizianagaram (0-5). Late leaf spot at Dharwad and Pavagada (0-9), and Raichur (0-8). Rust was observed at Dharwad (2-7), Vridhachalam (3-5) and Raichur (0-4). Collar rot at Bikaner (3-20%), Vridhachalam (5.2-14.3%), Pavagada (1-13%), Bhubaneswar (3-9.2%), Jalgaon (4-8%), and Raichur (0-7%). Dry root rot at Raichur (2-30%), Vridhachalam (5.2-14.3%), Aliyarnagar (0-14.2%) and Kadiri (12.20%). Stem rot from Raichur (7-30%), Dharwad (5-20%), Aliyarnagar (0-14.9%), and Vridhachalam (2.6-7.5%). PSNV at Kadiri (2-8%). At Research stations, early leaf spot was reported from Vizianagaram (2-6) and Pavagada (0-5). Late leaf spot from Dharwad and Pavagada (0-9), and Raichur (0-8). Rust at Raichur (0-4), Vridhachalam (3-5) and Dharwad (2-7). Collar rot from Bhubaneswar (3.6%), Jalgaon (8%), Bikaner (10-12%), Raichur (4.1-10%), Pavagada (13%) and Vridhachalam (22.4%). Dry root rot from Aliyarnagar (0-3%), Vridhachalam (12.7%) and Raichur (7-30%). Stem rot from Dharwad (8-20%), Aliyarnagar (17.4-20.1%), Vridhachalam (10.3-24.8%) and Raichur (7-30%). PSNV was observed at Kadiri (3-4%).

Screening of IVT-I & II, AVT and other materials for resistance/ tolerance to major diseases

Among genotypes screened,ISK-2016-10 was reported to be resistant to LLS and Rust at Aliyarnagar, Dharwad and Latur, collar rot at Tirupati.

Development of technologies for management of soil borne diseases

Treatment T4 was reported to be best at Aliyarnagar, Bikaner, Jalgaon, Junagadh, Kadiri, Tirupati and Vridhachalam with minimum incidence of soil borne diseases, supporting high pod and haulm yield. Collar rot from 1.06 to 7.57% at Junagadh, Kadiri, Jalgaon, Tirupati, Bikaner and Vridhachalam. Stem rot from 1.9 to 8.28% at Aliyarnagar, Junagadh, Kadiri, Tirupati, Jalgaon, Bikaner and Vridhachalam. Dry root rot ranged from 1.1 to 5.87% at Aliyarnagar, Tirupati and Vridhachalam. Pod yield ranged from 792 to 3040 kg/ha and haulm yield from 1590 to 5421 kg/ha across the reporting centres.

Management of major foliar diseases

Treatment T4 was reported to be best at Dharwad, Raichur, Pavagada and Vridhachalam with minimum incidences of foliar diseases, supporting higher pod and haulm yield. Early leaf spot ranged from 6.84 to 15 PDI at Dharwad, Raichur and Pavagada. Late leaf spot from 20.30-34.58 PDI at Dharwad, Raihcur, Pavagada and Kadiri. Rust from 1.0-30.83 PDI at Pavagada, Dharwad, Raichur and Vridhachalam. Alternaria blight from 6.22-27.50 PDI at Raichur and Vridhachalam. Pod yield from 2344-4223 kg/ha, Haulm yield from (2870-5028 kg/ha) across the centres.

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

The damage of diseases and pest was reported to be lowest supporting higher pod and haulm yield by adopting module II. Early leaf spot rangedfrom 0.83-24 PDI at Junagadh, Raichur and Pavagada. Late leaf spot from 20.85-37.19 PDI at Raichur, Pavagada, Jalgaon, Jalgaon and Vridhachalam. Rust from 2-30.65 PDI at Pavagada, Raichur, Jalgaon and Vridhachalam. Collar rot from 1.04-9.20% at Pavagada and Vridhachalam. Stem rot (10.73%) and Dry root rot (4.60%) from Raichur. Thrips at Pavagada (11.5%) and Vridhachalam (15.2%). Spodopteraspp. (20.48%) at Junagadh. Pod yield ranged from 720-3875 kg/ha and haulm yield from 1440-5911 kg/ha.

ENTOMOLOGY- Kharif

Report on the insect- pests' situation
The incidence defoliators like Spodoptera, Helicoverpa and leaf miner was observed in all the AICRPG centers, however Bud borer incidence was noticed in RRS and TANCOF farm fields alone from as reported by Vridhachalam. Kadri reported out breaks of grey weevil (11.43%), bud borer (18.39%) and Maruca(25.66%) were noticed in groundnut during kharif, 2016 both at ARS Farm, Kadiri and in farmer fields. Jalgaon has reported the incidence of semilooper and hairy caterpillar. Tirupati reported bud borer Anarsiaephippias as one of the emerging pests in the region which was observed during flowering phase. Recording incidence of natural enemies
Natural enemies like coccinellids at Dharwad, Jagtial, Kadiri, Latur, Vridhachalam; syrphid fly at Jagtial; spider at Jagtial, Kadiri, Latur and Vridhachalam; Chrysoperla at Dharwad, Jagtial, Kadiri and Latur; Campoletischloridae at Dharwad and Kadiri, Apantales sp. at Dharwad and Kadiri; Muscardine at Kadiri, was recorded.

Monitoring of Spodoptera, Helicoverpa, leaf miner and sucking pests' of groundnut

The incidence of Spodoptera started to appear from 23rd std week and its peek incidence was notice around 34th and 35thStd week at most of the centers. Helecoverpa incidence was noticed in Jalgoan, Kadri, Lathur which started at 28thStd week. Leaf miner incidence was noticed in Kadri and Tirupati started at 30th std week. Root grub incidence was also recorded from Tirupathi and Kadri.

Screening for resistance to insect pests

Groundnut entries like ISK-2016-9,13,14,31,37,39,40 showed minimum damage of thripsat Jagtial and Vridhachalam. IVK-I-2016-6 showed less incidence of Spodoptera at Jagtial and Kadiri. ASK-I-2016- 2, had resistance to leaf hopper at Kadiri and Jagtial. ISK-I-2015-23,26 showed minimum damage of leafhopper, leaf miner and Spodoptera spp. at Kadiri. Most of the entries showed < 10% incidence of sucking pests and defoliators at most of the centres.

Management of root-feeders in groundnut

Treatment clothianidin 50 WDG @ 2 g kg -1 seed and imidacloprid 600 FS @ 1.2 g a.i kg -1 seed was found effective in managing white grub.

Management of groundnut defoliator pests using botanicals

In most of the centers Poneem @ 3.0 ml L -1 was found effective among botanicals.

Crop Production

RABI-SUMMER 2015-16

Response of summer groundnut to fertilizer doses and plant population under check basin methods

The experiment was conducted at eight centers. Only Akola, Jagtial, Jalgaon, Junagadh, and Vriddhachalam centres have studied effect of irrigation methods, out of which Akola, Jagtial, Jalgaon, Junagadh reported significantly higher pod yield under drip irrigation as compared to check basin method of irrigation while at Vriddhachalam no significant effect of irrigation methods was found on groundnut pod yield. The significantly highest pod yield was reported with 5.0 lakh/ha plant population at Akola, Jalgaon, Junagadh and Shirgaon; 4.0 lakh/ha plant population at Bhubaneswar, Jagtial and Rahuri and 3.33 lakh/ha plant population at Vriddhachalam. Except Junagadh and Rahuri, where no significant effect of fertilizer doses was recorded, all other centres have reported significantly higher pod yield with application of 125% RDF.

Effect of mulching, hydrogel and nutrient management on productivity of summer groundnut

The experiment was conducted at six centers. Except Mohanpur and Rahuri, all other centers have reported significantly higher pod yield with mulch over no mulch. Bhubaneswar reported significantly higher pod yield with application of hydrogel @ 2.5 kg/ha, Jalgaon and Shirgaon with hydrogel @ 5.0kg/ha while Mohanpur, Rahuri and Vriddhachalam reported no significant effect of hydogel application on pod yield. The significantly highest pod yield was found with integrated nutrient management as compared to inorganic or organic management at Bhubaneswar, Jalgaon, Shirgaon and Vriddhachalam while no significant differences were reported at Mohanpur and Rahuri.

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

The experiment was conducted at eleven centres. The significantly higher pod yield was reported with FP 86 at Bhubaneswar, DAPG 2 at Dharwad, Kadiri, Shirgaon, and Tirupari; FP 98 at Jagtial, Jalgaon and Mohanpur; DAPG 4 at Tindivanam and Vriddhachalam; while no significant effect was found at Junagadh.

Standardization of levels and time of application of potassium in summer groundnut under drip irrigation

This experiment was conducted at Rahuri center. Significantly higher pod yield was found with application of 30 kg K2O per ha. and fertigation of potash uniformly in equal splits at weekly interval up to 60 DAS (8 Splits).

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

The experiment was conducted at eleven centers. The significantly higher groundnut productivity was observed with application of FYM@5t/ha + 100% P + DGRC-1/ DGRC-2 at all the centers except Jalgaon where application of FYM@5t/ha+ DGRC-2/DGRC-1 were found significantly superior over other treatments. However, application of FYM@5t/ha + 50% P + DGRC-1/ DGRC-2 was reported at par effect by most of the centers.

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

The experiment was allotted to Mohanpur center for rabi/summer 2015-16 but could not be conducted.

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

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

Agronomic management of AVT

The advanced genetic material was tested with local check at Vriddhachalam. The pod yield was not significant between the entry ICGV-06424 and VRI 8 whereas differs significantly with VRI 2 for pod yield, matured pods/plant and DMP (at 30DAS). The highest pod yield was achieved in 30cm x 10cm by virtue of higher plant population. Different levels of fertilizers did not show any significant variation for yield parameters and yield.

Standardization of periodicity and rates of sulphur and boron fertilization in prevalent groundnut based cropping system

The experimental results were reported by Bhubneswar, Jagtial, Tindivanam, Tirupati and Vriddhachalam for rabi-summer 2015-16. Application of 100% recommended dose of these nutrients every year in both the crops resulted in higher yield of main crop, subsequent crop and groundnut equivalent yield in different cropping systems at different locations except Tirupati where no significant difference was observed among periodicity of fertilization.

Kharif 2016

Survey of agronomic management practices in the farmers' fields

The survey was reported by nine centers covering about 500 farmers growing groundnut in different AICRPG zones of India during rabi-summer 2015-16 and kharif 2016. The surveys indicated that generally the adoption of improved production technologies is fair to good but some of the activities like field preparation, manual weeding, intercultural operations, inorganic management etc. having high degree of adoption throughout the India. Some of the centers like Junagadh, Kadiri, Vridhachalam reported a high degree of adoption for use of improve varieties, mechanical seeding, plant protection measures using chemicals and use of inorganic complex fertilizers etc. whereas Bikaner, Dharwad and Raigrah has low adoption for improved varieties and availability of quality seeds.Other than these centers the adoption of improved varieties has reported fair to good degree of adoption by farmers.Bikaner center reported an exhaustive use of groundwater using 100% sprinkler irrigation. Similarly, seed rate, plant spacing and population were also reported in fair to good degree of adoption by majority of the centers.

There was also fairly good adoption of improved package of practices viz.,

fertilizer application, integrated weed management, manure use, irrigation management etc. The agronomic management practices having poor adoption and required to be taken care are like use of bio-fertilizer, seed treatment using bio-agents, insecticides and pesticides, use of micronutrients and plant protection measures, use of soil amendments, use of organics, availability and use of quality seed etc.
Some of the common constraints need to be addressed:

1. Dependency of groundnut production system on monsoon.
2. Low seed multiplication and high seed cost slow down spread of improved cultivars.
3. Timely non-availability of good quality improved groundnut varieties seed at local market.
4. Miser use of seed treatment for soil borne disease and plant protection measures.
5. Non-optimal plant population in the field due to improper seed rate, seed quality or spacing.
6. Poor use of organics and soil amendments due to less availability in the market.
7. The high cost of cultivation, low price, labour intensive and poor availability of labourers.
8. Unawareness and lack of viable bio-agents both for nutrition as well as for bio-control of pests and diseases.
9. Yellowing of groundnut foliage is the common problem.
10. Competition from crops like pulses, hybrid Bt-cotton, hybrid maize and soybean etc.

Nutrient management in prevalent groundnut-based cropping system(s)

The experiment was conducted by Jagtial. The results also reported by Dharwad centre as it was not completed last year due to awaited results for wheat crop. At Dharwad, application of FYM @ 7.5 t ha-1 along with 100 % RDNPK (25 kg N, 75 kg P2O5 and 25 kg K2O ha-1) to groundnut during kharif + nofertilizers to rain fed rabi wheat produced on par yield with rest of the nutrient management practices in groundnut–wheat sequence cropping system. At Jagtial centre, application of 100% N + 125% PK gave significantly superior GPEY, net return and BCR. Non-significant difference was observed among the sub plots fertilizer regimes for rabi crop for all these parameters. The experiment was not conducted by Bikaner centre.

Effect of paclobutrazol on growth and productivity on rain fed groundnut

The experiment was conducted by three centers. Application of paclobutrazol with 100ppm concentration at 30DAE and 50DAE was found significantly superior at Bhubaneswar and Shirgaon, respectively. However, no effect for application of paclobutrazol on plant growth, yield and yield attributes were observed at Vridhachalam. The experiment was not conducted by Pudducherry centre.

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

The study was undertaken by fourteen centers. The inoculants FP 86 was found superior at Bhubaneswar, Kadiri, Mohanpur and Durgapura; FP 98 at Shirgaon, DAPG 4 at Jalgaon, Junagadh, Tindivanam and Tirupati; DAPG 1 at Raigrah. A non-significant effect was observed at Bikaner, Dharwad, and Vridhachalam. The result from Jagtial was not included due to inappropriate observations and reporting.

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

The study was undertaken by four centers. Application of pendimethalin @ 1.5 kgai/ha (PE) + imazethpyr (60%) + quizalofop ethyl (40%) was found most effective in terms of weed control and yield of groundnut at Kadiri. Application of pendimethalin @ 1.5 kg a.i/ha (PE) + tank mix imazethpyr (50%) + quizalopfop ethyl 50 (50%) at 20-30 DAS was found most effective at Tindivanam and Vridhachalam. However, application of pendimethalin @ 1.5 kg a.i/ha (PE) + one hand weeding at 25 DAS (T3) was found superior and at par in terms of growth and yield, economics, WCE in groundnut at Vridhachalam. At Tirupati, after weed free check application of pendimethalin as pre-emergence + imazethapyr @ 75 g a.i/ha as post-emergence at 45 DAS and 65 DAS was found the most effective and significant treatment in terms of yield, WCE, WI and economics. The experiment was not conducted by Pudducherry centre.

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

The study was undertaken by fourteen centers. Application of 5t FYM/ha + 100% P + DGRC 1/ DGRC 2 fertilization produced significantly higher groundnut yield and getting maximum economic return from kharif groundnut at all the centers except Bikaner and Durgapura where, non-significant results was observed at Bikaner and application of 5t FYM + 50% P + DGRC 1 was found significantly superior at Durgapura. However, application of 5t FYM + 50% P + DGRC 1/ 2 was found equally effective (at par) at Akola, Bhubaneswar, Dharwad, Junagadh, Kadiri. Overall the highest phosphorus use efficiency was observed by application of 5t FYM + 50% P + DGRC 1/ DGRC 2. The effect of bio-inoculants (i.e., DGRC 1 and DGRC 2) on growth, yield and economics was found at par at most of the locations tested.

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

The experiment was conducted by Dharwad centre using ten treatment combinations including groundnut, little millet, foxtail millet and finger millet as sole and intercrop using 2:1 and 4:2 row ratio of groundnut + millets. Groundnut + little millet (4:2), groundnut + foxtail millet (4:2) and groundnut + finger millet (4:2) recorded significantly higher groundnut pod equivalent yield, land equivalent ratio (1.29), net monetary returns (Rs. 97787) and benefit: cost ratio (2.26).

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

The experiment was conducted by three centers. The 4.0 lakh/ha plant population and 125% RDF was found significantly superior for plant growth, yield and economics at Bawal and Gwalior centers. However, use of 3.33 lakh plant geometry and 100% RDF was found best at Raigrah and at par to 4.00 lakh plant geometry. The experiment was not conducted by Ludhiana centre.

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

The experiment was conducted by five centers. The results reported by Akola and Durgapura for which yields are very high and did not represent true moisture stress conditions. Hence could not be considered for pooled results. Further the results were found non-significant at Durgapura and significantly higher with application of any DGREB with normal intercultural operations at Akola. Application of DGREB 2 with recommended intercultural operations was found superior over rest treatments at Kadiri but economics of the treatment was reported. At Hiryur, application of any DGREB with normal intercultural operations was found superior in terms of yield and economic of groundnut under moisture stress. The application of endophytic bacteria DGREB 1 with recommended intercultural operations was found best at Tirupati but there was net loss by using these endophytic bacteria in all the treatments. Overall the experiment needs the critical evaluation for imposing the moisture stress and related observations as well as observations on growth, yield and economics.

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

The experiment was conducted by Bikaner centre. It was observed that shallow sowing depth gave better yield with maximum growth and yield at 5cm soil depth which was at par with 7 and 9 cm and significantly superior over 11cm. Observations like seed germination, initial and final plant stand, seedling mortality due to high temperature, pests and diseases incidence and mortality etc. which was not taken care needs to be critically assessed.

Optimization of seed rate for groundnut cultivars having differential seed sizes during kharifseason

The experiment was conducted by five centers. Groundnut cultivar Devi (HKW, 52g) performed better at 30cm x 10cm spacing at Bhubaneswar. Cultivar RG 510 (HKW 50g) performed better at 30cm x 10cm spacing at Durgapura. The higher seed weight size cultivars performed better at higher plant spacing. At Jalgaon, groundnut cultivar JL 776 (HKW 50-60g) was found better at 30 cm x 10cm spacing. At Junagadh, cultivar (GJG 22) having 51g HKW recorded significantly higher pod yield when sowing was done at spacing of 45 cm x 10cm (seed rate 115 kg/ha). Similarly, cultivar (KDG 128) having 43g HKW recorded significantly higher pod yield at 45cm x 10cm (seed rate 95 kg/ha). The economics of the treatments revealed that spacing 45 cm x 10cm (seed rate 95 kg/ha) with cultivar KDG 128 and GJG 22 recorded higher net return.

Assessment of compatibility of post-emergence herbicides with insecticides in kharif groundnut (As pilot study for one year)

The experiment was conducted at Tirupati. No phyto-toxicity was observed but the separate application of post-emergence herbicides and insecticides were observed superior in terms of groundnut yield. Although highest economics was observed with tank mix application of imazethapyr 10% S.L. @ 75 g a.i./ha and monocrotophos 36% S.L. @ 800ml/ha at 5-20 DAS. The experiment needs to be critically evaluated for phyto-toxicity and bio-efficacy by plant protection group before further agronomical evaluations.

Agronomic management of AVT

The experiment using three cultivars (i.e., Phule Bharti, AK335 and TCGS 1157) were tested at three sowing dates, two plant spacing and three fertilizer levels at Jalgaon. The cultivar AK-355 performed better at early sowing as compared to normal and late sown conditions. Among cultivars, AK-335 performed better than others. Highest yield and economics was observed at 30cm x 10cm spacing. Higher yield and net return was observed at 125% RDF. Interaction was found non-significant.

Recommendations/ concluded

Total five recommendations were emerged out after three-year experimentation for ten different locations including Akola, Bhubaneswar, Dharwad, Durgapura, Jalgaon, Junagadh, Kadiri, Rahuri, Shirgaon and Vridachalam centers. Out of this two recommendations were made for rabi-summer and three for kharif seasons.

AICRP-G FLD

Kharif 2016

- During Kharif 2016, a total of 350 FLDs were allotted (all whole package component) and report received for 335 FLDs, thereby achieving 89 % implementation. There were 23 new varieties promoted as against 18 old ruling varieties in different groundnut growing regions of the country.
- The average pod yield achieved was 2132 kg/ha under improved whole package of practices (WP) whereas the average yield was 1706 kg/ha with farmers' practices. Thus, the yield increase with WP was 23.6 %.
- The average cost of cultivation and gross returns with Whole Package (WP) was Rs.39241/ha and Rs.95941/ha respectively whereas, with farmers practice it was Rs.36884 /ha and Rs. 75278/ha, respectively. The GMR increased by 26.6 % with WP.

Rabi-summer 2015-16

- During Rabi Summer 2015-16 a total of 300 FLDs were allotted (all Whole Package component) and report received for 183 FLDs, thereby achieving 61 % implementation. There were 16 new varieties put against 10 old ruling varieties which are cultivated with farmer's traditional cultivation practices.
- The pod yield achieved was 2522 kg/ha under improved Whole Package of practices (WP) component whereas 1913 kg/ha with farmers traditional practices. The yield increase observed was 31.3 %.
- The average Cost of Cultivation and Gross Marginal Returns with Whole Package (WP) was Rs.44963/ha and Rs.103696/ha respectively whereas, in farmers practice it was Rs.42592 /ha and Rs. 82693/ha respectively. The GMR increased by 33.58 %.

7 Externally Aided Projects

Relationship between Sclerotium rolfsii, Rhizoctonia solani, the soil and climatic variables in three major cropping system in the country and identification of markers for resistance to Sclerotium rolfsii (PI: Rathnakumar AL, CO-PI:

Thirumalaisamy PP, Kumar N)
Duration: 01.04.2013-31.03.2017
Total Funds: □ 275.95 Lakhs

Objectives:

- Study the nature of interaction of pathogen with crops, soil, temperature, and moisture
- in disease development
- Identification of QTLs governing genetic resistance of S. rolfsiiin groundnut

Summary of the results during 2016-17:

- For phenotyping of RILs (TG 37A x NRCG CS85); 350 RILs (F6 generation) in three replications were screened for stem rot disease incidence kharif 2016 after 70 days of sowing. Disease incidence (% wilting) was recorded along with various morphological traits (stem thickness, plant height, spread, number of nodes, number of primary branches, number of secondary branches, hairiness, growth pattern, leaf color, leaf shape, leaf length, leaf width, stem pigmentation, branching pattern, number of total pods, number of immature pods, number of mature pods, number of seeds, pod length, pod width, pod beak, pod constriction, pod reticulation, seed color, seed length, seed width, and shelling%). SNP based genotyping was attempted (chips with 14000 SNPs) at ICRISAT and the analysis is in progress.
- RNA-Seq was performed in stem rot resistant (NRCG CS85) and susceptible (TG 37A) genotypes under disease pressure on illumina NGS platform. A total of 290834434 (~14.5 Gbs) raw pair ended reads were generated in four samples multiplex. Raw reads were subjected to preprocessing to obtain high quality reads. A total of 39308834 (~13.5%) reads were discarded and 19998571688 (~86.5%) were used for reference based pair-wise alignment using Tophat program. The high quality raw reads were mapped to the two reference genomes of A. duranensis and A. ipeansis available publically (www.peanutbase.org). On an average 78.9% and 78.6% reads were mapped to the A. duranensis and A. ipeansis genome respectively. Differential expression analysis was also performed using cuffdiff program and 1391 and 100 up/down regulated genes were identified by comparing resistant inoculated/control and susceptible inoculated/control samples respectively, while 1188 and 1006 up/down regulated genes were identified by comparing resistant inoculated/susceptible inoculated samples and resistant control/susceptible control samples respectively. A total of 390 and 242 significantly up and down respectively regulated genes were identified exclusively in resistant inoculated/control, while 10 and 21 significantly up and down regulated genes were identified exclusively in susceptible inoculated/control.
- A GBS approach was used for SNP calling between the parents and genotyping the RILs as described by Elshire et al. (2011). GBS libraries from the parental lines and RILs were prepared using ApeKI endonuclease (recognition site: G/CWCG) and sequenced using the Illumina HiSeq 2000 platform (Illumina Inc, San Diego, CA, USA). A total of 34.37 Gb (340.30 million reads) data was generated, out of which samples having less than 80 Mb data were discarded from further analysis in order to reduce missing data error. Further, filtered sequencing reads will be analyzed for SNP identification using TASSEL-GBS pipeline followed by genetic map construction and QTL analysis.

Mapping of stem rot resistance gene (s) in groundnut and its transfer to an elite Groundnut cultivars

(PI: BeraSK, CO-PI: Ajay BC)
Funding agency: DBT, New Delhi
Duration: 01.04.2013-31.03.2018
Total Funds: □ 52.70 Lakhs

Objectives:

- Polymorphism survey of TMV2, Arachisdiogoi, CS19 and GG20 with RAPDs and SSRs
- Development of F3 mapping populations of cross between genotypes GG 20 X CS 19
- Development of BC1F1 of cross between genotypes GG 20 X CS 19
- Screening of F2 progenies for resistance to stem rot under artificially inoculated conditions
- RAPD and SSR analysis of F2 progenies with primers which are polymorphic to parents.
- Identification of markers associated with resistance to stem rot caused by Sclerotium rolfsii
- MABC to transfer the resistant gene into the genotype GG20

Achievements:

- Out of 1980 SSRs screened 504 (25.5%) markers were found polymorphic between two parents viz. GG 20 and CS 19. Out of which only 23 markers were able to differentiate homozygotes and heterozygotes.
- Screening of 178 F2 progenies were done under artificially inoculated condition during rabi-2016 (F4-5), kharif-2016 (F5-6). Six lines were found resistant to Stem rot disease over three generations.
- One major QTL was associated with resistance to stem rot disease in groundnut
- Five progenies/generations were developed for GMA analysis.
- A RIL population with different back ground has been phenotyped and genotyping is in progress besides validation of previously identified QTL.

All India Network Project on Soil Biodiversity-Biofertilizers

(PI: Pal KK, CO-PI: Dey R)
Funding agency: ICAR
Duration: 01.04.2014-31.03.2017
Total Funds: ₹ 31.00 lakh

Objectives:

- Development of microbial consortia for enhancing nutrient use efficiency and production of groundnut under low input system
- Microbial diversity in groundnut based cropping systems

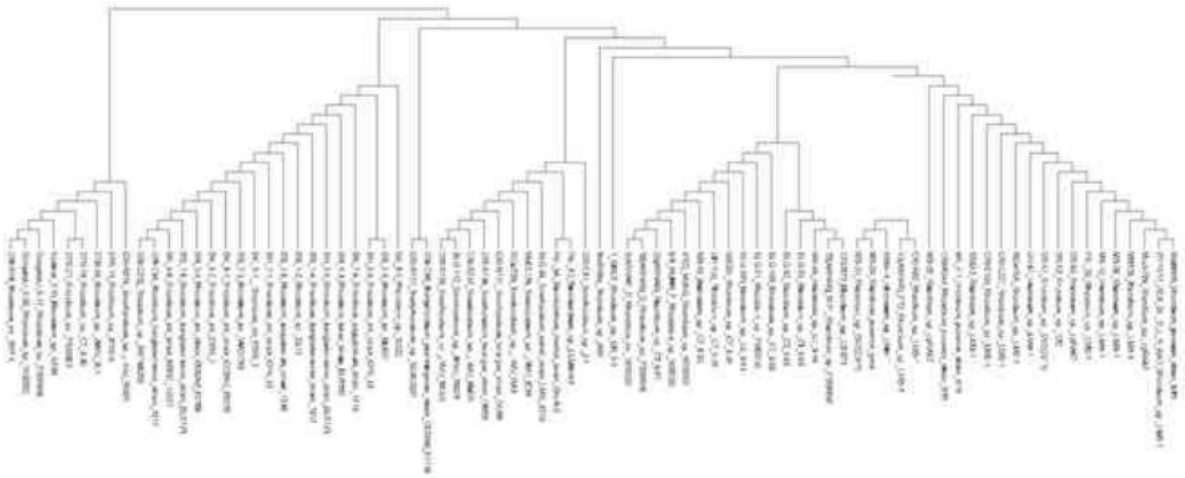
Achievements:

- After three years of trials on role of DAPG-producing fluorescent pseudomonads, identified under AINP-Biofertilizer programme, in enhancing yield and reducing the incidence of stem and collar rot pathogen, conducted at different AICRP(G) centres during kharif seasons of 2014-2016, following recommendations have been made for groundnut cultivation in India.

Recommendation made by AICRP-G (during kharif groundnut workshop held at Dharwad during 25-27 April, 2017) for use of DAGP-producing fluorescent pseudomonas for kharif groundnut cultivation at different agroclimatic zones in India

- Diversity of 465 cultures of nodulating and nitrogen fixing strains obtained from different AINP centres across 18 different legumes has been studied on the basis of 16S rRNA sequences and sequences of nod and nif genes. The dendrogram in figure depicted the extent of diversity of the rhizobia and other nodulating genera in different legumes in India, respectively.
- Diversity of 465 cultures of nodulating and nitrogen fixing strains obtained from different AINP centres across 18 different legumes has been studied on the basis of 16S rRNA sequences and sequences of nod and nif genes. The dendrogram in Figure 1 and Figure 2 depicted the extent of diversity of the rhizobia and other nodulating genera in different legumes in India, respectively.

Centre/Zone	Recommended DAPG-producing fluorescent pseudomonads
Bhubaneswar (E & SE coastal plain zone of Odisha)	*P. putida* FP86, *P. fluorescens* FP 98 and *P. putida* DAPG 4 either as seed treatment or furrow application with FYM multiplied cultures for higher yield and disease suppression.
Durgapura (Zone-1)	*P. putida* FP86 or *P. fluorescens* FP 98 or *P. putida* DAPG 4 or *P. putida* DAPG2 as seed treatment for higher yield and disease suppression.
Dharwad (Northern transitional zone of Karnataka) (Zone-VIII)	*P. putida* FP86 or *P. fluorescens* FP 98 or *P. putida* DAPG 4 or *P. putida* DAPG2 as seed treatment for higher yield and disease suppression.
Jalgaon (Plateau and assured rainfal zone of Maharashtra)	*P. putida* DAPG 4 as seed treatment for higher yield and disease suppression.
Junagadh (South Saurashtra agro climatic zone Gujarat) (Zone VII	*P. putida* DAPG 4as seed treatment for higher yield and disease suppression as seed treatment.
Kadiri	*P. putida* FP86 or *P. putida* DAPG 2 for enhancing groundnut yield, nutrient use efficiency and bio-control of soil borne diseases as seed treatment.
Shirgaon (South Konkan Coastal zone of Maharashtra)	*P. fluorescens* FP98 for higher yield and suppression of soil borne diseases (color rot/stem rot) as seed treatment.



Diversity of all nodulating genera in 18 different legumes in India

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

(PI: Pal KK, CO-PI: Dey R)
Funding agency: ICAR through AMAAS project
Duration: 01.04.2014-31.03.2017
Total Funds: ₹ 40.00 lakh

Objectives:

To understand the biochemical and molecular bases of osmoadaptation and osmoregulatory mechanisms of selected extreme halophilic bacilli, archaea and fungi on evolutionary perspective

- To identify candidate gene(s) having relevance to salinity tolerance for future exploitation in development of crops tolerant to salinity

Significant Achievements:

- Overexpression of Na-H antiporter, Na-K and bicarbonate transporter have been found to alleviate extreme salinity stress in extreme haloarchaeon 3A1-DGR. Besides exclusion of Na at entry level with concomitant uptake of K, the organisms survive and multiple by taking up dissolved CO2 as primary source of carbon which is then channelized for anabolism via the actions of a series of enzymes like phosphoenolpyruvate carboxylase, malate dehydrogenase, isocitrate lyase, malate synthase, and the enzymes of serine-glyoxylate cycle.
  Possible mechanism of extreme osmotolerance linked to carbon gain deciphered in extreme haloarchaeon 3A1-DGR
- GC-QTOF analysis of intracellular solute revealed that there has been consistent accumulation of L-valine across salinity level of 15-20-25-30% of NaCl. More accumulation of L-valine was noticed with increase in NaCl concentration.

Alleviation of moisture-deficit stress in groundnut, soybean, chickpea and pigeonpea by application of endophytic bacteria

(CC PI: Pal KK, CC CO-PI: Dey R, Rathnakumar AL, MahatmaMK, Ajay BC)
Funding agency: ICAR through NFBSFARA
Duration: 19.01.2016-31.03.2017
Total fund: ₹ 80.00 lakh

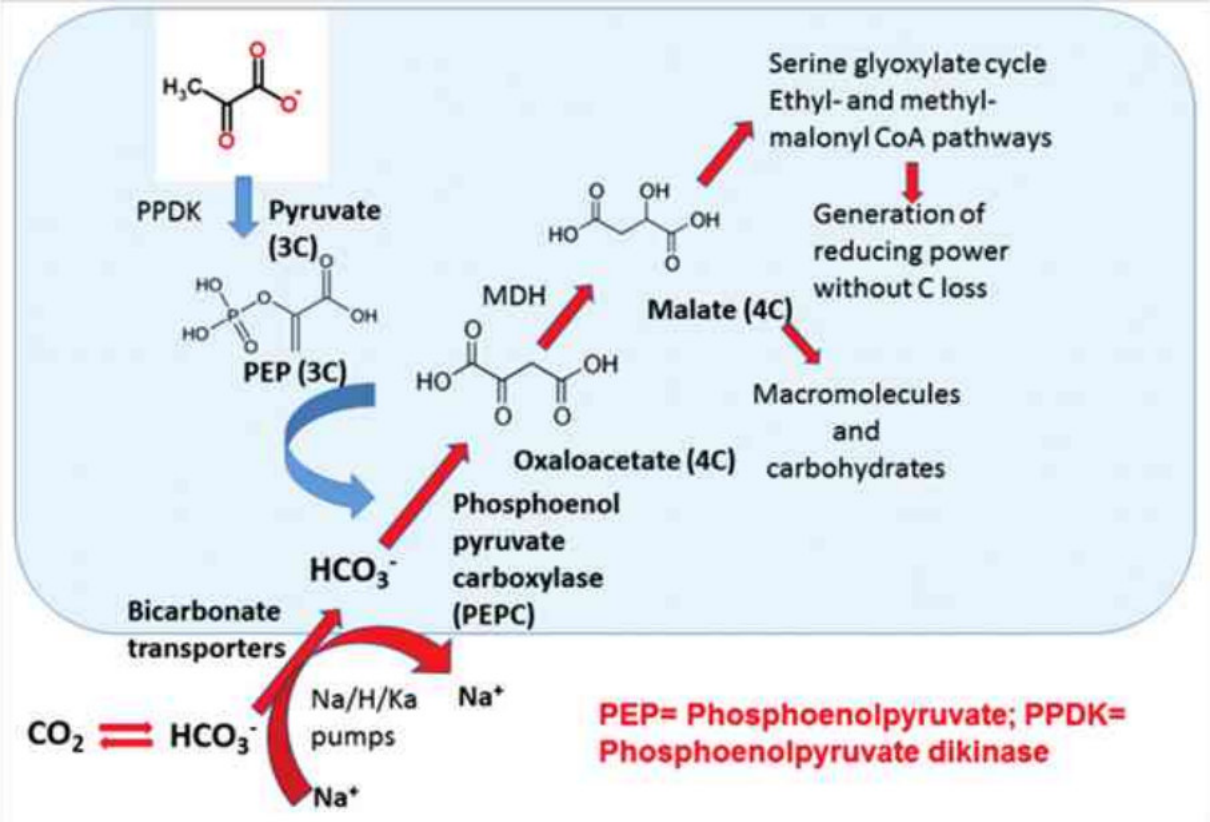
Objectives:

- To identify candidate endophytic bacteria of groundnut, chickpea, soybean, and pigeonpea for alleviation of moisture-deficit stress
- To understand mechanism(s) of alleviation of moisture-deficit stress by application of endophytes
- To scale up production of identified endophyte(s), development of suitable formulation, and delivery system(s)
- To evaluate the formulations at multilocations to alleviate moisture-deficit stress in target crops

Achievements:

- 379 bacterial endophytes have been isolated and purified obtained from germplasm accessions (drought tolerant; Junagadh) and advanced breeding lines and released cultivars (Kadiri 6, Kadiri 9 and Narayani) at Anantapur District of AP. Out of these endophytes, 71 isolates could grow at -2.2 MPa and 148 could grow at -1.7 MPa. Further characterization including PGP activity and seedling biomass are in progress.

  To ascertain whether substantial irrigation water can be saved by application of endophytic bacteria in summer groundnut, it was found that average yield with endophytes (REN51, SEN29 and J22) obtained with the application of three irrigations was more than that obtained with 10 irrigations without inoculation. Thus, it would be feasible to reduce number of irrigations substantially for raising summer groundnut with endophytes.



Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut (Summer 2016; TG37A)

Treatments	**Number of supplementary irrigations**				**Mean**
	1	**2**	**3**	**10**	
	Pod yield (kg/ha)				
Control	1312	1523	2065	2113	**1753**
J22	1724	1719	2260	2333	**2021**
SEN15	1578	1741	2277	2374	**1992**
SEN29	1558	2000	2309	2483	**2075**
Mean	**1543**	**1745**	**2228**	**2326**	**1961**
	LSD (0.05)				
Treatment	**70**				
Irrigation	**41**				
Treatment X Irrigation	**82**				

- Evaluation of endophytic bacterial isolates viz. J22, REN51 and SEN15 under rainfed conditions (around 200 mm rainfall) at RRS-DGR at Anantapur resulted in significantly higher haulm yield by J22 and pod yield by REN51.
- Evaluation of Bacillus firmus J22 at farmers' field in Anantapur District of Andhra Pradesh with nearly 180 mm rainfall and 4 protective irrigations, resulted in nearly 34% improvement in pod yield over uninoculated control with Kadiri 9 cultivar. Trial is being repeated during summer 2017 with 4 supplementary irrigations after sowing, against normal practice of 12-15 irrigations with Kadiri 9 variety.

Demonstration at farmers' fields: Anantapur and Kadiri (observation at 90 DAS; mean of 6 samples)

	Plant height (cm/p)	Root length (cm/p)	HY (g/m2) (30 plants)	PY (g/m2) (30 plants)	Branches/p
Treated	30.87	10.00	688.2	660	6.27
Untreated	29.27	8.53	430.5	497	5.33
paired t-test	0.044	0.017	0.12	2.04	0.15

Demonstration of the role of endophytes in alleviating drought-stress in famer's field in Anantapur district of Andhra Pradesh (cultivar Kadiri 9)

- Evaluation of endophytes in alleviation of moisture-deficit stress is in progress under AICRP(G) trials at multilocations.
- Inoculation of endophytes (J22, SEN29 and R51) in groundnut have been found to modulate the production of ROS scavenging enzymes, stomatal behaviour, K uptake, leaf water potential, and chlorophyll besides modulating the expression of the transcripts of the enzymes involved in C3-CAM transition during alleviation of moisture deficit stress.

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

CC-PIs: Harish G
Funding Agency: ICAR-NCIPM, New Delhi
Duration: June, 2013-March, 2018
Total Fund: Rs. 11.0 lakhs

Objectives:

- Development of location specific integrated pest management technology for groundnut crop.
- Validation of integrated pest management technology for groundnut crop
- on the farmers' fields with farmers' participatory approach.
- Popularization of the IPM technology.

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

Summary

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

NICRA - Pest Dynamics in Relation to Climate Change

CC-PIs: Thirumalaisamy PP
Funding Agency: Ministry of Agriculture, GOI, New Delhi
Duration: From October 2011 to March, 2017
Total Fund: 5.0 lakhs

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

Achievements

In kharif 2016, total rainfall received during the crop season (June 22 to October 8) was 1024.9 mm, distributed in 60 rainy days and maximum rain fall occurred in early stage of the crop (August 1st week, 123.4mm) and at maturity stage (3rd week of September 258.0 mm and 1st week of October 141.4 mm). Farmers of Junagadh and Rajkot districts mostly sown GG 20, TLG 45, SG 99, Bombay 55 and YLM 66.
The incidence of collar rot (25-30%) was severe in 15-30 days and stem rot (30-40%) was severe in 60-100 days old crop in few fixed fields. The severity of the foliar diseases viz., ELS, LLS and rust were low (ELS was 25 to 30%, LLS was 10 to 15% and rust up to 15-20%). The rust severity was more at the stage of harvest in few farmers' fields.
Insect pest viz., aphids, thrips, jassids, Spodoptera, Helicoverpa, ash weevil, black weevil and white grub were recorded in the fields. However, infestation of aphids (10-15%), thrips (30% to 35%), jassids (30% to 40%), Spodoptera (30 to 35%) and Helicoverpa (20% to 25%) were more. Scattered but severe incidence of white grub damage was recorded in many farmers' field.

Summary

The incidences of collar rot (25-30%) and stem rot (30-40%) were severe in less than 30 days and 60-100 days crop respectively in few fixed farmers' fields. The severity of the foliar diseases viz., early and late leaf spots and rust were low (less than 30%). Infestation of aphids (10-15%), thrips (30% to 35%), jassids (30% to 40%), Spodoptera (30 to 35%) and Helicoverpa (20% to 25%) were more. Scattered but severe incidence of white grub damage was recorded in many farmers' field.

Developing climate change resilient and sustainable groundnut-based cropping systems through conservation agriculture for Saurashtra region of Gujarat

PI: Jat RA
Funding agency: Science and Engineering Board, DST, New Delhi
Duration: 2015-2017
Total funds: Rs. 22.9 lakhs

Objectives:

- Assessing potential of Conservation Agriculture as climate change adaptation strategy by understanding its impact on soil moisture balance, soil surface temperature and crop productivity.
- Assessing carbon sequestration potential of conservation agriculture in Vertisols of Saurashtra region.
- Evaluating impact of conservation agriculture practices on soil quality vis-a-vis conventional agricultural practices.
- To work out the economics of conservation agriculture practices vis-a-vis conventional agricultural practices.

Achievements:

A field experiment was conducted during 2016-17 to validate the climate change adaptation potential of Conservation Agriculture in groundnut based cropping systems at ICAR-DGR, Junagadh research farm. The treatments were: four tillage practices viz. normal tillage, minimum tillage, zero tillage, and rota-till in main plots; two residue management practices viz. no residue, and residue application in sub-plot; and two cropping systems viz. groundnut+pigeonpea, and groundnut+cotton intercropping systems in sub-sub-plots. The experiment was laid out in split-split plot design with three replications. The salient findings of 2016-17 are reported hereunder:

Effect of tillage practices:

The results indicated that conventional tillage, being at par with rota-tillage, gave significantly higher pod yield of groundnut and GPEY over minimum tillage and zero tillage. Minimum tillage gave significantly higher pod yield and GPEY over zero tillage. However, minimum tillage being at par with zero tillage was found to give significantly higher haulm yield of groundnut over both conventional tillage and rota-tillage. The yield of pigeonpea and cotton was not significantly affected by tillage practices.

Effect of residue management practices:

Retention of pigeonpea/cotton residues improved groundnut pod and haulm yield, pigeonpea yield, cotton yield and GPEY but differences were significant for pigeonpea yield only.

Effect of cropping systems:

Groundnut-pigeonpea intercropping system gave significantly higher groundnut pod yield and GPEY while haulm yield of groundnut was significantly higher under Groundnut-cotton intercropping system.

ICAR seed project "Seed production in agricultural crops"

(Nodal Officer: Kumar N; Co-Nodal Officer: Gangadhara K)
Funding Agency: ICAR-Indian Institute of Seed Science, Mau, Uttar Pradesh
Duration: 2006 onwards
Total Fund: Rs. 44 Lakhs

Breeder Seed Production Achievement:

Summer-2016: Compensatory seed production programme of both DGR varieties Girnar 2 and Girnar 3 was not taken up in summer 2016.

Kharif-2016:

The DAC indent for breeder seed of Girnar 2 and Girnar 3 was 59.0 q and 277.76 q respectively for kharif 2016-17. Against the DAC indent, breeder seed production of Girnar 2 variety was taken up in 5.8 ha at ARC, Bikaner; and that of Girnar 3 in 7.1 ha of land at DGR, Junagadh. The total production was 134.15 q (111.40 q breeder seed and 22.75 q nucleus seed) of Girnar 2, and 72.35 q (33.30 q breeder seed and 39.05q nucleus seed) of Girnar 3. We have produced surplus quantity of breeder seed of Girnar-2 against the indent of 59.0q but huge shortfall of 244.61 q of Girnar 3 against the indent of 277.76 q due to unexpected huge indent of breeder seed resulting shortfall of sufficient quantity of nucleus seed. Now we have enough nucleus seed of Girnar-3 to meet out demand of breeder seed of Girnar 3 of about 300 q for kharif 2017.Compensatory breeder seed production programme of Girnar 3 was also taken up in summer 2017 in 1.5 ha area to meet out shortfall of DAC indent of Girnar 3 for kharif-2016-17.

Seed of different classes and varieties produced in kharif 2016

Variety	Plot no.	Area (ha)	Total production (q)	Seed Production (q) Breeder Seed	Nucleus Seed	TFL Seed
Girnar 2	ARC, BKN	**5.80**	**134.15**	**111.40**	**22.75**	--
Girnar 3	L-4	1.8	**72.35**	**33.30**	**39.05**	--
	K-4	0.6				
	N-8	1.7				
	J-6/7	1.1				
	H-6	1.4				
GG 20	**Total**	**7.10**				24.60
TG 37A						10.00

Director General, ICAR visited breeder seed production plots

Minister of State for Finance (GOI), Shri Arjun Ram Meghwal visited groundnut breeder seed production of ICAR-DGR, Junagadh at Arid Region Campus, Bikaner

Distribution of seed/planting material
During 2016-17, a total 15.0 q breeder seed of Girnar 2 to NSC, Himatnagar (13.0 q) and IISWC, Dehradun (2.0 q). Total 25.85 q breeder seed of Girnar 3 was supplied to OSSC, Odisha (25.70 q), Dhan Foundation, Odisha (0.10 q) and Mr. Amit Kumar, Ranchi (0.05 q) for research purpose was supplied.

For cluster demonstration and seed production under the programme of "Rejuvenation plan for groundnut in Sitapur districts and adjoining areas of Uttar Pradesh" during Summer/Spring-2017, Seed production unit has supplied the 660 kg quality seed (Kernel) of TG 37A variety for spring/summer season in Sitapur, Uttar Pradesh.

Details of seed materials supplied during 2016-17

SN	Variety	Firm	Quantity (q)	Resource generation (Rs.)
1.	Girnar-2	National Seeds Corporation Ltd, Idar, Himatnagar, Gujarat Director, ICAR-Indian Institute of Soil & Water Conservation (IISWC), Dehradun2.0027,000.00	13.0	1,95,000.00
		Sub total	**15.0**	**2,22,000.00**
2.	Girnar-3	Seed Production Officer, Odisha State Seeds Corporation Ltd, Bhubaneswar	25.70	3,85,500.00
		DHAN Foundation, Alupur, Balasore, Odhisha	0.1	1350.00
		Amit K Gautam, PhD Scholar,	0.05	675.00
3.	Groundnut Fodder	Ranchi	--	15,187.00
		Sub total		**4,02712.00**
		Total	**40.85**	**6,24,712.00**

Resource generation

During 2016-17, revenue of Rs. 2,22,000/- by sale of total 15 q breeder seed of Girnar 2 to NSC, Himatnagar (13.0 q) and IISWC, Dehradun (2.0 q) and revenue of Rs. 3,87,525/- was generated by selling of 25.85 q breeder seed of Girnar3 to OSSC, Odisha (25.70 q), Dhan Foundation, Odisha (0.10 q) and Mr. Amit Kumar, Ranchi (0.05 q) was generated. An amount of rupees 15,187 was generated by selling of groundnut fodder. Thus, during 2016-17, total resource generation was Rs. 6,24.712.00/- under this project of annual budget of Rs. 5.5 lakhs received from the ICAR-Indian Institute of Seed Science, Mau during the period under report.

Capacity building and technology dissemination

During the 2016-17, under HRD programme of ICAR seed project a total 367 farmers had attended the training programme organized on groundnut seed production with improved technologies at ARC, Bikaner and DGR, Junagadh. The aim of training programme was to demonstrate latest technology of groundnut cultivation. A field day on seed production of groundnut under arid ecosystem for 164 farmers from 18 villages of Bikaner district on 28th September 2016 at ARC, Bikaner and one Kisan Gosti on pre-kharif campaign on management of white grub and stem rot in groundnut for 203 farmers from 18 village of Junagadh district on 30th March, 2017 at DGR Junagadh.

Details of HRD programme organized during 2016-17

SN	Programme name	Date	No of farmers	Place of farmers
1.	शुष्क पारस्थितिकी तंत्र के अंतर्गत मूँगफली बीज उत्पादन	28th September, 2016	164	18 villages of Bikaner district
2.	मूँगफली में सफेद लट एवं तन विगलन के प्रबंधन के लिए पूर्व खरीफ अभियान हेतु किसान गोष्ठी	30th March, 2017	203	18 villages of Junagadh district


Field day organized at ARC, Bikaner


Kisan Gosthi organized at ICAR-DGR, Junagadh

8 Publication

Research Articles

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Singh, A.L., Kumar, N., Mann, A., Bera, S.K., Ajay, B.C., Chaudhari, V., Patel, C.B., 2016. Iron-efficiencies among groundnut advanced breeding lines for their suitability to calcareous soils. In: National Conference of Plant Physiology-2016 on "Challenges in Crop Physiology Research: From Molecular to Whole Plant", GKVK, Bengaluru, India, 8-10thDec 2016.

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जादोन के. एस., थिरुमलाइसामी पी. पी., दत्ता आर., मावर आर., मीना एच. एन., 2016. मूँगफली के प्रमुख रोग एवं उनकी रोकथाम. कृषिज्ञान गंगा 1:15-21.

જાટ આર. એ., ઝાલા પી. વી., તુમ્બર બી., 2016. જંગલી જાનવરોથી પાકને થતું નુકશાન અને તેનાથી બચવા માટેના ઘરેલું ઉપાયો. મગફળી સંશોધન નિદેશાલય, જુનાગઢ -362001, ગુજરાત.

Participation in Conference/ Workshop/ Seminar/ Symposia/Meetings/ Training Programmes

Radhakrishnan T.

- Attended the meeting to examine the various parameters/components of Fair Average Quality (FAQ) norms of Groundnut in Andhra Pradesh for the purpose of procurement under Price Support Scheme (PSS) in next season convened by Shri Ashok Dalwai, Addl. Secretary, DAC &FW on 27th July, 2016 at New Delhi
- Attended XXIV meeting of ICAR Regional Committee (VI) held during 13-14 Sept, 2016 at ICAR-CAZRI, Jodhpur
- Attended the Inter-session meeting of Consultative Committee of the Ministry of Agriculture & Farmers welfare held on 25th Oct, 2016 at New Delhi
- Attended the interactive workshop on administrative matters for the ICAR institutes located in west zone to be held on 24th November 2016 at CIFE, Mumbai
- Attended the Varietal Identification Committee meeting to be held on 29th November 2016 at SKRAU, Bikaner
- Attended the Brainstorming Session on Climate Smart Technologies for Enhancing Vegetable Oil Production organised by ISOR at IIOR, Hyderabad on 19-21st January 2017
- Attended the Interactive meeting on Groundnut Transgenics developed and its future course of action to be held on 1st December 2016 at UAS, Bangalore
- Attended the Brainstorming Session on Climate Smart Technologies for Enhancing Vegetable Oil Production organised by ISOR at IIOR, Hyderabad on 19-21th January 2017
- Attended the first meeting of State Level Coordination Committee (SCC) to discuss doubling of farmers" income by 2022 held at AAU, Anand on 23.3.17
- Delivered a lead lecture on Translational Research in Groundnut in the symposium on Genomicsand Translational Research in Crop Improvement organized by the Department of Genetics and Plant Breeding, Ch. Charan Singh University, Meerut, 14-15th Dec, 2016
- Delivered a lead lecture on "Retrospect and prospect of improving groundnut (Arachis hypogaea L.) for drought-prone areas of India" at InterDrought-V, Hyderabad, India, 21-25 February, 2017.

Ajay BC

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016
- Attended InterDrought-V International Conference held from 21-25, February 2017 at Hyderabad International Convention Centre (HICC), Hyderabad

Bera SK

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Bishi SK

- Attended InterDrought-V International Conference held from 21-25, February 2017 at Hyderabad International Convention Centre (HICC), Hyderabad
- AttendedInternational Conference on Nutraceuticals and Functional Foods –The Challenges and Opportunities (ICNF16), Dec 6-8, 2016, Indian Society of Agricultural Biochemists and Anand Agricultural Univ, Anand
- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Dey R

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Dutta R

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Jat RA

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Kumar A

- Attended the Interactive meeting on transgenics developed and its future course of action held on 21st December, 2016 at ICAR-IARI, New Delhi
- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Kumar N

- Attended AICRP-G Annual groundnut workshop from 18-20th April 201 at Junagadh Agricultural University, Junagadh
- Attended monitoring team to assess the groundnut situation and prepare rejuvenation plan for groundnut in Sitapur district and adjoining areas in Uttar Pradesh from 5-6 May 2016 at Lucknow
- Attended and presented seed production achievements of 2015-16 in XIth Annual Review Meeting of ICAR Seed Project-"Seed Production in Agricultural Crops" held at GBPUA & T, Pantnagar on 17-18 August, 2016
- Attended monitoring of groundnut AICRP-G trials and breeder seed production in the zone V (Tirupti, Kadiri, Anantapur and Hiriyur) from 12.09.16 to 18.09.16
- Delivered lecture on principals of groundnut seed production and recommended varieties for Odisha on 16.12.2016 in a farmers training programme from Dhan Foundation, Bhubaneswar, Odisha on "Improved technologies for groundnut cultivation" from 16-18th Dec, 2016 at ICAR-DGR, Junagadh
- Attended XX Annual Breeder Seed Review Meeting of ICAR held at ICAR-NBPGR, New Delhi on 16th Jan, 2017

- Attended and given oral presentation on "Soil salinity tolerance among recently released groundnut cultivars of India" in the 5th National Seminar "Climate Resilient Saline Agriculture: Sustaining Livelihood Security" from 21-23rd January 2017 at SKRAU, Bikaner
- Attended InterDrought-V International Conference held from 21-25, February 2017 at Hyderabad International Convention Centre (HICC), Hyderabad

Mahatma MK

- Attended InterDrought-V International Conference held from 21-25, February 2017 at Hyderabad International Convention Centre (HICC), Hyderabad
- AttendedInternational Conference on Nutraceuticals and Functional Foods –The Challenges and Opportunities (ICNF16), 6-8th Dec, 2016, Indian Society of Agricultural Biochemists and Anand Agricultural University, Anand
- Attended National Conference of Plant Physiology on "Challenges in crop Physiology Research: From Molecular to whole plant" Dec 8-10 2016, UAS, GKVK, Bangaluru
- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Meena HN

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016
- Participated in 4thInternational Agronomy Congress held in New Delhi on 22-26th Nov, 2016

Narayanan G

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Pal KK

- Attended 1st International Agrobiodiversity Congress, 2016 and delivered an invited lecture on 'Exploiting the essence of the microbial diversity of the Rann of Kutch for devising strategies for salinity and drought tolerance" on 8th November 2016 as an Invited Speaker
- Attended National Conference on 'Management of microbial resources for food security under climate smart agriculture' held at Dept of Microbiology, Dr Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar from 22-24 December, 2016 and presented a Lead lecture 'Breeding for enhancing beneficial plant-microbe interaction: Prospects and future strategies'
- Attended Inter-Drought V at ICRISAT (21-25 Feb. 2017), Hyderabad and presented a poster
- Attended Annual Groundnut Workshop of AICRP(G) at JAU, Junagadh from 18-20 April, 2016
- Attended review meeting of All India Network Project on Soil Biodiversity Biofertilizers held from 20-22 August, 2016 at OUAT, Bhubaneswar

Rathnakumar AL

- Organised Annual Groundnut Workshop at JAU, Junagadh on 18-20th April, 2016
- Attended InterDrought-V International Conference held from 21-25, February 2017 at Hyderabad International Convention Centre (HICC), Hyderabad

Sangh C

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Singh AL

- AttendedInternational Conference on Nutraceuticals and Functional Foods –The Challenges and Opportunities (ICNF16), Dec 6-8, 2016, Indian Society of Agricultural Biochemists and Anand Agricultural Univ, Anand
- AttendedNational Conference of Plant Physiology on "Challenges in crop Physiology Research: From Molecular to whole plant" Dec 8-10 2016, UAS, GKVK, Bangaluru
- Attended5th National Seminar on "Climate Resilient Saline Agriculture: Sustaining Livelihood Security" 21-23 Jan 2017 at Swami Keshwanand Rajasthan Agricultural University, Bikaner
- Attended InterDrought-V International Conference held from 21-25, February 2017 at Hyderabad International Convention Centre (HICC), Hyderabad
- Attended as an expert member for assessment of scientists in Plant Physiology at ICAR-National Institute of abiotic stress management (NIASM),Baramati on 20th Dec 2016
- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Thirumalaisamy PP

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016

Yadav RS

- Participated in the AICRP-Groundnut Workshop at Junagadh Agricultural University, Junagadh during on 18-20th April, 2016
- Participated in the 1st Asian Conference on Water and Land Management for Food and Livelihood Security held during January 20-22, 2017 at IGKV, Raipur, Chhattisgarh Participated in 4thInternational Agronomy Congress held in New Delhi on 22-26th Nov, 2016

9 Training and Capacity Building

Bera SK

- Organised farmers training programme on Improved seed production technology in groundnut (women farmers) on 7th June,2016 at ICAR-DGR, Junagadh

Bishi SK

- Co-ordinated a three days training programme on ''मूँगफली खेती के लिए उन्नत प्रौद्योगिकीयां'' at ICAR-DGR Junagadh on 16-18th Dec, 2016

Gangadhara K

- Agricultural Statistics and Computing (SSC) at ICAR-IASRI, New Delhi 1st Sept – 19th Nov, 2016
- Attended training programme on "Competency Enhancement Programme for Effective implementation of Training Functions by HRD Nodal officers of ICAR" held at ICAR-NAARM, Hyderabad, 13-15th Feb, 2017

Ghetia NR

- Attended training programme on ''ऑनलाईन पोर्टल से नोडल अधिकारी प्रशिक्षण'' at ICAR-NAARM, Hyderabad on 25th Oct, 2016
- Attended training programme on ''सीपीजी पोर्टल के माध्यम से एनऊईसीआई-खरीद समाधान'' at ICAR-NDRI, Karnal 21-22nd July, 2016

Joseph R

- Attended training programme on "Enhancing efficiency and behavioural skills" at ICAR-NAARM, Hyderabad from 28th July-3rd Aug, 2017

KariaYS

- Attended training programme on "Reservation in Services for SC/ST/OBC" at Institute of Secretariat Training and Management, New Delhi, 3-5th Oct, 2016
- Attended training programme on "Enhancing efficiency and behavioural skills" at ICAR-NAARM, Hyderabad, 4-10th Jan, 2017

Kumar N

- Co-ordinated a three days training programme on ''मूँगफली खेती के लिए उन्नत प्रौद्योगिकीयां'' at ICAR-DGR Junagadh on 16-18th Dec, 2016
- Co-ordinated a one day training programme on ''शुष्क पारस्थितिकी तंत्र के अंतर्गत मूँगफली बीज उत्पादन'' at ICAR-DGR on 28th September, 2016

Makawana CG

- Attended training programme on E-Procurement at NDRI, Karnal 21-22nd July, 2016

MauryaAK

- Attended training on ICAR-ERP held at ICAR-IASRI, New Delhi, 20-25th March, 2017.

Narayanan G

- Attended training programme on developing agribusiness skills among farmers for maximizing farm income at ICAR-IARI, New Delhi on 11-20thJuly, 2016
- Co-ordinated a five days training programme on "Technologies for Improved Groundnut Production in Madhya Pradesh" to Madhya Pradesh farmers held at ICAR-DGR on 26-30th September, 2016

Radhakrishnan T

- Attended training programme on managerial effectiveness organised by ICAR at Indian Institute of Management, Ahmedabad from 1-9thJanuary, 2017

Awards/Rewards/Recognition

- Dr. RS Yadav bagged"Special Research Award-2016" for "Characterization and conservation of soil biodiversity in arid and semi arid eco-systems" bestowed by Soil Conservation Society of India, New Delhi honored in 1st Asian conference on water and land management for food and livelihood security held during January 20-22, 2017 at IGKV, Raipur, Chhattisgarh.

- Dr. MK Mahatma received Fellow of Indian Society of Biochemist (FISAB) in 2016 during International Conference on Nutraceuticals and Functional Foods–The Challenges and Opportunities, December 6-8, 2016 held at Anand, Gujarat.

- Ms. Sneha M. Dodia, SRF (Biotechnology) bagged the best oral research paper presentation at 3rd International Conference on Agriculture, Horticulture & Plant Science held at New Delhi, 25-26 June, 2016.

10 Meetings / Work Plan 2016-17 Staff List / Finance & Accounts

Meetings

ICAR-DGR Industries Interface Meeting (31st January 2017, Junagadh)

In the current scenario of groundnut gaining more and more relevance as a food crop besides an oilseed, the stake of food industries and export houses is on the rise. The stringent imposition of acceptable limit of aflatoxin load in exported groundnut in different countries has also creating barrier for export of groundnut. The demand of groundnut to the kitty of value added products is also in the rise in the domestic market. Besides, the demand and awareness of use of biofertilizers and biocontrol agents for enhancing the productivity is also expanding. To provide a common platform to all the stakeholders in groundnut cultivation and related industries for deliberations on issues of mutual interest and for formulating future strategies for research, extension, mechanization, sensitization about latest development, and trade, ICAR-DGR conveyed an Industries Interface meeting on 31st January, 2017.

Dr. Radhakrishnan T., Director, ICAR-DGR welcomed the participants. ShriSanjivSawla, Chairman, IOPEPC was the chief guest. The other dignitaries attending the meeting were Dr. I.U. Dhruj, Associate Director of Research, JAU, Junagadh; Shri Sanjay Shah, Vice-Chairman, IOPEPC; Dr J.B. Misra, Technical Adviser, IOPEPC. Groundnut researchers also attended the meeting from ICRISAT and DGR. Representatives from local export houses, seed industries, major food industries, progressive farmers, manufacturers of biofertilizer and biocontrol agents, and manufacturers of farm implements participated in the meeting. Director, DGR, Junagadh emphasized the need for producing export-worthy and confectionary groundnut and also the need for joint venture between DGR and industries in achieving the goal.

During this meet, the key challenges in the groundnut production across India with particular emphasis on export-worthy groundnut cultivation, which needs to be addressed together with industries, were discussed thoroughly. Various aspects like problems faced by the groundnut industries (aflatoxin contamination, bruchid infestation, etc.), improvement in the seed replacement rate, researchable issues to meet the growing demand of domestic and export market, need for large-seeded and confectionery groundnut for food industries, need for mechanization of groundnut cultivation, adaption of available technologies for reducing pre- and post-harvest aflatoxin contamination, etc. were covered. The technical session included presentations on successful cultivation of export-worthy groundnut, problems of aflatoxin contamination faced by confectionary industries, major trade barriers in groundnut, R&D requirements of export and domestic market of groundnut, production constraints of groundnut in Tamil Nadu with special reference to export, management of post-harvest aflatoxin contamination, and role of mechanization in reducing aflatoxin contamination. Dr. A. L. Rathnakumar, Principal Scientist summed up issues raised and their possible way outs.

Dr. K.K. Pal, Principal Scientist, DGR thanked all the speakers from both private and public sectors; entrepreneurs and others who had attended and contributed to the success of the meet.

XVIII Meeting of Research Advisory Committee

The 18th meeting of the Research Advisory Committee was held at ICAR-DGR, Junagadh from 27-28 April, 2016. The meeting was chaired by Dr. Padma Raju, Ex VC, ANGRAU, Hyderabad, Dr. SN Nigam, Ex. Principal Groundnut Breeder in ICRISAT, Hyderabad, Dr. SR Bhat, Ex. Principal Scientist at NRCPB, New Delhi, Dr. IU Dhruj, Associate Director of Research, JAU, Junagadh, Dr. KP Patel, Dean Faculty of Agriculture, Anand Agricultural University, Anand, Radhakrishnan T. Director, ICAR-DGR, Junagadh and Dr. SK Bera, Principal Scientist, DGR was the member secretary of 18th RAC meeting. Works done report of the ongoing projects were delivered before the committee, extensively discussed and the future work plan was tweaked as per the suggestions of the research advisory committee.

XVIX Meeting of Research Advisory Committee

The nineteenth meeting of the Research Advisory Committee was held at ICAR-DGR, Junagadh from 3-4 March, 2017. The meeting was chaired by Dr.A. Padmaraju, Former VC, ANGRAU, Hyderabad. Other members participated in the meeting were Dr. S. N. Nigam, Retd. Principal Scientist, ICRISAT; Dr. I.U. Dhruj, Assitant Director of Research, Junagadh Agricultural University, Junagadh; Dr. K.P. Patel, Dean, Anand Agricultural Universitry, Anand;Dr. Radhakrishnan T., Director, ICAR-DGR, Junagadh;Dr. S.K. Bera, Principal Scientist, ICAR-DGR and Member Secretary, RAC. Presentations on ongoing research projects were made by the PIs and Co-PIs which were discussed meticulously and the work plan was customized as per the remarks of the research advisory committee. In their concluding remarks, Chairman and members of RAC appreciated the research work being done at ICAR-DGR and pointed out the need for further improvements/modifications as per need of the hour.

'Groundnut farmer fair-cum-exhibition' organized by ICAR-DGR

ICAR-Directorate of Groundnut Research, Junagadh organized a 'Groundnut farmer fair cum exhibition' on 1st October, 2016, to acquaint the farmers of Saurashtra region of Gujarat about Management of Nilgai, White boars in groundnut, legal issues associated with and Government policy support for managing these pests and on managing white grubs in groundnut with a special emphasis on community based approach. This fair was sponsored to ICAR-DGR, Junagadh under NMOOP with a financial assistance of Rs. 4.00 lakh. In all, there were more than 700 farmers from five (Junagadh, Amreli, Jamnagar, Gir-Somnath, and Rajkot) districts covering about 35 villages. The sarpanchs and Talatis of the 25 adopted villages under the "MeraGaonMeraGourav" programme, 34 progressive farmers from Madhya Pradesh have also participated.

Dr AR Pathak, Vice-Chancellor, JAU, Junagadh, Dr Manoranjan Dutta, Advisor, DAC, Ministry of Agriculture and Cooperation and Farmers welfare, New Delhi, Er. Pradeep Singh, Deputy Conservator of Forest, Junagadh and
Dr A Bandhyopadhyaya, Former Director, ICAR-DGR, Junagadh and Dr IU Dhruj Associate Director of Research, JAU were the Special Guests of the function. The other guests present on the occasion included Dr Gonthiya, Dean, College of the Agricultural Engineering, Dr Tank, Dean, College of Veterinary Sciences and Deputy Director Department of Agriculture, Government of Gujarat, Junagadh. In this occasion, programme coordinators of various KrishiVigyanKendras like Amreli, Kodinar and Pipaliya (Dhoraji) and scientists from JAU were also present.
The program started by the lighting of the lamp by the guests present on the dais. At the inaugural session,
Dr Radhakrishnan T., Director, ICAR-DGR, Junagadh, welcomed all the farmers and dignitaries and requested the participants to take full advantage of the programme organized during the farmers' fairs-cum-exhibitions to the improve their productivity and profit.

After the inaugural session, lectures on, 'Management of nilgai, white boars in groundnut, legal issues associated with and government policy support' and 'Management of white grubs in groundnut' with a special emphasis on community based approach were delivered by Er Pradeep Singh, Deputy Conservator of Forest, Junagadh and
Dr MK Ghelani, Assoc. Professor, Dept. of Entomology, from Junagadh Agricultural University, Junagadh respectively in local languages. Interactive sessions were well organized between Scientist and farmers after the formal inaugural session.

The mela was inaugurate by Dr. AR Pathak,
Hon. Vice Chancellor, Junagadh Agricultural University

Farmers' interactive session in progress

Work Plan 2016-17

Programme 1: Genetic improvement of groundnut

Breeding for tolerance to abiotic stress in groundnut Ajay BC, Kumar N, Kumar A, Gangadhar K andChandranohan S

Breeding for resistance to major diseases and insect pests ingroundnut Kumar N, Rathnakumar AL, Nataraja MV,Dutta R, Gangadhara K and Chandramohan S

Enhancement and management of groundnut genetic resources Rathnakumar AL, Bera SK, Mahatma MK and Ajay BC

Biotechnological approaches to the characterization and geneticenhancement of groundnut Kumar A, Chandramohan S, Rathnakumar AL, Bera SK,Thirumalaisamy PP and Kumar N

Utilization of wild Arachis gene pools for improvement of groundnut Bera SK, Thirumalaisamy PP and Ajay BC

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

Development of management module for soil borne diseases of groundnut Dutta R and Thirumalaisamy PP

Management of aflatoxin contamination in groundnut Thirumalaisamy PP

Management of insect-pests of groundnut Harish G and Nataraja MV

Influence of fungal pathogens on metabolomes of groundnut Mahatma MK and Bishi SK

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

Development of technologies for enhancing resource use efficiency ingroundnut-based cropping systems Jat RA, Meena HN and Yadav RS

Development of conservation agriculture technologies for groundnutbased cropping system(s) Jat RA and Yadav RS

Management of soil and irrigation water salinity in groundnut Meena HNand Yadav RS

Studies on dynamics of soil phosphorus under various managementpractices in groundnut cultivation Yadav RS, Meena HN and Ajay BC

Programme 4: Biochemistry and physiology of groundnut in relation tophotosynthetic efficiency, nutritional quality, biotic and abioticstress tolerance

Iron and zinc bio-fortication in groundnut Singh AL and Bishi SK

Impact of climate change on physiology and productivity of groundnut Bishi SK, Chakraborty K, Singh AL,Mahatma MK and Jat RA

Physiological studies in groundnut under water-deficit and salinity stresses Singh AL andMahatma MK

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

Application of microorganisms for management of biotic and abioticstresses in groundnut Pal KK, Dey R, Nataraja MV, Ajay BC and Meena HN

Programme 5: Socio economic research and extension for groundnut indevelopments

Innovative approaches to bridging yield gaps in groundnut throughtechnology dissemination and capacity building Narayanan G and Jat RA

Staff List 2016-17

	Name of employees	Designation
1	Dr. Radhakrishnan T.	Director
2	Dr.A.L. Singh	Principal Scientist
3	Dr.A.L. Rathnakumar	Principal Scientist
4	Dr.S.K. Bera	Principal Scientist
5	Dr.K.K. Pal	Principal Scientist
6	Dr.Rinku Dey	Principal Scientist
7	Dr. Ram Dutta	Principal Scientist
8	Dr.R.S. Yadav	Senior Scientist
9	Dr.R.A. Jat	Senior Scientist
10	Dr. M.K. Mahatma	Senior Scientist
11	Dr. H.N. Meena	Scientist (Senior Scale)
12	Dr. Abhay Kumar	Scientist
13	Dr. S.K. Bishi	Scientist
14	Dr. P.P. Thirumalaisamy	Scientist (Senior Scale)
15	Dr. Harish G.	Scientist
16	Dr. Narendra Kumar	Scientist
17	Dr. K. Chakraborty	Scientist (Transfered at NRRI,Cuttack on 28.5.16)
18	Dr. Debarti Bhaduri	Scientist (Transfered at NRRI, Cuttack on 28.5.16)
19	Dr. Ajay B.C.	Scientist
20	Sh. M.V. Nataraja	Scientist
21	Dr. G. Narayan	Scientist
22	Sh. Murlidhar Meena	Scientist
23	Dr. K. Gangadhara	Scientist
24	Dr. Sangh Chandramohan	Scientist
25	Sh. Kiran Kumar Reddy	Scientist
26	Dr. D.L. Parmar	Chief Technical Officer
27	Sh. D.M. Bhatt	Chief Technical Officer
28	Sh. P.R. Naik	Assistant Chief Technical Officer
29	Sh. N.R. Ghetia	Chief Technical Officer
30	Sh. V.G. Koradia	Chief Technical Officer
31	Sh. P.K. Bhalodia	Chief Technical Officer
32	Sh. P.V. Zala	Chief Technical Officer
33	Sh. H.B. Lalwani	Assistant Chief Technical Officer
34	Dr. H.K. Gor	Assistant Chief Technical Officer
35	Sh. H.M. Hingrajia	Assistant Chief Technical Officer
36	Dr. J.R. Dobaria	Assistant Chief Technical Officer
37	Dr. M.V. Gedia	Assistant Chief Technical Officer
38	Sh. Ranvir Singh	Assistant Chief Technical Officer
39	Dr. S.D. Savaliya	Assistant Chief Technical Officer
40	Mrs. V.S. Chaudhari	Assistant Chief Technical Officer
41	Sh. B.M. Chikani	Assistant Chief Technical Officer
42	Sh. Virendra Singh	Assistant Chief Technical Officer
43	Sh. D.R. Bhatt	Assistant Chief Technical Officer

44	Sh. R.D. Padvi	Technical Officer
45	Sh. H.V. Patel	Technical Officer
46	Sh. J.G. Kalariya	Technical Officer (Tractor Driver)
47	Sh. K.H. Koradia	Technical Officer (Driver)
48	Sh. A.M. Vakhariya	Technical Officer (Photographer)
49	Sh. C.B. Patel	Technical Officer
50	Sh. G.J. Solanki	Tech.Officer/ Retired/ 31.5.16
51	Sh. P.B. Garchar	Tech. Officer (Electrician)
52	Sh. N.M. Safi	Tech. Officer (Driver)
53	Sh. A.D. Makwana	Technical Assistant
54	Sh. G.G. Bhalani	Sr.Technical Assistant (Driver)
55	Sh. B.M. Solanki	Sr.Technical Assistant (Tractor Driver)
56	Sh. Anil K Maurya	Sr.Technical Assistant
57	Sh. Lokesh Kumar	Sr,Technical Assistant
58	Sh. Pitabas Das	Technical Assistant
59	Sh. Indra Raj Meena	Administrative Officer (w.e.f. 19.11.16)
60	Sh. Amit Kumar	FAO
61	Sh. R.T. Thakar	Assistant Administrative Officer
62	Mrs. Rosamma Joseph	Personal Secretary
63	Sh. Y.S. Kariya	Personal Assistant
64	Sh. L.V. Tilwani	Personal Assistant
65	Mrs. Santha Venugolan	Assistant
66	Mrs. M.N. Vaghasia	Assistant
67	Sh. M.B. KherSecurity	Supervisor
68	Sh. C.G. Makawan	Upper Division Clerk
69	Sh. H.S. Mistry	Upper Division Clerk
70	Sh. P.N. Solanki	Lower Division Clerk
71	Sh. N.M. Pandya	Skilled Support Staff
72	Sh. R.B. Chawada	Skilled Support Staff
73	Sh. D.M. Sachaniya	Skilled Support Staff
74	Sh. M.B. Shaikh	Skilled Support Staff
75	Sh. J.G. Agrawat	Skilled Support Staff
76	Sh. K.T. Kapadia	Skilled Support Staff
77	Sh. V.N. Kodiatar	Skilled Support Staff
78	Sh. R.P. Sondarwa	Skilled Support Staff
79	Sh. V.M. Chawada	Skilled Support Staff
80	Sh. G.S. Mori	Skilled Support Staff
81	Mrs. D.S. Sarvaiya	Skilled Support Staff
82	Sh. P.M. Solanki	Skilled Support Staff
83	Sh. N.G. Vadher	Skilled Support Staff
84	Sh. B.J. Dabhi	Skilled Support Staff
85	Sh. C.G. Moradia	Skilled Support Staff
86	Sh. D.A. Makwana	Skilled Support Staff
87	Sh. Jay R. Purohit	Skilled Support Staff

Staff Strength

Category of staff	Sanctioned	Filled	General	SC	ST	OBC
Scientific	39 + 1RMP	24+1RMP	12+1RMP	03	03	06
Technical	39	33	19	03	05	06
Admin.	17	12	07	01	01	03
SSS	19	17	04	03	03	07
Total	**114+1RMP**	**86+1RMP**	**42+1RMP**	**10**	**12**	**22**

Discipline and grade wise sanction of scientific positions

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

DPC/Promotion/probation/MACP

- Five Scientists of our Directorate viz. Drs. S.K. Bishi, Abhay Kumar, Nataraja MV, G. Narayanan and Harish G. are promoted to RGP 7000 through DPC held on 13.05.2016 and 20.08.2016.

Finance and Accounts

DGR Main Unit (Rs. in lakhs)		
Budget Head	**Non Plan**	**Plan**
Establishment charges	718.71	0.00
Wages	68.79	0.00
Loans & Advances	1.67	0.00
Pension	84.14	0.00
T.A.	7.99	14.01
Recurring Contingencies	129.29	199.65
HRD	2.98	6.34
Works	0.00	183.37
Equipment	4.97	1.03
Furniture	1.98	0.50
IT	0.00	0.03
Books	0.00	0.00
Vehicles	0.00	0.00
Others	0.00	0.00
TSP	0.00	30.00
TOTAL	**1020.52**	**434.93**

AICRP-G (Rs. in Lakhs)	
Budget Head	
Pay &Allowance	641.21
TA	9.56
Recurring Contingency	59.03
Need Based Research	24.36
TSP	64.65
TOTAL	**798.81**

- Five Technical Staff viz. P.V. Zala, N.M. Safi, G.G. Bhalani, B.M. Solanki and P.B. Garchar were promoted through DPC Held on 22.07.2016 and three technical personnel viz. D.R. Bhatt, A.K. Maurya and Lokesh Kumar through DPC Held on 31.01.2017.
- MACP granted to 4 Skilled Supporting Staffviz. K.T. Kapadia, M.B. Sheikh, J.G. Agrawat and B.J. Dabhi through DPC for MACP Held on 21.07.2016.

Retirement

- Sh. G.J.Solanki,Technical Officer retired on superannuation w.e.f.31.05.2016
- Sh. V.G.Koradia, Chief Technical Officer retired on superannuation w.e.f. 31.07.2016
- Sh.J.G.Kalariya, Technical Officer retired on superannuation w.e.f. 31.08.2016
- Sh.Virendra Singh, Asstt Chief Technical Officer retired on superannuation w.e.f. 31.12.2016

Transfer

- Dr. K Chakraborty, Scientist (Plant Physiology) was transferred to National Rice Research Institute, Cuttak on 28th May, 2016.
- Dr. Debarti Bhaduri, Scientist (Soil Science) was transferred to National Rice Research Institute, Cuttak on 28th May, 2016.
- Sh. Darvesh Kumar, Administrative Officer was transferred to Indian Institute of Sugarcane Research, Lucknow on 16th May, 2016.

Institute Joint Staff Council

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

Members: Staff side

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

Members:- Office side

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