



वार्षिक प्रतिवेदन ANNUAL REPORT 2020



भाकृअनुप-मूँगफली अनुसंधान निदेशालय

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

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

ICAR-Directorate of Groundnut Research

(An ISO 9001 : 2015 Certified Institute)

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

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अनुदेश

- मूँगफली में उत्पादकता तथा गुणवत्ता सुधार के लिए आधारीय, नीतिगत तथा अनुकूल अनुसंधान।
- उपयुक्त किस्मों तथा प्रौद्योगिकियों के विकासार्थ जानकारीयों ज्ञान तथा आनुवंशिक सामग्री को उपलब्ध करवाना।
- स्थान विशिष्ट किस्मों तथा तकनीकियों के विकास हेतु अनुप्रयुक्त अनुसंधान का समन्वयन।
- प्रौद्योगिकियों का प्रचार-प्रसार तथा क्षमता निर्माण।

Mandate

- Basic, strategic and adaptive research on groundnut to improve productivity and quality
- Provide access to information, knowledge and genetic material to develop suitable varieties and technologies
- Coordination of applied research to develop location specific varieties and technologies
- Dissemination of technology and capacity building

परिकल्पना

खाद्य तेल उत्पादन, पोषण और आजीविका सुरक्षा में आत्मनिर्भरता प्राप्त करने के लिए मूँगफली की उत्पादकता और गुणवत्ता में वृद्धि करना।

Vision

Enhancing the productivity and quality of Groundnut for attaining self-sufficiency in edible oil production, nutritional and livelihood security.

Preface



It gives me immense pleasure to present the annual report of the ICAR-Directorate of Groundnut Research, Junagadh (2020), an organization which make every effort to serve a wide range of stakeholders, from farmers to industries. The cultivation of groundnut has been spread on almost all soils throughout the world due to its wide adoptability and is now being cultivated globally on about 29 million hectares (m ha) of land. India, with 10 million tons (mt) of pods produced from about its 5 million ha area, is the second largest producer as well as consumer of groundnut in the world. During the last decade (2010-2020) much attention was paid to increase the productivity. As a result, the groundnut productivity in India surpassed the world average with 1764 kg ha⁻¹ pod with 9.7 mt production of groundnut pods during 2013-14 and finally reached 2065 kg ha⁻¹ with 10.1 mt of pods during 2020. Though in India groundnut is grown in almost all states in a small to large area and consumed by local people, the Gujarat (32% of total area and 39% of production), Andhra Pradesh (19% area and 10% production), Rajasthan (11% area and 14% of production), Tamil Nadu (7% area and 11% of production), Karnataka (11% area and 6% production), Madhya Pradesh (4% area and 5% of production) and Maharashtra (6% area and 4% of production) are the main groundnut growing states. During last decade the Gujarat, Rajasthan and Tamil Nadu accounted for about 50% of the area producing about 65% of the groundnut of India and now are the best belt for commercial production.

Low productivity, due to unfavourable climate in most parts of India, is the biggest hindrance in sustainable groundnut cultivation. High temperatures and drought during crucial growth stages, the catastrophic environmental changes and a combined pressure of diseases and insects, have a significant effect on productivity. The ICAR-DGR is working hard to solve these issues and continue to improve groundnut production in the face of climate change. The major areas of research at ICAR-DGR include resistance to biotic and abiotic stresses, early maturity, fresh seed dormancy, confectionery, high oil and oleic acid. To address specific issues, the ICAR-DGR has opened three regional stations, (a) Anantpur, Andhra Pradesh (drought of various intensities), (b) Bikaner, Rajasthan (high temperature, drought and soil-borne diseases) and (c) Medinipur, West Bengal (viability and fresh seed dormancy). The present annual report highlights the significant achievements made under different research activities.

During 2020 several promising advanced breeding lines with high kernel yield (PBS12221, PBS12228 and PBS 29079B), resistance to *Alternaria* blight (PBS12190, PBS22131, PBS22132 and PBS22133), and having 15 days fresh seed dormancy (PBS11077, 11092, 14060, 14068, 15027, 15028, 16023, 16038 and 16044) were identified. Two high oil genotypes NRCGCS635 (HOS30) and NRCGCS636 (HOS89) were registered. To control stem and collar rot *i.e.* deep summer ploughing + seed treatment with tebuconazole (@ 1.5 g/kg of seed) + soil application of *T. harzianum* S1 (@ 4 kg/ha enriched in FYM) was recommended. The groundnut cultivars RHRG6083, KDG128 and KDG123 are identified as novel source of resistance to rust. Fungicides pyraclostrobin + metiram and tebuconazole were effective in reducing the severity of *Alternaria* leaf blight. The leaf blight and wilt, a new disease caused by *Fusarium incarnatum*, was reported at Bikaner and Jodhpur. A large variability in tocopherol was found in groundnut cultivars (27.8 mg/100 g oil in OG52-1 to 56.7 mg/100 g oil in OG52-1). Cultivar Dharani, GJG22, GG20, GG7, Girnar3 and TG51 with more than 5 traits (low or high oil, high protein, Zn, K, Fe, phenol, catechin, resveratrol, sugars, tocopherols, high antioxidant activity and low raffinose sugars) were reported. Endophytes inoculation was recommended to reduce 3-4 irrigations for summer groundnut. Two efficient Zn-solubilising isolates, *Acinetobacter oleivorans* strain ZM-12 and *Enterobacter cloacae* sub spp., *dissolvens* strain ZM-9 and two efficient K-solubilising isolates, *Acinetobacter lactucae* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9 were found promising. The severity of *Alternaria* leaf blight was reduced by spraying with leaf epiphytic bacteria *Bacillus amyloliquefaciens* 9S2.

The annual report 2020 includes a comprehensive picture of the ICAR-DGR's research and extension activities. I gratefully acknowledge the whole-hearted support and co-operation of all the scientific, technical, administrative and supporting staff of this directorate. I would like to thank the editorial board for all their hard work in compiling and editing this report.



(A. L. Singh)

सारांश



फसल सुधार

- प्रारंभिक उपज मूल्यांकन परीक्षण में एनआरसीजीसीएस 183 को उत्कृष्ट नियंत्रण की तुलना में अनंतपुर में अधिक उपज प्रदान करता के रूप में पहचान की।
- स्पेनिश बंच की उन्नत प्रजनन लाइन पीबीएस-12221 को उत्कृष्ट नियंत्रण किस्म टीजी 37ए की तुलना में ग्रीष्म 2019-2020 के दौरान दाना उपज के संदर्भ में 10 प्रतिशत अधिक उपज के लिए पहचान की गई। इसे रबी-ग्रीष्म फसल काल में एआईसीआरपी-जी स्पेनिश बंच के तहत बहु स्थानीय परीक्षण के लिए प्रस्तावित किया जायेगा।
- स्पेनिश बंच की उन्नत प्रजनन लाइन पीबीएस-12828 को उत्कृष्ट नियंत्रण किस्म टीजी 37ए की तुलना में खरीफ 2019-2020 के दौरान दाना उपज के संदर्भ में 59 प्रतिशत अधिक उपज के लिए पहचान की गई। इसे खरीफ फसल काल में एआईसीआरपी-जी स्पेनिश बंच के तहत बहु स्थानीय परीक्षण के लिए प्रस्तावित किया जायेगा।
- उन्नत प्रजनन लाइनों (नयी तथा पुरानी), कल्टीवारों, जननद्रव्यों तथा एआईसीआरपी - जी में प्रस्तावित कुल 181 लाइनों का ग्रीष्म 2020 (45), खरीफ-2020 (236) में उपज तथा परीक्षण के लिए पर्याप्त मात्रा में बीजों के लिए गुणन किया गया।
- ग्रीष्म फसल कालों (2017, 2018, 2019) तथा 2020) में जाँच के आधार पर चार उन्नत प्रजनन लाइनों अर्थात पीबीएस-12190, पीबीएस - 22131, पीबीएस-22132 तथा पीबीएस 22133 तथा चार अंतर विशिष्ट उत्पादों यदा, एनआरसीजी सीएस - 176, एनआरसीजी सीएस - 180 , एनआरसीजी सीएस - 196 तथा एनआरसीजी सीएस - 298 को अल्टरनेरिया पत्ती झुलसा के लिए प्रतिरोधी पाया गया (1 से 9 पैमाने पर <3)।
- तीन ग्रीष्म फसल कालों (2018, 2019, 2020) के परीक्षण परिणामों के आधार पर 47 जननद्रव्य लाइनों की पचाहन अल्टरनेरिया पत्ती झुलसा प्रतिरोधिता के लिए की गई (1 से 9 पैमाने पर <3)।
- सात कल्टीवारों अर्थात एचएनजी-10, मल्लिका (आईसीएचजी00440), एचएनजी-69, राज दुर्गा (आरजी-

425), जीएयूजी-10, गिरनार3 तथा जीजेजी2 2 के सभी प्रतिकृतियों में बीकानरे पर खरीफ 2020 में कॉलर सड़न के विरुद्ध 17 प्रतिशत मृत्यु दर था।

- एक उन्नत प्रजनन लाइन पीबीएस 29079बी ने जूनागढ़ में (75 ग्राम) तथा बीकानेर में (122 ग्राम) सर्वाधिक 100 दाना भार रिकार्ड किया।
- अधिक ब्लेंचेबिलिटी (>75 प्रतिशत) मूँगफली जीनोटॉप की पहचान की गई।
- अधिक तेल की मात्रा युक्त जननद्रव्य 635 (एचओएस 30) तथा एनआरसीजीसीएस 636 (एचओएस89) को पंजीकृत किया गया।
- दो वर्षों तक (खरीफ 2019 तथा 2020 एवं ग्रीष्म 2019 तथा 2020) ताजा बीज प्रसुप्ति तथा फली उपज के लिए उन्नत प्रजनन लाइनों का किया गया मूल्यांकन तथा 15 दिनों से अधिक जाता बीज प्रसुप्ति युक्त 9 प्रजनन लाइनों पीबीएस 14060, 14068, 16044, 11077, 11092, 15027, 15028, 16023 तथा 16038 की पहचान की गई।
- 40 प्रजनन लाइनों के समूह को 6 नियंत्रकों तथा दो रेप्लीकेशन के साथ फली उपज के लिए खरीफ 2019 तथा 2020 खरीफ में मूल्यांकित किया गया। दो वर्षों के समूहीकृत आकड़ों के औसत के

आधार पर तीन प्रजनन लाइनों का (पीबीएस 16022, पीबीएस 15027 तथा पीबीएस 16045) को अधिक छिलका उतराई प्रतिशत (70 प्रतिशत) के लिए, छः प्रजनन लाइनों (पीबीएस 16053, पीबीएस 16029, पीबीएस 16033, पीबीएस 16029, पीबीएस 16035 तथा पीबीएस 14064) को दाना लंबाई: चौड़ाई अनुपात (>2 एल/डब्ल्यू अनुपात) तथा पाँच प्रजनन लाइनों (पीबीएस 16033, पीबीएस 16023, पीबीएस 14068, पीबीएस 14060 तथा पीबीएस 11092) को अधिक फली उपज के लिए पहचान की गई।

- उन्नीस उन्नत प्रजनन लाइनों का पाँच नियंत्रणों के साथ आलू परती में दीसा, गुजरात तथा मोहनपुर, पश्चिम बंगाल में दो प्रतिकृतियों में ग्रीष्म 2020 में मूल्यांकित किया गया। उन्नत प्रजनन लाइनों पीबीएस 16044, 11092, 11077, 3002 तथा 14080 ने मोहनपुर, पश्चिम बंगाल में जेएल 501 के समतुल्य फली उपज दर्शाया। उन्नत प्रजनन लाइनों 15050, 11077, 16004, 16020, 14060, 14080, 30002 तथा एनआरसीजीसीएस 254 ने जूनागढ़ में नियंत्रण के बराबर उपज दर्शाया।
- 2266 जननद्रव्यों तथा 30 विमोचित किस्मों के बीज 10 मांगकर्ताओं को दिया गया।
- आशाजनक प्रजनन लाइनों का

परीक्षण 2020 खरीफ के दौरान किया गया तथा प्रजनन लाइनें एचओएस-724 ने 27-109 प्रतिशत उपज लाभ चार नियंत्रण किस्मों - जीजेजी 22, केडम्भी 128, केडीजी 123 तथा टीजी 37ए की तुलना में रिकार्ड किया। इसके अलावा एचओएस- 724, एचओएस-93 तथा एचओएस-395 ने विभिन्न नियंत्रणों की तुलना में 10 प्रतिशत से अधिक उपज लाभ ग्रीष्म 2020 में दर्शाया। एचओएस-724 को मे एआईसी आरपी-जी में परीक्षण किया जायेगा।

मूलभूत विज्ञान

- मूँगफली किस्मों में टोकोफेराल की मात्रा में काफी अंतरा (ओजी 52-1: 27.8 मिग्रा/100 ग्राम तेल से टीजी 51:56.7 मिग्रा/100 ग्राम तेल) रिपोर्ट किया गया।
- भूने तथा पानी में भिगोने से मूँगफली में प्रतिरोधी श्वेतसार की मात्रा में वृद्धि रिपोर्ट की गई।
- कल्टीवार धरणी, जीजेजी 22, जीजी 20, जीजी 7, गिरनार-3 तथा टीजी 51 में पाँच से अधिक गुण (कम से अधिक तेल, अधिक प्रोटीन, जिंक, पोटेशियम, लौह, फिनाल, केटेचिन, रेसवेरेटाल, शर्करा, टोकोफेराल, उच्च अ-आक्सीकारक क्षमता तथा कम रेफीनोस शर्करा) रिपोर्ट किये गये।
- मूँगफली के प्रोटीन पृथक्कृतों के लिए लाइपेस तथा अल्ट्रासोनिकेशन

- उपचारों में प्रोटीन प्राप्ति की मात्रा में 5-1 प्रतिशत वृद्धि की।
- एनआईआर के द्वारा शर्करा की मात्रा का विश्लेषण 185 विमोचित किस्मों में किया गया, इसमें से 29 किस्मों में कुल घुलनशील शर्करा की मात्रा >6 प्रतिशत तथा एचएनजी 10 में अधिकतम (7.62 प्रतिशत) तथा इसके बाद के क्रम में गिरनार-3 (7.19) प्रतिशत तथा एमएच 2 (7.12 प्रतिशत) में दर्ज किया गया।
 - अंतःपादपों का उपयोग तथा पाँच सिंचाईयों से (औसत 2 4 7 1 किग्रा/हे.) अंकुरण पश्चात् 1 0 सिंचाईयों के बिना अंतःपादप के बराबर (2335 किग्रा/हे.) उपज प्राप्त की जा सकती है।
 - अंतःपादप के साथ ग्रीष्म मूँगफली उगाने से पानी की मात्रा (30-50 प्रतिशत) तथा सिंचाई संख्या (3-4) में कमी करना संभव है।
 - एसीनिटोबेक्टर जुनाई जे20एन, बेसीलस फरमस जे 22एन तथा बेसीलस प्रजाति आर5 1 जैसे अंतःपादपों का प्रयोग उपज हानि में सुधार के द्वारा क्रमशः 19.5 प्रतिशत, 23 प्रतिशत तथा 28.0 प्रतिशत की कमी कटाई के समय 3.15 मृदा ईसी पर करता है।
 - मूँगफली में अंतःपादपों से सूखा तथा लवणता प्रतिबल में कमी का प्रमुख घटक पाथवे में उतरा-चढ़ाव के कारण सीएएम की अभिव्यक्ति है।
 - टीजी 3 7 ए के सी3 - सीएएम रूपांतरों का उपज मूल्यांकन टीजी 37ए में दो सहायक सिंचाई के साथ जैव भार में 47 प्रतिशत की कमी दर्शाता है, जबकि समान अवस्था में सी४-सीएएम अवस्थांतर रूपांतरों में जैव भार की कमी केवल 29-34 प्रतिशत था। जैव भार में न्यूनतम कमी ओजीआरएमबी 5 में दर्ज की गई। डीजीआरएमबी 5 तथा डीजीआरएमबी 19 ने नियंत्रण की तुलना में 4.55 मृदा ईसी पर, सीसीएसआरआई, माण्डवी में अधिक फली उपज प्रदान की।
 - टीजी 37ए के अधिक अभिव्यक्त सी४-सीएएम अवस्थांतर रूपांतरों (जो की सूख सहनशील है) जैसे डीजीआरएमबी 19 ने जैव भार को कम होने से बचा था (सामान्य स्थिति के 6746 किग्रा/हे. से 4954 किग्रा/हे.) तथा इसे 26 प्रतिशत पर बनाये रखा जब मृदा ईसी 3.95 थी।
 - पाँच नये स्पर्धात्मक मूँगफली स्ट्रेनों (डीजीआर 23, डीजीआर 24, डीजीआर 25, डीजीआर 26 तथा डीजीआर 35) से मूँगफली बीजों के टीकाकरण के परिणाम स्वरूप मूँगफली कल्टीवार टीजी 37ए में सार्थक फली वृद्धि (15 से 19 प्रतिशत) हुई।
 - मूँगफली के बीजों का दो सक्षम जिनक विलेयकारी पृथक्कृतों जैसे एसीनिटोबेक्टर ओलीवोरान्स स्ट्रेन जेडएम - 12 तथा एंटेरोबेक्टर क्लोयके उपप्रजाति डिजालवेंस स्ट्रेन जेडएम 59 से टीकाकरण के परिणाम से फली उपज में 13 प्रतिशत की सार्थक वृद्धि हुई।
 - मूँगफली के बीजों का दो सक्षम पोटेशियम विलेयकारी पृथक्कृतों अर्थात् एसीनिटोबेक्टर लेक्टुके स्ट्रेन केएम 8-2 तथा सुडोमोनास तायवानसिस स्ट्रेन केएम-9 से टीकाकरण के परिणाम से फली उपज में क्रमशः 16.3 तथा 15 प्रतिशत वृद्धि हुई।
 - पत्ती अधोपादप जीवाणु बेसीलस एमाइलोलिक्वी फेसियंस 9एस2 के छिड़काव से अल्टरनेरिया पत्ती झुलसा की गंभीरता में अटीकाकृत नियंत्रण के 7.0 स्कोर से 4.0 स्कोर तक कमी हुई तथा फली उपज में 17 प्रतिशत की वृद्धि हुई।
 - शर्करा प्रोफाइलिंग से ज्ञात हुआ की लवणता तनाव से इनोसिटोल की मात्रा में तीव्र वृद्धि तथा ग्लूकोस एवं फ्रक्टोस स्तरों में कमी होती है।
 - 100 मूँगफली कल्टीवारों के जाँच से पता चला की 35 कल्टीवारों के दानों में जिनक की उच्च मात्रा (>40 पीपीएम) थी। इनमें से वीआरआई 2, सीओ 4, जीजेजी 32 में कम फाइटिक अम्ल की मात्रा (<0.5 ग्राम/100 ग्राम) रिकार्ड की गई। यह लक्षण उच्च पोषक घनत्व तथा खाने पर बेहतर उपलब्धता को सुनिश्चित करता है।
 - जिनक सल्फेट तथा एफपी 82 के ऊपरी उपचार में नियंत्रण की तुलना में बीजों में जिनक की मात्रा में

12 प्रतिशत से 16 प्रतिशत की वृद्धि दर्ज की गई।

- जीजेजी 22, गिरनार-2, टीजी 37ए, एचएन 10 तथा कादिरी 6 मूँगफली किस्मों के बीजों को 8 घंटे तक भिगोने से फाइटिक अम्ल की मात्रा में (23 से 68 प्रतिशत) तथा इसी क्रम में एमडब्ल्यू विकिरण तथा भूतने से भी सामान्य नमूनों की तुलना में सार्थक कमी हुई।
- मूँगफली राइजोबिया के पाँच नये पृथक्कृतों से बीज टीकाकरण ने उपज में सार्थक वृद्धि की (13.1 से 22.6 प्रतिशत)।
- पोटेशियम विलेयकारी जीवाणु संवर्धों के तीन पृथक्कृतों (एसीनीटोबेक्टर लेक्टुके स्ट्रेन केएम 5-2, एसीनीटोबेक्टर लेक्टुके स्ट्रेन केएम 8-2 तथा सुडोमोनास टायवानसिस स्ट्रेन केएम-9) से बीज टीकाकरण के परिणाम स्वरूप फली उपज में 14.7 से 23.2 प्रतिशत की सार्थक वृद्धि हुई।
- टीएजी 24 में पत्ती क्षेत्रफल अधिक पाया गया जो कि एनआरसीजी 12431 (227 वर्ग सेमी/ग्राम) के बराबर था, जबकि एनआरसीजी 14336 (18 मिग्रा/वर्ग सेमी) में पत्ती जल सार्थक अधिक था।
- 2:30 अपरान्ह में पीबीएस 14068 (43.4 डिग्री सेंटीग्रेड) का पत्ती सतह तापमान सार्थक अधिक था।
- दो गहराईयों पर मृदा परिच्छेदिका पोषक विश्लेषण (0-15 तथा 15-30

सेमी) दर्शाता है की सतही मृदा में पोषक स्थिति (एन-पी-के, 530-33-390 किग्रा/हे) उप सतही मृदा की तुलना में (एन-पी-के, 251-21-361 किग्रा/हे) उच्च था। सतही मिट्टी में जैविक कार्बन की मात्रा 0.62 प्रतिशत, जबकि उप सतही मृदा में यह 0.41 प्रतिशत था।

- विभिन्न समय अवधियों पर मृदा सतह तापमान दर्शाता है कि 11:00 बजे सवेरे तथा 2:30 बजे दोपहर को बी/डब्ल्यू उच्च मृदा सतह तापमान तथा निचली पत्ती सतह तापमान में 20 से 30 डिग्री सेंटीग्रेड का अंतर था।
- फास्फोरस नियंत्रण उपचार (0.0 किग्रा/हे फास्फोरस पेंटा आक्साइड) के अंतर्गत सार्थक अधिक औसत फली उपज प्रति पौध आईसीजीवी-91114, कादिरी-7 तथा पीबीएस-29148, क्रमशः स्पेनिश बंच, वर्जीनिया समूह तथा उन्नत प्रजनन लाइनों में रिकार्ड किया गया।
- फास्फोरस उपचार (75 किग्रा/हे फास्फोरस पेंटा आक्साइड) के अंतर्गत सार्थक अधिक औसत फली उपज प्रति पौध सीओ-3, सीएसएमजी 884 तथा पीबीएस-29138 में रिकार्ड किया गया जो क्रमशः स्पेनिश बंच, वर्जीनिया समूह तथा उन्नत प्रजनन लाइनें हैं।
- नियंत्रण की तुलना में 75 किग्रा/हे फास्फोरस पेंटा आक्साइड के प्रयोग से कल्टीवारों/जीनोटाइपों में औसत फली उपज प्रति पौधा तथा पौधा

शुष्क भार प्रति पौधा में वृद्धि क्रमशः 6.5 से 15.2 प्रतिशत तथा 1.3 से 24.8 प्रतिशत हुई।

- नियंत्रण की तुलना में वर्जीनिया कल्टीवारों में फास्फोरस की अधिक मात्रा के अंतर्गत और जड़ गाँठ शुष्क भार/पौधों में 8.9 प्रतिशत की कमी हुई।
- मूँगफली कल्टीवारों जीजी 7 तथा टीजी 37ए में विकास नियंत्रकों के उपयोग ने फली उपज तथा बीज आकार में वृद्धि की।

फसल सुरक्षा

- माडयूल-एम 17ए अर्थात् मोल्ड बोर्ड प्लो से ग्रीष्म में गहरी जुताई + जीजी 20 किस्म के बीज + टेबूकोनाजोल 1.5 ग्राम/किग्रा बीज की दर से बीज उपचार + टी. हर्जीयेनम एस। का एफवायएम के साथ 4 किग्रा/हे की दर से बुवाई के समय मिट्टी में प्रयोग, दूसरी बार 35 डीएएस (बुवाई पश्चात दिन) तथा तीसरा 80 डीएएस को किसानों की विधियों की तुलना में प्रभावकारी पाया गया।
- मूँगफली के अल्टरनेरिया पत्ती झुलसा रोग से जुड़े कुल 77 पृथक्कृतों को भारत के विभिन्न कृषि जलवायु क्षेत्रों से एकत्रित किया गया, किन्तु इन्हें कालोनी आकारिकी कवक जाल विकास दर तथा बीजाणु गुणधर्मों के आधार पर अलग नहीं किया जा सका। फिर भी अल्टरनेरिया प्रजातियों के रोगकर्ताओं में अंतर को रिकार्ड

- किया गया। अल्टरनेरिया पृथक्कृतों में आनुवंशिक विविधता की उपस्थिति को आरएपीडी तथा यूआरपी मार्करों के उपयोग से देखा गया।
- पाइराक्लोस्ट्रोबिन+ मेटेरीराम तथा टेबूकोनाजोल कवकनाशियों को एएलबी रोग की तीव्रता को कम करने में प्रभावी पाया गया।
 - महामारी विज्ञानीय घटक: 70-110 दिन की फसल अवस्था, 60 प्रतिशत के नीचे सापेक्ष आर्द्रता तथा 37 डिग्री सेंटीग्रेट के ऊपर तापमान, अल्टरनेरिया पत्ती झुलसा रोगा का 7.0 स्कोर (1 से 9 पैमाने पर) तक फैलाने में मदद करता है (अधिकतम 60 प्रतिशत तीव्रता)। चार या इससे अधिक सप्ताह तक पानी का तनाव, नत्रजन, लौह तथा जस्ते की कमी, जैसिड तथा थ्रिप्स द्वारा मूँगफली को नुकसान तथा 4 डीएस प्रति मीटर अथवा इससे अधिक लवणीय मृदा पर मूँगफली की खेती अल्टरनेरिया पत्ती झुलसा को बढ़ावा देती है।
 - कल्टीवार आरएचआरजी 6083, केडीजी 128 तथा केडीजी 123 की पहचान रस्ट प्रतिरोधिता के उत्कृष्ट स्रोत, पी. एराचीडिस के लिए की गई तथा प्रतिरोधी किस्मों के विकास के लिए मूँगफली प्रजनन कार्यक्रम में एक सक्षम दाता के रूप में उपयोग तथा रस्ट व्याप्त क्षेत्रों में उपयोग के लिए थी।
 - रूपात्मक तथा आण्विक चित्रण के आधार पर बीकानेर तथा जोधपुर में मूँगफली पत्ती झुलसा तथा उकठा से जुड़े रोग जनक की पहचान फ्यूजेरियम इनकानेन्टम के रूप में की गई। मूँगफली पर एफ. इनकानेन्टम रोग जनकता की प्रथम पुष्टिकृत रिपोर्ट। इसके उपरांत टीईएफ-1ए जीन का क्रम विश्लेषण तथा रोग व्याप्त क्षेत्रों के मूँगफली से छः प्रतिनिधि वियोजकों के आरडीएनए-आईडीएस क्षेत्रों तथा फ्यूजेरियम-आईडी डाटा बेस को खोजने पर >9 8 प्रतिशत न्यूक्लियोटाइड समानता फ्यूजेरियम इनकानेन्टम-एफ. इक्वीसेटी काम्प्लेक्स (एफआईएससी) दर्शाया।
 - थ्रिप्स तथा पत्ती फुदका संख्या पूरे साल भर दिखाई दी परन्तु हमें इनके संख्या का दो सार्थक शीर्ष 6वें तथा 38वें मानक सप्ताह में दिखाई दिया।
 - पत्ती फुदका की तीन शीर्ष अवस्था 7वें, 43वें तथा 45वें सप्ताह में था।
 - स्पोडोप्टेरा तथा हेलीकोवर्पा की अधिकतम पिंजड़े में पकड़ संख्या (8 भृंग प्रति पिंजड़ा) 35वें मानक मौसम विज्ञानीय सप्ताह में रिकार्ड किया गया।
 - हेलीकोवर्पा की न्यूनतम संख्या उपचार टी-4 क्लोरेनट्रानिलीप्रोल 18.5एससी 0-3 मिली/लीटर की दर पर तथा इसी क्रम में उपचार टी-3 क्रीनालफॉस 2 5 ईसी 2 मिली/लीटर तथा टी-1-बीटी-127 एससी सूत्रिकरण 3 मिली/लीटर की दर पर दर्ज किया गया जो की आपस में बराबर थे। उपचार टी-4 क्लोरेनट्रानिलीप्रोल 18.5 एससी 0.3 मिली / लीटर की दर पर सर्वाधिक फली उपज (1866 किग्रा/हे.) दर्ज की गई।
 - गिरनार-3 में छोटे बीज आकार तथा कुल फिनाल की अधिक मात्रा के कारण कम फली नुकसान गिरनार-2 के बड़े बीज आकार तथा कम कुल फिनाल की मात्रा की तुलना में रिकार्ड किया गया।
 - प्राकृतिक अवस्था में मूँगफली भंडारण के लिए जूट के थैलों की तुलना में 160 माइक्रान के एचडीपी थैलियां मूल्य सुलभ तथा मूँगफली के भंडारण में सुधार परक पाई गई।
 - मेलोईडीगाइन, टाइलेंकोरिकंस, एफेलेंकस प्रजाति, टाइलेंकुलस, झिफिनेमा, हेलीकाटीलेंकस जीनस रिपोर्ट किये गये पादप परजीवी थे।
 - डोरीलेमिडस, चिलोप्लेकस, एक्रोवीलोइडस, पेराकोबेलेस, सीफेलोबस, यूसीफेलोबस, सूडोएक्रोबेलिस, यूसीफेलोबस, हेटरोसीफेलोबस, रेबडीटीडा जीनस सूत्रकृतियों के मुक्त जीवीय समूह के हैं। संरक्षण कृषि तथा कम मृदा हल-चल के कारण फसल उत्पादन प्लाटों में अधिक विविधता पाई गई।

Summary



Crop improvement

- Preliminary yield evaluation trial identified NRCGCS 133 to be high yielder than superior check at Anantpur.
- Spanish bunch advanced breeding line, PBS 12221 was identified with 10% higher kernel yield over the best check variety TG 37A during summer 2019-2020. It will be proposed for multi-location testing under AICRP-G Spanish bunch trials of *rabi*-summer season.
- One Spanish bunch advanced breeding line, PBS 12228 with 59% superiority in kernel yield over the best check variety TG37A during *kharif* 2019-2020 was identified. It will be proposed for multi-location testing under AICRP-G Spanish bunch trials of *kharif* season.
- A total 281 advanced breeding lines (new and existing), cultivars, germplasm lines and AICRP-G proposed lines were mass multiplied during summer 2020 (45) *kharif*-2020 (236) to get sufficient seed for conducting yield and screening trials.
- Based on four summer season (2017, 2018, 2019, 2020) screening results, four advanced breeding lines *viz.*, PBS-12190, PBS-22131, PBS-22132 and PBS-22133 and four interspecific derivatives *viz.*, NRCGCS-176, NRCGCS 180, NRCGCS 196 and NRCGCS 298 were found resistance to *Alternaria* leaf blight (score ≤ 3 on 1-9 scale).
- Based on three summer season (2018, 2019, 2020) screening results, 47 germplasm lines were identified to be resistant to *Alternaria* leaf blight (score ≤ 3 on 1-9 scale).
- Seven cultivars *viz.*, HNG-10, Mallika (ICHG 00440), HNG-69, Raj Durga (RG-425), GAUG-10, Girnar 3 and GJG 22 had less than 17% plant mortality against collar rot in all the replications during *kharif* 2020 at Bikaner.
- An advanced breeding line, PBS 29079B recorded highest

100 Kernel Weight at Junagadh (75 g) and at Bikaner(122 g).

- High blanchability (> 75%) groundnut genotypes were identified
- High oil content germplasm NRCGCS 635 (HOS 30) and NRCGCS 636 (HOS 89) were registered.
- Two years (*kharif* 2019 and 2020 and summer 2019 and 2020) evaluation of advanced breeding lines for fresh seed dormancy and pod yield identified nine breeding lines PBS14060,14068,16044, 11077, 11092, 15027, 15028,16023 and 16038 with more than 15 days fresh seed dormancy.
- A set of 40 breeding lines along with 6 checks in two replications were evaluated for pod yield during *kharif* 2019 and *kharif* 2020. Based pooled mean data for two years, three breeding lines (PBS 16022 and PBS 15027 and PBS 16045) for higher shelling percentage (70%); Six breeding lines (PBS 16053, PBS 16029, PBS 16033, PBS 16021, PBS 16035 and PBS 14064) for kernel length to width ratio (>2 L/W ratio) and five breeding lines (PBS 16033,

PBS 16023, PBS 14068, PBS 14060 and PBS 11092) for high pod yield have been identified.

- Nineteen advanced breeding lines along with five checks were evaluated in Potato fallows of Deesa, Gujarat and Mohanpur, West Bengal in two replications during summer 2020. Advanced breeding line PBS 16044, 11092, 11077, 3002 and 14080 showed at par pod yield with JL 501 in Mohanpur, West Bengal. Advanced breeding lines 15050, 11077, 16004, 16020, 14060, 14080, 30002 and NRCGCS 254 showed at par yield with check in Junagadh.
- Seeds of 2266 germplasm and 30 released varieties were supplied to 10 indenters.
- Promising breeding lines were tested during 2020 *kharif* season and breeding line, HOS-724 recorded 27-109 % yield advantage over four checks viz., GJG 22, KDG 128, KDG 123 and TG 37A. Besides, HOS-724, HOS-93 and HOS-395 also recorded more than 10% yield advantage over different checks during 2020 summer season. HOS-724 will be further tested in AICRPG.

Basic sciences

- A large variability for tocopherol content in groundnut cultivars (OG 52-1: 27.8 mg/100 g oil to TG 51: 56.7 mg/100 g oil) were reported.
- Roasting and seed soaking in water was reported to increase the resistant starch content in groundnut.
- Cultivar Dharani, GJG 22, GG 20, GG 7, Girnar3 and TG51 with more than 5 traits (low or high oil, high protein, Zn, K, Fe, phenol, catechin, resveratrol, sugars, tocopherols, high antioxidant activity and low raffinose sugars) were reported.
- For groundnut protein isolates, lipase and ultrasonication treatment improved protein recovery from 5-10%.
- Among 185 released groundnut varieties analysed for sugar content by NIR, 29 varieties had > 6% of total soluble sugars of which HNG 10 possessed highest (7.62 %) followed by Girnar 3 (7.19%) and MH 2 (7.12%).
- Application of endophytes and 5 irrigations can provide as much pod yield (average 2471 kg/ha) that can be obtained with 10

supplementary irrigations after emergence (2335 kg/ha) without endophytes.

- It would be feasible to reduce quantity (30-50%) and frequency of irrigations (3-4 irrigations) substantially for raising summer groundnut with endophytes.
- Application of endophytes like *Acinetobacter junii* J20N, *Bacillus firmus* J22N, and *Bacillus* sp. R51 prevented the reduction in yield losses by improving the yield by 19.5%, 23.0%, and 28.0%, respectively at soil EC of around 3.15 at harvest.
- Modulation of pathways leading to expression of CAM has been found to be the major factor in alleviation of drought and salinity stress in groundnut by endophytes.
- Yield evaluation of C3-CAM variants of TG 37A showed that whereas reduction of biomass was around 47% in TG 37A with two supplementary irrigations, C3-CAM transited variants showed biomass reduction from 29-34% in similar conditions. Least reduction in biomass was obtained with DGRMB 5. DGRMB 5 and DGRMB 19 gave higher pod yield over

checks at salinity level of 4.55 soil EC at CCSRI, Mandvi.

- Over-expressive C3-CAM transited variants of TG 37A (which are otherwise drought tolerant) like DGRMB 19 minimized the biomass reduction (6746 kg/ha on normal condition to 4954 kg/ha) and maintained at 26% level of reduction at 3.95 soil EC.
- Seed inoculation with five new competitive strains of groundnut rhizobia (DGR 23, DGR 24, DGR 25, DGR 26, and DGR 35) resulted in significant enhancement of pod yield (15 – 19%) of groundnut, cultivar TG37A.
- Seed inoculation of groundnut with two efficient Zn-solubilising isolates, *Acinetobacter oleivorans* strain ZM-12 and *Enterobacter cloacae* sub sp. *dissolvens* strain ZM-9 resulted in significant increase in pod yield of 13%.
- Seed inoculation of groundnut with two efficient K-solubilising isolates, *Acinetobacter lactucae* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9 resulted in significant increase in pod yield of 16.3 and 15%, respectively.

- The severity of *Alternaria* leaf blight reduced from a score of 7.0 (in a scale of 1-9) in uninoculated control to 4.0 when sprayed with leaf epiphytic bacteria *Bacillus amyloliquefaciens* 9S2, along with enhancement of pod yield by 17%.
- Sugar profiling revealed that salt stress led to increase in inositol content with a sharp decline in glucose and fructose levels
- Screening of 100 groundnut cultivars revealed 35 cultivars with high Zn density (>40 ppm) in their kernels. Out of these VRI 2, CO 4, GJG 32 recorded low phytic acid content (< 0.5 g 100g⁻¹). These traits would ensure high nutrient density with better availability upon consumption.
- An increase in seed Zn content by 12% and 16% was recorded with exogenous treatment using ZnSO₄ and FP 82 respectively, when compared to control.
- Seed soaking of groundnut cultivars GJG 22, Girnar 2, TG 37A, HNG 10 and Kadiri 6, for 8 h caused a significant reduction in phytic acid (23-68%) content followed by MW irradiation and roasting as compared to raw samples.

- Seed inoculation with 5 new isolates of groundnut rhizobia caused significant increase in yield (13.1-22.6%)
- Seed inoculation with 3 isolates (*Acinetobacter lactucae* strain KM5-2, *Acinetobacter lactucae* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9) as K solubilizing bacterial cultures resulted in significant increase in pod yield ranging from 14.7 to 23.2%
- Specific leaf area was observed to be significantly great in TAG 24, which was at par with NRCG 12431 (227 cm²/g), while leaf water content was significantly more in NRCG 14336 (18 mg/cm²).
- Leaf surface temperature was found to be significantly high in PBS 14068 (43.4°C) at 02:30 PM.
- Soil profile nutrient analysis at two depths (0-15 and 15-30 cm) revealed that surface soil has higher nutrient status (N-P-K 530-33-390 kg/ha) compared to sub surface soil (N-P-K 251-21-361 kg/ha). Organic carbon in surface soil was 0.62%, while in sub-surface soil it was 0.41%.
- Soil surface temperatures at different time periods revealed that there was a

minimum of 20-30 °C difference b/w higher soil surface temperature and lower leaf surface temperatures at 11:00 AM and 2:30 PM.

- Under P control treatment (0 kg P₂O₅/ha), significantly higher mean pod yield plant-1 was found in ICGV 91114, Kadiri 7, and PBS 29148 belonging to Spanish bunch, Virginia group and advanced breeding lines respectively
- In P treatment (75 kg P₂O₅/ha), significantly higher mean pod yield plant-1 was found in CO-3, CSMG 884, and PBS-29138 belonging to Spanish bunch, Virginia group and advanced breeding lines respectively.
- Mean pod yield plant-1 and Shoot dry wt. plant-1 increased by 6.5-15.2% and 1.3-24.8% respectively across cultivars/genotypes, when 75 kg P₂O₅/ha was used, compared to control
- There was 8.9% decrease in average nodule dry wt. plant-1 under high P doses in Virginia cultivars compared to control
- Growth regulators increased pod yield and seed size in the groundnut cultivars GG 7 and TG 37A.

Crop-protection

- Module-M17A i.e. Deep summer ploughing with mould board plough + seed of variety GG 20 + seed treatment with tebuconazole @ 1.5 g/ kg of seed + soil application of *T. harzianum* S1 @ 4 kg/ ha enriched in FYM first at the time of sowing, second at 35 DAS (days after sowing) and third at 80 DAS was found effective over farmers' practice.
- Total 77 isolates of *Alternaria* sp. associated with leaf blight disease of groundnut were collected from different agro-climatic regions of India could not be differentiated based on colony morphology, mycelial growth rate, and spore characters. However, differences in pathogenicity of *Alternaria* sp. isolates were recorded. Existence of genetic diversity among isolates of *Alternaria* sp. was observed using RAPD and URP markers.
- Fungicides namely pyraclostrobin + metiram and tebuconazole were found to be effective to reduce the disease severity of ALB.
- Epidemiological factors - crop age of 70-110 days, relative humidity below 60% and

temperature above 37⁰ C, favoured occurrence of *Alternaria* leaf blight up-to 7 rating scale (max. 60% severity) of 1-9 scale. Water stress for 4 weeks or above, deficiencies of nitrogen, iron and zinc, damage of peanut by jassids and thrips, and peanut grown in the saline soil at 4 dsm-1 or above were favoured the *Alternaria* leaf blight.

- Cultivars RHRG 6083, KDG 128 and KDG 123 were identified as novel source of resistance to rust, *P. arachidis* and used as potential donor parent in groundnut breeding programme for developing variety resistant and also in the rust prevailing areas.
- Based on morphological and molecular characterization, the pathogen associated with leaf blight and wilt of peanut occurring at Bikaner and Jodhpur was identified as *Fusarium incarnatum*, the first confirmed report of *F. incarnatum* as pathogenic on peanut. Further, sequence analysis of TEF-1a gene, part of rpb2 gene and rDNA-ITS region of six representative isolates from peanut in areas where the disease prevails, and a search of the Fusarium-ID database showed > 98%

nucleotide similarity with the *Fusarium incarnatum*–*F. equiseti* species complex (FIESC).

- Thrips and leafhopper population was found throughout the year, but we observed two significant peaks of thrips population during 6th and 38th Standard week
- Leafhopper population had three peaks at 7th, 43rd and 45th Standard week.
- Maximum trap catch of Spodoptera (25 moths per trap) and Helicoverpa (8 moths per trap) was recorded on 35th Standard meteorological week.
- *Helicoverpa* population was found lowest in the treatment of T4- Chlorantraniliprole 18.5 SC @ 0.3 ml/l recorded lowest population of and was followed by was followed by T3- Quinalphos 25 EC @ 2 ml/l and T1- Bt-127 SC formulation @ 3 ml/l and which showed at par results with each other. The treatment T4- Chlorantraniliprole 18.5 SC @ 0.3 ml/l recorded highest pod yield (1866 kg/ha)
- Pod damage was less in Girnar 3 due to smaller seed size and higher content of total phenols

compared to Girnar 2 were damage was significantly higher due to large seed size and low total phenol content.

HDPE bag of 160 micron was cost effective and improve the storability of groundnut compared to gunny bags when stored under natural condition.

- *Meloidgyne*, *Tylenchorynchus*, *Aphelenchus* sp, *Tylenchulus*, *Xiphinema*, *Helicotylenchus* genus were reported plant parasites.
- *Dorylaimids*, *Chiloplacus*, *Acrobeloides*, *Paracrobeles*, *Cephalobus*, *Eucephalobus*, *Pseudoacrobeles*, *Eucephalobus*, *Heterocephalobus*, *Rhabditida* genus of nematodes belongs to free living group. Crop production plots were found to have high diversity due to conservation agriculture and less disturbance of soil.

1 Genetic improvement of groundnut



Project: Management of Stem and Collar Rot Diseases of Groundnut

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1. Hybridization

Five crosses were effected in net house conditions to

develop improved groundnut varieties resistant of collar rot during summer 2020. The number of harvested crossed pods varied from 31 (TG 37A × OG 52-1) to 353 (Girnar 2 × OG 52-1). The mean success rate (%) of the hybridization programme was 27.6, which ranged from 8.1 to 67.6% (Table 1a).

Four crosses were effected in hybridization block to develop improved groundnut varieties resistant of stem rot during *kharif* 2020. The number of harvested crossed pods varied from 58 (GG 20 × PBS 18037) to 214 (TG 37A × PBS 18037). The mean success rate (%) of the hybridization programme was

Table 1a. Crosses effected in summer 2020 (Net house)

SN	Name of crosses	Purpose of crosses	Pollination made (no.)	F ₁ pods harvested (no.)	Success rate (%)
1	Girnar 2 × OG 52-1	High yield and collar rot resistance	522	353	67.6
2	OG 52-1 × J 11	High yield and collar rot resistance	441	112	25.4
3	OG 52-1 × KDG 128	High yield and collar rot resistance	532	43	8.1
4	OG 52-1 × PBS 22092	High yield and collar rot resistance	522	67	12.8
5	TG 37 A × OG 52-1	High yield and collar rot resistance	179	31	17.3
			2196	606	27.6

Table 1b. Crosses effected in *kharif* 2020 (hybridization block)

SN	Name of crosses	Purpose of crosses	Pollination made (no.)	F ₁ pods harvested (no.)	Success rate (%)
1	TG 37A × PBS 18037	High yield and resistance to stem rot	575	214	37.2
2	GG 20 × PBS 18037	High yield and resistance to stem rot	413	58	14.0
3	TG 37A × CS 19	High yield and resistance to stem rot	602	145	24.1
4	TG 37A × CS 319	High yield and resistance to stem rot	345	165	47.8
			1935	582	30.0

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Table 1c. Crosses effected in *kharif* 2020 (net house)

SN	Name of crosses	Purpose of crosses	Pollination made (no.)	F ₁ pods harvested (no.)	Success rate (%)
1	Girnar 2 × OG 52-1	High yield and resistance to collar rot	198	109	55.1
2	OG 52-1 × Girnar 2	High yield and resistance to collar rot	356	120	33.7
3	Girnar 2 × J11	High yield and resistance to collar rot	222	167	75.2
4	J 11 × Girnar 2	High yield and resistance to collar rot	364	64	17.6
5	PBS 22092 × F ₁ (OG 52-1 × J 11)	High yield and resistance to collar rot	203	177	87.2
6	J 11 × F ₁ (OG 52-1 × PBS 22092)	High yield and resistance to collar rot	151	125	82.8
7	K 1812 × Dh 257	High yield for dual season	295	256	86.8
8	Dh 256 × Dh 257	High yield for dual season	199	166	83.4
9	GJG 31 × PBS 22040	High yield and tolerant to iron chlorosis	366	327	89.3
10	PBS 22040 × GJG 31	High yield and tolerant to iron chlorosis	219	134	61.2
11	GJG 31 × CS 298	High yield and resistance to <i>Alternaria</i> leaf blight	160	85	53.1
12	Kadiri 6 × CS 298	High yield and resistance to <i>Alternaria</i> leaf blight	170	95	55.9
13	GJG 31 × PBS 22131	High yield and resistance to <i>Alternaria</i> leaf blight	145	118	81.4
14	Kadiri 6 × PBS 22131	High yield and resistance to <i>Alternaria</i> leaf blight	130	97	74.6
			3178	2040	64.2

30.0, which ranged from 14.0 to 47.8% (**Table 1b**).

In addition to that 14 crosses were effected in net house conditions to develop improved groundnut varieties resistant of collar rot and *Alternaria* leaf blight during *kharif* 2020. The number of harvested crossed pods varied

from 64 (J 11 × Girnar 2) to 256 (K 1812 × Dh 257). The mean success rate (%) of the hybridization programme was 64.2, which ranged from 17.6 to 89.3% (**Table 1c**).

2. Identification of hybrids

Nine different crosses were raised in *kharif* 2020 to

identify F₁'s effected for developing resistant genotypes to stem rot and collar rot. A total 130 single plants have been identified as hybrids in nine crosses, which ranged from 6 to 34. Highest number of hybrids have been identified in the cross TG 37A × NRCGCS 319 (34) followed

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Table 2. Details of F_1 's raised and hybrids isolated in *kharif* 2020

SN	Name of cross	Purpose of cross	F_1 seed obtained (no.)	Hybrids identified (no.)
1	TG 37 A $\times$ PBS 18037	High yield with resistance to stem rot	193	10
2	GG 20 $\times$ PBS 18037	High yield with resistance to stem rot	180	7
3	TG 37 A $\times$ NRCGCS 19	High yield with resistance to stem rot	247	24
4	TG 37 A $\times$ NRCGCS 319	High yield with resistance to stem rot	220	34
5	GIRNAR 2 $\times$ OG 52-1	High yield with resistance to collar rot	400	15
6	OG 52-1 $\times$ GIRNAR 2	High yield with resistance to collar rot	120	9
7	OG 52-1 $\times$ PBS 22092	High yield with resistance to collar rot	32	6
8	OG 52-1 $\times$ KDG 128	High yield with resistance to collar rot	61	19
9	TG 37 A $\times$ OG 52-1	High yield with resistance to collar rot	33	6
			1486	130

by TG37A $\times$ NRCGCS19 (24)

3. Advancement of different filial generations

A total 25 progenies of two crosses in F_6 generation of stem rot resistance were advanced to next filial generation in summer 2020. Among them 22 progenies were rejected at the time of harvesting due to

large proportion of poor recombinants and absence of desirable trait in the recombinants. From remaining three progenies, three new advanced high yielding stable breeding lines of Virginia bunch (PBS 22168, PBS 22169, PBS 22170) identified during summer 2020.

The breeding materials generated earlier were advanced to next filial generation. A total 197 progenies of 19 crosses were advanced in *kharif* 2020 to different filial generations (F_3 : 2, F_4 : 12, F_5 : 5). Among them, 14 crosses in early generations (up to F_4) and



Fig. Generation advancement and selection of segregating material during summer 2020

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Fig. Generation advancement and selection of segregating material during *kharif* 2020

Summary of advancement of different filial generations in *kharif* 2020

SN	Crosses (no.)	Generation	Cross reject	SPP/rows	Rejection	SPP (no.)
1.	2	F ₃	0	22	184	
2.	12	F ₄	0	130	60	70
3.	5	F ₅	0	45	32	13
	19			197	110	87

5 crosses in advanced generation. A total 110 progenies from 19 crosses were rejected from 197 progenies at the time of harvesting due to large proportion of poor recombinants and absence of desirable trait in the

recombinants.

4. Yield evaluation of advanced breeding lines

A. Summer 2020

Preliminary trial:

A total nine Spanish bunch genotypes with six checks (TAG 24, TG 37A, Dh 86 and

TPG 41, GJG 31, GJG 34) were evaluated in RBD with three replications for yield and its component traits during summer 2020. The results revealed that none of the genotypes found significantly superior over best check variety GJG 31 for

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pod (2424 kg/ha) and TG 37A for kernel yield (1126 kg/ha). These genotypes need to be tested one more year for final conclusion.

Advanced trial

A total fifteen Spanish bunch advanced breeding lines with six checks (TAG 24, TG 37A, Dh86 and TPG 41, GJG 31, GJG 34) were evaluated in RBD with three replications for yield and its component traits during summer 2019 and summer 2020. The results revealed that an advanced breeding line PBS 12221 (kernel yield: 1283kg/ha; SOT: 63%) was found at par with best check variety TG-37A for kernel yield (1167 kg/ha) and TPG 41 for SOT (62%). Based on two year testing in station trials these an advanced breeding line (PBS 12221) had 10% higher kernel yield over the best check variety hence could be proposed for *rabi*-summer testing under AICRP-G trials for yield.

B. Kharif

Spanish bunch (Second year): A total six Spanish bunch genotypes including four high yielding checks varieties viz., GG 7, TG 37A, JL 501 and GG 9 were evaluated in five rows of 5m row length for yield and its component traits in a RBD



Fig. Yield evaluation trials in summer 2020 (left) and *Kharif*-2020 (right)

with three replications during *kharif*-2019 and *kharif*-2020. The results revealed that advanced breeding line PBS 12228 (Pods/plant: 17, pod yield: 2602, kernel yield: 1734, SOT: 67%) was found significantly superior over best check varieties viz., JL501 for pods/plant (14), TG 37A for pod and kernel yield (1847 & 1089 kg/ha). This breeding line had 59% superiority in kernel yield over the best check variety. Therefore, it can be proposed for multi-location testing under AICRP-G Spanish bunch trials of *kharif* season.

Virginia bunch (First year):

A total seventeen genotypes of Virginia bunch including with four high yielding recommended checks viz. GG 20, KDG 123, KDG 128 and GJG 22 were evaluated in five rows of 5m length for yield and its component traits in RBD with three replications for *kharif* 2020. The results revealed that none of the genotypes significantly surpassed the best check

variety KDG 123 for pods/plant (17), kernel yield (1553 kg/ha) and SOT (71%) and KDG 128 for pod yield (2300 kg/ha). This breeding lines need to be tested one more year for final conclusion for testing under AICRP-G trials.

Virginia bunch (Second year):

A total fourteen genotypes of Virginia bunch including with four high yielding recommended checks viz. GG 20, KDG 123, KDG 128 and GJG 22 were evaluated in five rows of 5m length for yield and its component traits in RBD with three replications for *kharif* 2019 and *kharif* 2020. The results revealed that none of the genotype significantly surpass the best check varieties viz., KDG 128 for number of pods/plant (21) and pod yield (2962 kg/ha) and KDG 123 for kernel yield (1945 kg/ha) and SOT (68%). But one advanced breeding line PBS 22140 (pods/plant: 1, pod yield: 2786 kg/ha) was found significantly superior over best local check variety GG 20 for pods/plant (12) and

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pod yield (2297 kg/ha). This breeding line also had 13.8% superiority in kernel yield over the variety GG 20. It may be given for state groundnut trials.

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

I. Development of new advanced breeding lines

During summer 2020, a total six new advanced high yielding breeding lines were developed from advanced materials, of which three lines belongs to Virginia bunch (PBS 22168, PBS 22169, PBS 22170) and three lines belongs to Spanish bunch (PBS 12246, PBS 12247, PBS 12248). Five new Virginia bunch advanced breeding lines (PBS 22171, PBS 22172, PBS 22173, PBS 22174, PBS 22175) were developed during *kharif* 2020.

II. Multiplication and maintenance of breeding materials

A. Summer-2020: A total 45 advanced breeding lines (new and existing), germplasm lines and cultivars were mass multiplied during summer-2020 to get sufficient seed for conducting yield and screening trials.

B. Kharif-2020: A total 236

advanced breeding lines (new and existing), cultivars, germplasm lines and AICRP-G proposed lines were mass multiplied during *kharif* 2020 to get sufficient seed for conducting yield and screening trials.

III. Multiplication and status of AICRP-G lines

During *kharif* 2020, seed of four elite breeding lines (PBS 12201, PBS 12217, PBS 12218 and PBS 12223) were mass multiplied to get sufficient seed required for AICRP-G trials. An elite breeding line PBS 12200 was tested under IVT-II (SB) of AICRP-G trials in *kharif* 2019

Genotype	Summer 2020	Kharif 2020	Total
ABLs for conducting trials	15	6	21
ABLs for maintenance	16	106	122
New ABLs	13	19	32
Cultivars/Minicore	0	101	101
AICRP-G lines	1	4	5
	45	236	281

and it was failed to surpass the best checks in all the zones and an elite breeding line PBS 12201 was tested under IVT-II (SB) of AICRP-G trials in *kharif*-2020. Elite breeding line PBS 12200 was also found superior in summer therefore it was proposed for testing under IVT-I (SB) of AICRP-G trials for *rabi*-summer 2019-20.



Fig. PBS 12217: Elite breeding line identified for *rabi*-summer AICRP-G trials

6. Screening of genotypes for resistance to *Alternaria* leaf blight

A. Summer 2020

A total 179 groundnut mini-core germplasm along with



Fig. PBS 12218: Elite breeding line identified for *rabi*-summer AICRP-G trials

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PBS 12221: Elite breeding line identified for *rabi*-summer AICRP-G trials



PBS 12218: Elite breeding line identified for *kharif* AICRP-G trials

resistant check (NRCGCS 298 and PBS 22131) and susceptible check (GJG 31) were screened in the augmented design for resistant to *Alternaria* leaf blight by infector row technique during two consecutive summer 2018 and summer 2019. Artificial Inoculum of pathogen was sprayed after 30 days and there after 15 days interval of crop growth in the evening (06:00 PM) on infector as well as test entries for uniform spread of disease in screening trial. Based on two year results, 60 mini-core germplasm had disease score 3 were evaluated in 3rd year during summer

2020. The result revealed that 49 mini-core germplasm had disease score 3 on 1-9 scale. Maximum disease incidence was observed in the susceptible check (score 7.0 on 1-9 scale). Results of three years revealed that 47 mini-core germplasm (NRCG 14331, NRCG 14347, NRCG 14354, NRCG 14376, NRCG 14378, NRCG 14390, NRCG 14396, NRCG 14400, NRCG 14402, NRCG 14406, NRCG 14412, NRCG 14415, NRCG 14416, NRCG 14427, NRCG 14438, NRCG 14441, NRCG 14443, NRCG 14457, NRCG 14483, NRCG 14487, NRCG 14495, NRCG 14325, NRCG 14330, NRCG 14339, NRCG 14341, NRCG 14342, NRCG 14352, NRCG 14355, NRCG 14356, NRCG 14357, NRCG 14370, NRCG 14372, NRCG 14386, NRCG 14432, NRCG 14459, NRCG 14466, NRCG 14478, NRCG 14324, NRCG 14326, NRCG 14336, NRCG 14348, NRCG 14349, NRCG 14364, NRCG 14422, NRCG 14452, NRCG 14506, NRCG 14504) and based on two season (Summer 2019-20) two mini-core (NRCG 14340 and NRCG 14503) had a disease score 3 on 1-9 scale. These genotypes need to be screen at least two more season/year to confirm their resistance stability to *Alternaria* leaf blight across the years.

A total 34 groundnut genotypes including advanced breeding lines, cultivars and interspecific derivatives were screened in the replicated design for resistant to *Alternaria* leaf blight by infector row technique for three consecutive year's summer 2017, 2018 and 2019. Maximum disease incidence was observed in the cultivar GJG 31, GG 2 (score 7.0 on 1-9 scale) in summer 2019. Based on three year data revealed that three cultivars viz., Kaidiri 9, Kaidiri Haritendra, ICGV 00348; four advanced breeding lines viz., PBS 12190, PBS 22131, PBS 22132 and PBS 22133; four interspecific derivatives viz., NRCGCS 176, NRCGCS 180, NRCGCS 196 and NRCGCS 298 recorded a disease score 3 on 1-9 scale. These short listed genotypes along with three promising genotypes again evaluated in summer 2020 to confirm their resistance for *Alternaria* leaf blight across the four years. Result revealed that four advanced breeding lines viz., PBS 12190, PBS 22131, PBS 22132 and PBS 22133; four interspecific derivatives viz., NRCGCS 176, NRCGCS 180, NRCGCS 196 and NRCGCS 298 recorded a disease score 3 on 1-9 scale. These genotypes now can be used as novel resistance sources for

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Screening of genotypes for resistance to *Alternaria* leaf blight in summer 2020 (left) screening genotypes for leaf spot and rust in *kharif* 2020 (right)

Alternaria leaf blight and can be registered these genotypes as novel genetic stock for *Alternaria* leaf blight. In addition to that cultivars viz., Kaidiri 9, Kadiri Haritendra, ICGV 00348, GJG 17 and ICGS 44 were found tolerant to *Alternaria* leaf blight and should be used directly in high disease incidence groundnut areas.

7. Screening of genotypes for resistance to collar rot

A total 18 genotypes were screened in replicated trial for resistance to collar rot at Bikaner during *kharif* 2020. Data were recorded on plant mortality up to 45 DAS. The maximum collar rot incidence was 61.5% in cultivar TBG 39. Results revealed that seven cultivars viz., HNG 10, Mallika (ICHG00440), HNG-69, Raj Durga (RG 425), GAUG 10, Girnar 3 and GJG 22 had less than 17% plant

mortality in all the replications. These cultivars will be tested 3 more years to ascertain their resistance to collar rot.

8. Screening of breeding lines for tolerance to iron chlorosis

Total 53 genotypes including advanced breeding lines and cultivars were screened in un-replicated for tolerance of iron chlorosis for summer-2019. The genotypes viz., PBS 12228, PBS 12230, PBS 12231, PBS 12232, PBS 12228, PBS 12228, Dh 245 and ALR1 had 2 visual chlorotic rating (VCR) score. These lines need to be screened for 3 more year to identify iron tolerant genotypes. During summer 2020, a total 73 germplasm and breeding lines screened for tolerance of iron chlorosis in augmented trial. Results revealed that breeding lines (PBS 12218, PBS 22040) and

germplasm lines viz., NRCGs 14324, 14339, 14341, 14342, 14349, 14370, 14390, 14406, 14438, 14483, 14506 had a maximum score 2 on 1-5 scale while susceptible genotype GJG 31 had a maximum score 5. Hence, the breeding lines and germplasm lines will be tested for 2-3 more years to identify tolerant source of iron chlorosis in groundnut.



Fig. Field view of iron tolerant breeding line, PBS 22040 during summer 2020

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Project: Breeding Groundnut for Paddy and Potato Cropping systems

PI: K Gangadhara

Co-PI: KK Pal, MV Nataraja, KK Reddy, Praveen Kona, Kirti Rani and Rupak Jena

Hybridization and generation advancement

- Eight crosses were effected for short duration and fresh seed dormancy during *kharif* 2020 and 1505 hybrid pods were harvested. The success rate was highest in cross TG 37A × TL G45 (76%) followed by PBS 15022 × KDG128 (73%), TG 37A × NRCG 14380 (73%), TG 37A × Girnar1 (68%), TG 51 × NRCG 14380 (50%), PBS 16004 × GG 20 (40%), TAG 24 × NRCG 14380 (33%). The lowest success rate was in TAG 24 × JL 501 (15%).
- F₁s from nine crosses generated during *kharif* - 2019, were raised along with their parents during summer-2020 and total of 309 hybrid plants were identified from nine crosses (Dh 256 × TG 26, GJG 31 × Girnar 3, Dh 256 × Chico, TG 37A × Dh 256, PBS 11154 × VRI 3, KDG 128 × Chico, (KDG 128 × VRI 3) × Dh 256, (KDG 128 × VG 13113) × GG 7 and (KDG 123 × VRI 3) × TAG 24 and harvested individually for further generation

advancement.

- A total 202 family progenies (F₀) from four crosses (TAG 24 × NRCG 6255 (96), TAG 24 × Girnar1 (63), JL 24 × NRCG 14338 (30) and JL 24 × NRCG 14368 (13)) were evaluated for pod yield and days to maturity during *kharif* 2020. A total of 26 new breeding lines viz., Seven ABLs (#28, 44, 46, 89, 63, 91 and 95) from TAG 24 × NRCG 6255; twelve ABLs (#17, 45, 40, 20, 176, 189, 134, 120, 136, 125, 8 and 10) from TAG 24 × Girnar1; Four ABLs (#125, 61, 5 and 3) from JL 24 × N 143668 and three ABLs (#39, 25 and 3) from JL 24 × N 14368 crosses have been isolated based on pod yield and short duration for further large scale yield evaluation.

Evaluation of Advanced breeding lines for Fresh Seed dormancy

Two years (*kharif* 2019 and 2020 and summer 2019 and 2020) evaluation of advanced breeding lines for fresh seed dormancy and pod yield identified nine breeding lines PBS 14060, 14068, 16044, 11077, 11092, 15027, 15028, 16023 and 16038 with more than 15 days fresh seed dormancy.

Evaluation of fresh seed dormant groundnut breeding

lines for pod yield and its attributing traits

During *kharif* 2018, forty breeding lines (PBS 16021, 14064, 16004, 16015, 16053, 16047, 16039, 16045, 16041, 16032, 14068, 16033, 15027, 16037, 16020, 16052, 16042, 16017, 16029, 15022, 16035, 16044, 16051, 16031, 15028, 16025, 16026, 16038, 16027, 11092, 14060, 15044, 16022, 15014, 16023, 11077, 16016, 16028, 16013 and 16024) showing more than 15 days fresh seed dormancy have been isolated. A set of 40 breeding lines along with 6 checks in two replications were evaluated for pod yield during *kharif* 2019 and *kharif* 2020. Based pooled mean data for two years, three breeding lines (PBS 16022 and PBS 15027 and PBS 16045) for higher shelling percentage (70%); Six breeding lines (PBS 16053, PBS 16029, PBS 16033, PBS 16021, PBS 16035 and PBS 14064) for kernel length to width ratio (>2 L/W ratio) and five breeding lines (PBS 16033, PBS 16023, PBS 14068, PBS 14060 and PBS 11092) for high pod yield have been identified with more than 15 days fresh seed dormancy.

Screening advanced breeding lines in potato fallows

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Nineteen advanced breeding lines along with five checks were evaluated in Potato fallows of Deesa, Gujarat and Mohanpur, West Bengal in two replications during summer 2020. Advanced breeding line PBS 16044, 11092, 11077, 3002 and 14080 showed at par pod yield with JL 501 in Mohanpur, West Bengal. Advanced breeding lines 15050, 11077, 16004, 16020, 14060, 14080, 30002 and NRCGCS 254 showed at par yield in Junagadh.

Validation of identified QTL/markers for fresh seed dormancy and search for causal variants for dormancy

A set of 30 genotypes (PBS 12171, PBS 12187, PBS 12189, PBS 12190, PBS 12192, GG 20, GJG 22, KDG 123, GJG 17, TG 37A, Dh 86, TPG 41, Girnar 3, TG 26, ICGS 44, GPBD4, ICGV 86590, Girnar1, GAUG 10, TMV 2, ICGS 11, KDG 128, GJG 17, Girnar 2, TMV 8, TMV 5, TMV 9, Co1, CS 19, CS 319) of diverse genetic background (Spanish and Virginia) reported for FSD was genotyped with reported diagnostic markers and newly synthesized tetraprimer for FSD. Of three markers, two markers A09_5289 and A10_4970 failed to distinguish dormant and non-

dormant parents, moreover they amplified same band in all the genotypes. However B 0 5 _ 8 1 9 6 showed polymorphism between dormant and non dormant parents with few exceptions. The designed primer were used to genotype the selected genotypes of groundnut. The designed tetra primer when amplified on set of genotypes, it failed to show variations for assumed causal variant C: A substitution. It may be the variant is absent in studied genotypes, or causal variation for dormancy is SNPs other than C: A substitution. So, need to search for new variants by sequencing outer primer band of dormant and non-dormant parent.

Survey and identification of Nematodes in Potato cropping systems

About 35 nematode samples were collected from Potato cropping systems in Deesa were fixed and dehydrated. From each fixed sample 200 ml of solution was taken and

counted for nematodes. Nematodes ranged from 750-2253 per 200 ml of sample. Villages like Kumpat, Deesa, Boyan, Rasana Nani and Rasana Mota showed nematodes population at a range of 6-8 nematodes/gram soil. Slides were prepared for nematode identification and diversity study. Both free living nematodes and plant parasitic nematodes were identified from each sample. Free living nematodes like *Cephalobus sp.*, *Acrobeloides sp.*, *Pseudoacrobeles sp.*, *Acrobellesciliatus*, *Eucephalobous sp.*, *Chiloplacus sp.*, *Heterocephalobus sp.*, *Dorylaimids*, *Rhabditids*, *Mononchids* were identified. Plant parasitic nematodes like *Meloidogyne arenaria*, *Tylenchorynchus sp.*, *Heliocotylenchus nannus.*, *Rotylenchulus sp.*, *Aphelenchus sp.*, *Longidorus sp.*, *Xiphinema sp.* identified from the sample. Plant parasitic nematodes were extracted from each sample but it was under economic threshold level.

Dynamics in leaf nutrient, physiological parameters and surface temperature in short duration Spanish bunch genotypes

A time lapse study was conducted in summer 2020 to



Fig. : Field view of fresh seed dormant and short duration groundnut elite breeding lines

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Fig : Potential groundnut advanced breeding lines for cultivation in potato fallows



PBS 14080



PBS 15014



PBS 15022



PBS 16004

study the time lapse nutrient content, plant physiological parameter changes in 24 short duration Spanish bunch genotypes (6 released varieties, 5 germplasm accessions and 14 advanced breeding lines). Leaf K, Na, P%, leaf, soil surface temperatures (65 DAS) were estimated at 5 different time periods (8AM, 11AM, 2:30 PM, 4:30 PM and 07:00 PM) in a day along with analysis of specific leaf area and leaf surface temperatures. Leaf K% at 2:30 PM was significantly high in NRCG 12431 and least was found in Dh 86 (0.30%). Leaf Na % at 2:30 PM was observed to be significantly high in PBS 14064 (0.060%). Mean K/Na ratio was considerably great in NRCG 12431 (25.6). Specific leaf area was observed to be significantly great in TAG 24, which was at

par with NRCG 12431 (227 cm²/g), while leaf water content was significantly more in NRCG 14336 (18 mg/cm²). Leaf surface temperature was found to be significantly high in PBS 14068 (43.4°C) at 02:30 PM. Soil profile nutrient analysis at two depths (0-15 and 15-30 cm revealed that surface soil has higher nutrient status (N-P-K 530-33-390 kg/ha) compared to sub surface soil (N-P-K 251-21-361 kg/ha). Organic carbon in surface soil was 0.62%, while in sub-surface soil it was 0.41%. Soil surface temperatures at different time periods revealed that there was a minimum of 20-30 °C difference b/w higher soil surface temperature and lower leaf surface temperatures at 11:00 AM and 2:30 PM.

Project: Management of drought stress in groundnut at Anantapur and adjacent areas

PI: Ajay BC

Co-PI: K Gangadhar, KK Pal, AL Singh and Sushmita

Hybridization and advancement of segregating generations

Seven fresh crosses were attempted in *kharif* 2020 to enhance yield under drought stress and more than 2000 hybrid pods were harvested with 14.6% crossing success (**Table 1**). In summer 20

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probable hybrid (F_1 generation) from seven crosses attempted in *kharif* 2019 were raised and F_2 hybrid pods were harvested as single plants. These seven crosses in F_2 generation were raised in Anantapur under rainfed conditions during *kharif* 2020 and advanced to next generation by bulk method (**Table 2**). A set of 227 single plant progenies were advanced to F_6 52 SPPs to F_4 and 23 SPPs to F_3 generations. A set of 23 breeding lines in F_6 and 22 breeding lines in F_7 generations were identified for preliminary yield evaluation trials.

Multiplication of promising breeding lines

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

Advanced yield evaluation trials

Advanced yield evaluation Spanish genotypes consisting 9 advanced breeding lines, 2 interspecific derivatives and 7 Virginia breeding lines were evaluated along with R 2001-2 and Kadiri Anantha as Spanish and virginia checks respectively. In Virginia group PBS 26052 had higher yield than the check whereas in

Table 1: Crosses effected in *kharif* 2020

SN	Crosses	Purpose	No. of Buds pollinated	F_1 pods harvested (no.)	Success rate (%)
1	PBS 30044×PBS 16040	High yield under drought	89	2	2.2
2	PBS 30044×PBS 11090		237	11	4.6
3	PBS 30044×PBSA 21116		305	13	4.3
4	PBS 30027×PBS 16040		425	41	9.5
5	PBS 30027×PBS 11090		408	64	15.7
6	PBS 30027×PBSA 21116		624	148	23.7
7	K 1812 x K 6		631	118	18.7
			2719	397	14.6

Table 2: Details of F_1 's raised and hybrids isolated in Summer 2020

SN	Crosses	Purpose of cross	F_1 seed obtained (no.)	Hybrids identified (no.)
1	PBS 15044×PBS 25038	High yield and high Shelling %	241	47
2	PBS 15044×NRCGCS 567		234	40
3	PBS 15044×PBS 21117	High yield and high stable RWC	450	102
4	PBS 15044×PBS 21110		278	38
5	PBS 15044×PBS 11093		303	22
6	PBS 15044×R-2001-2		289	44
7	PBS 15044×ICGV 91114		28449	2079

Spanish group PBS 40534 and PBS 11085 had high yield than the check R 2001-2.

Advanced yield evaluation of CAM transited genotypes and inter-specific derivatives

A set of 20 CAM transited genotypes and 20 interspecific derivatives were evaluated with three replications in row length of 5m having 5 rows with R 2001-2 and K 6 as checks. None of CAM

genotypes were superior to check R 2001-2 whereas among interspecific derivatives NRCGCS 254 was found superior over R 2001-2 for pod yield (**Table 4**).

Minimize yield losses under frequent drought situations

In order to minimize yield losses in frequent drought situations an experiment consisting of combinations of hydrogel, mulching with

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agrowaste, spray of Paclobutrazol and endophytes were undertaken in comparison with conventional practices. Experiment was laid out during the month during 3rd week of July 2020 and harvested during 1st week of November 2020. All different treatment combinations produced high yield in comparison to farmers practice of which treatment combination consisting of hydrogel, mulching with agrowaste, endophytic bacteria and pycobutrazol

recorded 57% higher yield over farmer's practice.

Evaluation of in-situ rain water conservation practices to mitigate drought

An experiment consisting of compartmental bunding, deep ploughing and their combinations were evaluated in comparison with conventional method for insitu rain water conservation to mitigate drought and to have high yield with four replications following RCBD design. Experiment was laid out during the month during

Table 4: Yield advantage of selected interspecific derivatives over best check

Genotype	PY (kg/ha)	Increase over R 2001-2 (%)
NRCGCS 254	1247	32.9
NRCGCS 297	954	1.7
NRCGCS 397	884	-5.8
NRCGCS 386	865	-7.8
NRCGCS 194	860	-8.3
NRCGCS 123	859	-8.5
K 6 (Check)	648	
R 2001-2 (Check)	938	

Table 3: Details of Spanish and Virginia breeding lines and their yield advantage over check

Spanish			Virginia		
Genotype	PY (kg/ha)	% increase over check	Genotype	PY (kg/ha)	% increase over check
PBS 11085	1488	46.2	PBS 26052	1368	5.3
PBS 40534	1112	9.3	PBS 25069	1026	-21.0
PBS 30027	981	-3.6	PBS 21116	1009	-22.3
PBS 11090	942	-7.4	PBS 25106	945	-27.3
PBS 16013	842	-17.3	PBS 25118	756	-41.8
PBS 30044	765	-24.9	PBS 25060	696	-46.4
PBS 11110	655	-35.6	PBS 25089	473	-63.6
NRCGCS 563	459	-54.9	Anantha (Check)	1299	
NRCGCS 379	404	-60.3			
PBS 16040	394	-61.3			
PBS 11072	364	-64.3			
R 2001-2 (Check)	1018				

1st week of July 2020 and harvested during 4th week of October 2020. Compartmental bunding produced 9% higher yield over conventional method.

Project: Management of groundnut genetic resources, development of pre-breeding material and trait discovery

PI: SK Bera

Co-PI: K Gangadhara, MK Mahatma, Ananth Kurella, Narendra Kumar, Ajay BC, Harish G, Kirti Rani, Rupak Jena and Rajaram Choudhary

Rejuvenation of germplasm

Germplasm with limited quantity of seeds in storage were planted during 2020 summer season for multiplication. A total of 442 germplasm lines were planted

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Table 5: Yield advantage of combinations of agronomic practices over farmers practice

Treatment	PY (kg/ha)	increase over conventional (%)
T1: Control (Farmers Practice)	471	
T2: Hydrogel+Mulching with Agrowaste+Pycobutrazol	672	42.6
T3: Hydrogel+Endophytic Bacteria+Pycobutrazol	603	28.0
T4: Mulching with Agrowaste +Endophytic Bacteria +Pycobutrazol	621	31.9
T5: Hydrogel+Mulching with Agrowaste+ Endophytic Bacteria+Pycobutrazol	740	57.2

in single line on five meter-bed. Out of which 277 lines germinated and further multiplied during 2020 *kharif* season.

Similarly, 228 FST and 1097 VUL germplasm were planted during 2020 *kharif* season. Out of which 174 FST and 1079 VUL germplasm germinated. Pod yield/10 plant, kernel yield/10 plant and shelling percent in FST group ranged from 1.9 g to 39.3 g, 1.3 g to 26.8 g and 46.6 g to 75.0 g, respectively with a mean of 13.3 g, 9.4 g and 60.9%, respectively. In VUL group pod yield/10 plant, kernel yield/10 plant and shelling percent ranged from 1.1 g to 80.0 g, 0.6 g to 50.0 g and 42.9 % to 77.8 %,

respectively with a mean of 15.4 g, 10.2 g and 66.1%, respectively.

Supply of germplasm

Altogether, seeds of 2266 germplasm and 30 released varieties were supplied to 10 indenters.

Screening of germplasm accessions for drought tolerance

Germplasm set consisting of 650 accessions were screened for drought tolerance at Anantapur along with three check K6, R 2001-2 and KDG 128 following augmented design. KDG 128 was superior check in terms of yield and also showed field resistance to LLS disease. Six accessions (NRCG 6774, 10753, 9272, 10398, 10406, 8223 and 6912) had high pod

Table 6: Yield advantage of in-situ rainwater conservation practices over conventional method

Treatment	PY (kg/ha)	increase over conventional (%)
T1: Conventional Method	990	
T2: Compartmental Bunding	1078	8.9
T3: Deep Ploughing	1062	7.3
T4: Compartmental Bunding +Deep Ploughing	1001	1.1

yield over superior check KDG 128 and accession NRCG 13582 showed field resistance to LLS disease with LLS score of 3.

Screening of RILs for resistance to stem rot

RILs of a cross between GG 20 × CS 19 were screened for resistance to stem rot under artificial sick plot during 2020 summer season. Two hundred and sixty four RILs were planted in three replications. Each RIL was sown in single line of two-meter bed. Screening was done as per previously reported method. Mortality was recorded after 15 days of inoculation and all the lines were found susceptible with more than 70% mortality including GG

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20 and CS 19. Distribution of mortality percent is depicted in **Fig. 1**. Majority of RILs were grouped in to the class ranging 91-100%.

Screening for optimum stage of resistance to stem rot

Artificial screening for resistance to stem was conducted at different stages of crop during summer season. The experiment was conducted to know the stage of crop expressing maximum resistance level. Three resistant and two susceptible genotypes were planted in RBD with three replications. Screening was done as per previously reported method. Plants were inoculated at three stages, immediate after sowing, 40 days after sowing and 60 days after sowing. TG 37A, a highly susceptible genotype recorded 92-100% mortality in all three stages of screening, while GG 20 recorded comparatively less mortality during sowing and maximum during both 40 DAS and 60 DAS. Similarly, CS 19, CS 319 and PBS18307 recorded less mortality during germination stage, while it reached maximum in both 40 DAS and 60 DAS (Table 1). CS 19 showed minimum mortality at the time of germination than all other genotypes and could be more resistant during

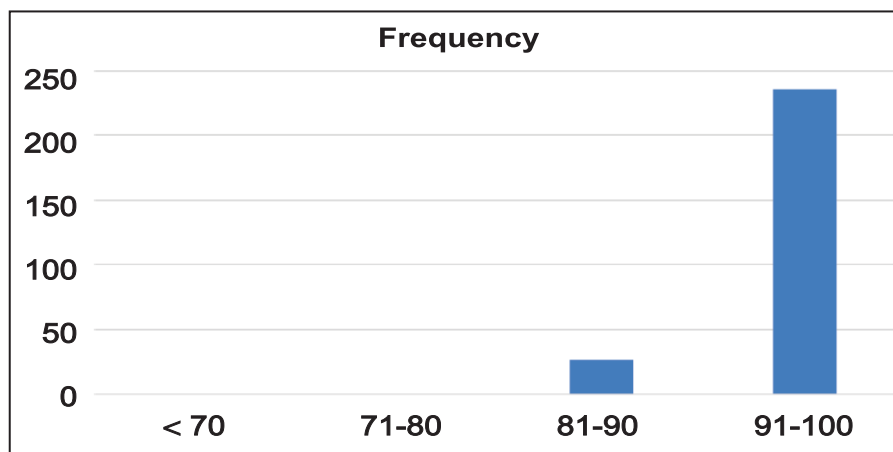


Fig. 1 Frequency distribution of 264 RILs for mortality per cent due to stem rot disease

germination stage. Results will be confirmed next season.

Yield evaluation of high oleic Virginia advanced breeding lines

Advanced lines (F_{5-6}) with high oleic acid were tested for yield during 2020 summer season. Eighty-five high oleic Virginia breeding lines were planted in augmented design. Each line was planted in three lines on five meter-bed. Pod yield was recorded at harvest and yield of breeding lines

were compared with checks. Out of which 36 lines performed better with 8% - 175% of yield advantage over check variety, Girnar 4 (**Fig. 2**).

Yield evaluation of high oleic Spanish bunch advanced breeding lines

Similarly, 37 Spanish bunch high oleic advanced lines were tested in augmented design during 2020 summer season. Each line was planted in three lines on five-meter

Table 1 Mortality percent for stem rot disease in three different stages

Varieties	Mortality percent		
	Sowing	40 DAS	60 DAS
CS 19	59	98	99
CS 319	76	90	98
PBS 18307	85	99	96
GG 20	79	97	73
TG 37A	93	100	92
CD@5%	28.4	9.3	19.2
CV%	19.3	5.1	11.18

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bed. Pod yield was recorded at harvest and yield of breeding lines were compared with checks. Out of which eight lines performed better with 5% to 59% of yield advantage over both check varieties, GJG 32 and TG 37A (**Fig 3**). Performance of these lines will be confirmed further in next *khair* season.

Yield evaluation of very high oil content (>55%) genotypes

High oil content lines were selected and tested for their yield advantage. Two high oil content lines, HOS-89 and HOS-30 along with checks were planted in three replications during 2020 summer season. Each line was planted in five lines on five meter bed. None of the high oil content lines were found superior in pod yield over check (Table 2). However, breeding lines HOS-89 and HOS-30 with 57% and 56% oil content, respectively were subsequently registered as

novel high oil content groundnut germplasm.

Genotyping of $F_{1.2}$ plants for high oleic specific alleles

F_1 populations for 10 crosses were developed to transfer high oleic trait into high yielding varieties. $F_{1.2}$ progenies of 10 crosses were planted in 2020 summer season and plants were genotyped for presence of *ahfad2* mutant alleles. A total

of 492 plants were genotyped and 216 plants were selected using linked molecular markers (**Table 3**). Individual plants were harvested for further advancement and selection of high oleic and high yielding genotype.

Advanced yield evaluation of selected Virginia breeding lines

Selected advanced Virginia breeding lines were tested for their yield performance

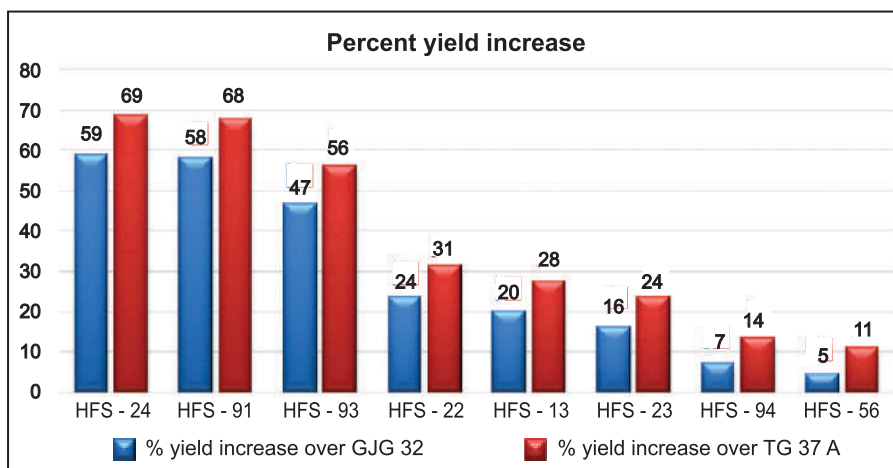


Fig. 3 Selected Spanish bunch high oleic genotypes showing yield advantage over checks GJG 32 and TG 37A

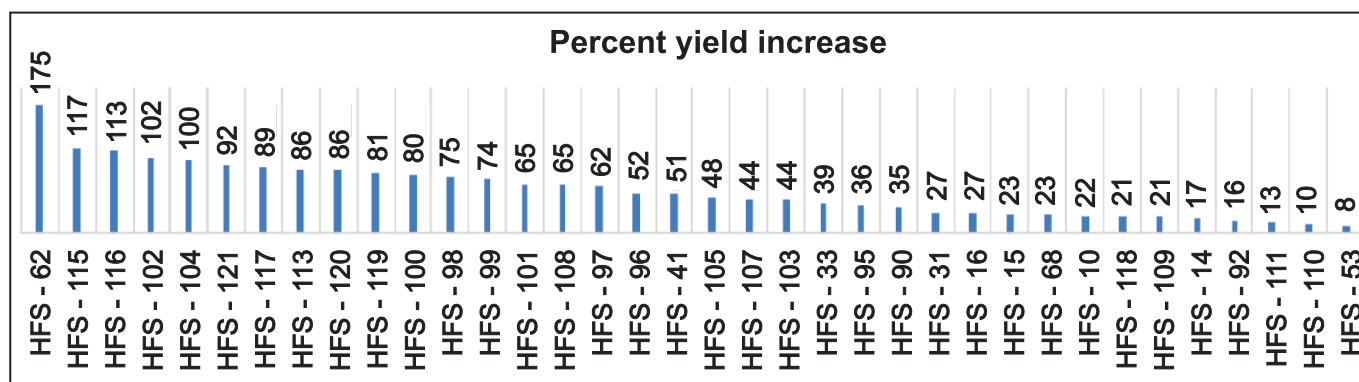


Fig. 2 Selected Virginia high oleic genotypes showing yield advantage over check Girnar 4

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during 2020 summer season. Eight breeding lines and check variety were planted in three replications. Each breeding line was planted in four lines on five meter bed.

Table 2 Pod yield and oil content of selected breeding lines

Genotype	Oil %	Pod yield/250 plants (g.)
HOS-89	57	1437
HOS-30	56	1467
GJG 9	48	1233
TG 37A	51	1771
CD	-	194.29
CV	-	7.22

Pod yield was recorded at harvest and three breeding lines had 7% - 26% pod yield advantage over check variety KDG 128 (**Table 4**).

Initial yield evaluation of Virginia breeding lines

Selected Virginia breeding lines were tested for yield superiority over check during 2020 summer season. A total of 13 Virginia lines were initially tested under augmented design. Each breeding line was planted in single line on five meter bed and pod yield per plant was recorded at harvest. Since plant population in different breeding lines were varying, hence pod yield was expressed per 20 plants.

Table 3 Details of cross wise number of plants genotyped and selected using molecular markers

Cross	No. of plants genotyped	No. of plant selected
Girnar 2 × Girnar 4	29	7
SG-99 × Girnar 4	27	6
CS 25-7-39 × Girnar 4	36	17
JL 501 × ICGV 15080	67	24
TG 51 × ICGV 15080	67	25
DH 257 × ICGV 15080	159	78
K 6 × Girnar 4	60	27
KDG 128 × Girnar 4	47	21
TG 37A × BC ₁ F ₂ (TG 37A × Sunoleic 95R)	11	6
GG 20 × BC ₁ F ₂ (GG 20 × Sunoleic 95R)	25	5
Total	492	216

Seven breeding lines had more than 10% pod yield superiority over check KDG 128 (**Table 5**) and maximum (138%) pod yield superiority was observed in ICGV 4747 × TMV NLM2-11-4-1 followed by ICGV 4747 × TMV NLM 2-2-5-6-3 (83%). Performance of these breeding lines will be confirmed further in 2020 *kharif* season.

Initial yield evaluation of Spanish bunch breeding lines

Selected Spanish Bunch breeding lines were tested for yield superiority over check during 2020 summer season. A total of 10 Spanish bunch lines were initially tested

under augmented design. Each breeding line was planted in single line on five meter bed and pod yield per plant was recorded at harvest. Since plant population in different breeding lines were varying, hence pod yield was expressed per 20 plants. Six breeding lines had more than 10% pod yield superiority over check GJG 32 (**Table 6**) and maximum (56%) pod yield superiority was observed in GG 7 × Sunoleic 95R-54-10-8 followed by ICGV 4747 × TMV NLM 2-11-4-1 (49%). Performance of these breeding lines will be confirmed further in 2020 *kharif* season.

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Table 4 Pod yield and related traits of eight Virginia advanced breeding lines

Breeding line	Mean pod yield/200 plants (g)	Percent yield increase over KDG 128
HOS-177	1.30	-12
HOS-474	1.53	3
HOS-152	1.04	-30
HOS-724	1.86	26
HOS-93	1.74	18
HOS-395	1.58	7
GG 20×CS 19 13-8	1.45	-2
GG 20 × CS 19 8-8	1.31	-11
KDG 128 (check)	1.48	-

Initial evaluation of RILs for tolerance of drought

RILs were developed from a cross between ICGV 474, susceptible germplasm and TMV2NLM, a tolerant mutant. A total of 145 RILs were planted tested under both fully irrigated and limited irrigated conditions during 2020 summer season. RILs were planted in augmented design in both conditions. Each RIL was planted in single line on five meter bed. Irrigation was provided as and when required to RILs planted under fully irrigated conditions till maturity of the crop. While normal irrigation was provided to RILs planted under limited irrigation condition up to 60 days after germination as and when required. After 60 days of

germination irrigation was skipped alternately in case of limited irrigated crop compared to fully irrigated

crop. Pod yield per 25 plants were recorded at harvest from both trials and reduction in yield was calculated between fully irrigated and limited irrigated crop. Yield reduction in different RILs ranged from 8% to 95%. However, 12 RILs recorded minimum (<20%) yield reduction. Experiment will be repeated in 2021 summer season for confirmation.

Hybridization

In 2020 *kahrif* season hybridization was done under field conditions and a total of 10 crosses were attempted. Out of which five crosses involve wide hybridization to introgress desirable allele

Table 5 Details of Virginia breeding lines and their yield advantage over check

SN	Cross	Plant no.	PY/ 20pp	Percent yield increase over KDG 128
1	ICGV 4747 × TMV NLM2	71-6	204	1
2	ICGV 4747 × TMV NLM2	25-2-1	203	1
3	ICGV 4747 × TMV NLM2	25-2-2	200	-1
4	ICGV 4747 × TMV NLM2	25-2-3	208	3
5	ICGV 4747 × TMV NLM2	25-2-4	233	16
6	ICGV 4747 × TMV NLM2	2-5-6-1	232	15
7	ICGV 4747 × TMV NLM2	2-5-6-2	228	13
8	ICGV 4747 × TMV NLM2	2-5-6-3	369	83
9	ICGV 4747 × TMV NLM2	11-4-1	480	138
10	ICGV 4747 × TMV NLM2	11-1-3	216	7
11	ICGV 4747 × TMV NLM2	11-1-1	187	-8
12	GG 7 × Sunoleic 95R	54-1-9	235	16
13	TKG 19 A × Sunoleic 95R	A-11	26	933
	KDG 128 (check)		202	

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Table 6 Details of Spanish bunch breeding lines and their yield advantage over check

SN	Cross	Plant no.	PY/ 20pp	% yield increase over GJG 32
1	ICGV 4747 × TMVNLM2	2-6-1	222	10
2	ICGV 4747 × TMVNLM2		241	19
3	ICGV 4747 × TMVNLM2	11-4-1	300	49
4	GG 7 × Sunoleic95R	54-10-8	316	56
5	GG 7 × Sunoleic95R	29-32-15	237	17
6	JL 24 × CS 85	3	227	12
7	JL 24 × CS 85	43-24	144	-29
8	JL 24 × CS 85	43-22	146	-28
9	JL 24 × CS 85	43-24	60	-70
10	TKG 19A × Sunoleic95R	8-2-8	183	-9
	GJG 32	Check	246	

from wild relatives into cultivated groundnut, while rest five crosses involve transfer of high oleic trait into high yielding cultivars. Altogether 6273 pollination were made and 1100 probable cross pod and 1690 kernels were harvested from 10 crosses (**Table 7**).

Genotyping F2-3 progenies

F₁₋₂ progenies containing both *ahfad2* mutant alleles from 10 crosses were planted during 2020 *kharif* season. A total of 4308 F₁₋₂ plants from 10 crosses were further genotyped for presence *ahfad2* mutant alleles. Out of which 1313 single plants having both *ahfad2* mutant alleles were selected. Maximum number of single plants were selected in the

cross Dh 257 × ICGV 15080, while single plant was

Table 7 Details of cross, number of pollinations made, number of probable cross pods and kernels harvested.

Cross Name	No of pollination done	No. of cross pod harvested	No of kernels harvested
J 87 × HFS-24	618	67	103
TG 81 × HFS-24	704	85	115
GJG 32 × GIRNAR 4	779	185	300
GJG 32 × HOS-89	677	69	100
J 11 × <i>A. stenosperma</i> (NRCG 14863)	498	95	134
J11 × <i>A. stenosperma</i> (NRCG 14867)	473	79	122
J 11 × <i>A. stenosperma</i> × <i>A. cardenasii</i> (NRCG 17262)	703	114	192
J11 × <i>A. duranansis</i> × <i>A. khulmani</i> (NRCG 17261)	608	133	221
J 11 × Pot No. 207 (<i>A. duranansis</i> × <i>A. khulmani</i>)	692	124	170
K 1812 × HFS-62	521	149	233
Total	6273	1100	1690

selected in the cross SG-99 × Girnar 4. Maximum pod yield per plant ranged from 12.5 to 40.2 g in 10 different crosses (**Table 8**). These 1313 individual plants will be evaluated further for yield and oleic acid content.

Initial yield evaluation of high oleic Spanish bunch breeding lines

Selected high oleic Spanish breeding lines (F₆₋₇) were evaluated in 2020 *kharif* season. A total of 33 breeding lines were planted in three replications. Each breeding line was sown in three lines on five-meter bed. Out of 33 breeding lines 24 lines were

1

found promising with more than 10% yield advantage over either of the check (**Fig. 4**). Moreover, five lines out of these 24 lines had more than 10 % yield advantage over checks during 2020 summer season. Yield evaluation of these lines will be repeated for further selection.

Initial evaluation of high oleic Virginia breeding lines

Selected high oleic Virginia breeding lines (F_{6-7}) were evaluated in 2020 *kharif* season. A total of 54 breeding lines were planted in three replications. Each breeding line was sown in three lines on five-meter bed. Out of 54 breeding lines 17 lines were

found promising with more than 10 % yield advantage over either of the check (**Fig. 5**). Moreover, six lines out of these 24 lines were had more than 10% yield advantage over checks during 2020 summer season. Yield evaluation of these lines will be repeated for further selection.

Initial yield evaluation of high oleic breeding lines (F_{5-6})

A total of 38 high oleic breeding lines (35 VB and 3 SB) were tested during 2020 *kharif* season. Breeding lines were planted in augmented design. Each line was planted in three lines on five-meter bed. Pod yield was recorded at

harvest. However, trial was vitiated due to continuous heavy rainfall, staggered germination, poor plant stand, and very poor expression of yield traits.

Initial yield evaluation of advanced breeding lines

A total of 19 promising breeding lines (F_{5-6}) were planted in augmented design during 2020 *kharif* season. Each line was planted in three lines on five meter bed and pod yield was recorded at harvest and was compared with checks. Fourteen breeding lines (12 VB and 2 SB) breeding lines recorded more than 10%t pod yield advantage over different checks (**Fig. 6**). A few of them recorded more than 400% yield advantage over check. Performance of these lines will be confirmed further.

Advanced yield evaluation of promising breeding lines

Selected promising breeding lines were tested during 2020 *kharif* season. Eight breeding lines were planted in RBD with three replications. Each breeding line was planted in five lines on five-meter bed. Pod yield was recorded at harvest and breeding line, HOS-724 recorded 27-109 % yield advantage over four checks (**Table 9**). Besides, HOS-724, HOS-93 and HOS-

Table 8 Details of crosswise plants genotyped and selected for *ahfad2* mutant alleles

SN	Name of Cross	No. Plant genotyped	No. of plants selected	Maximum pod yield/plant
1	Dh 257 x ICGV 15080	1936	662	40.2
2	JL 501 x ICGV 15080	344	143	30.6
3	CS 25-7-39 x Girnar 4	199	972	6.7
4	K 6 x Girnar 4	488	171	26.3
5	KDG 128 x Girnar 4	821	118	33.1
6	TG 51 x ICGV 15080	337	103	22.5
7	Girnar 2 x Girnar 4	46	8	21
8	SG 99 x Girnar 4	16	1	4.29
9	GG 20 x (GG 20 x Sun Oleic 95R)	58	5	15.0
10	TG 37A x (TG 37A x Sun Oleic 95 R)	63	5	12.5
	Total	4308	1313	

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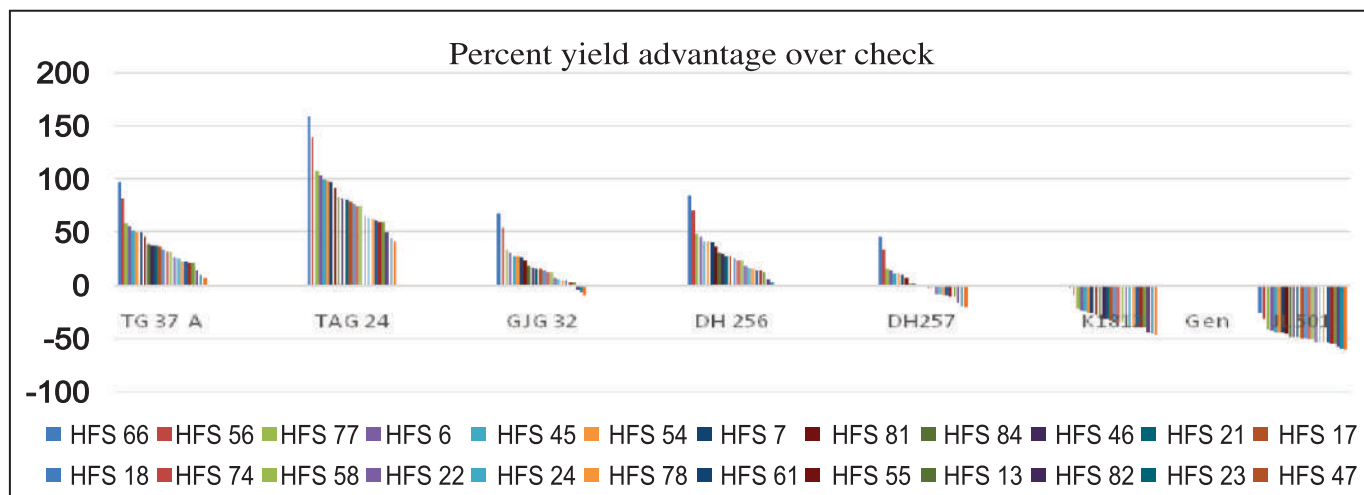


Fig. 4 Pod yield advantage of high oleic Spanish bunch breeding lines over checks

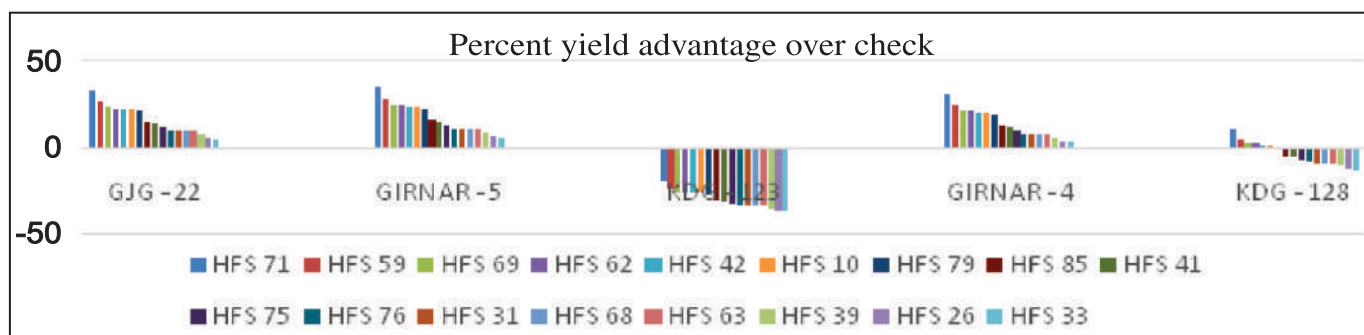


Fig. 5 Pod yield advantage of high oleic Virginia breeding lines over checks

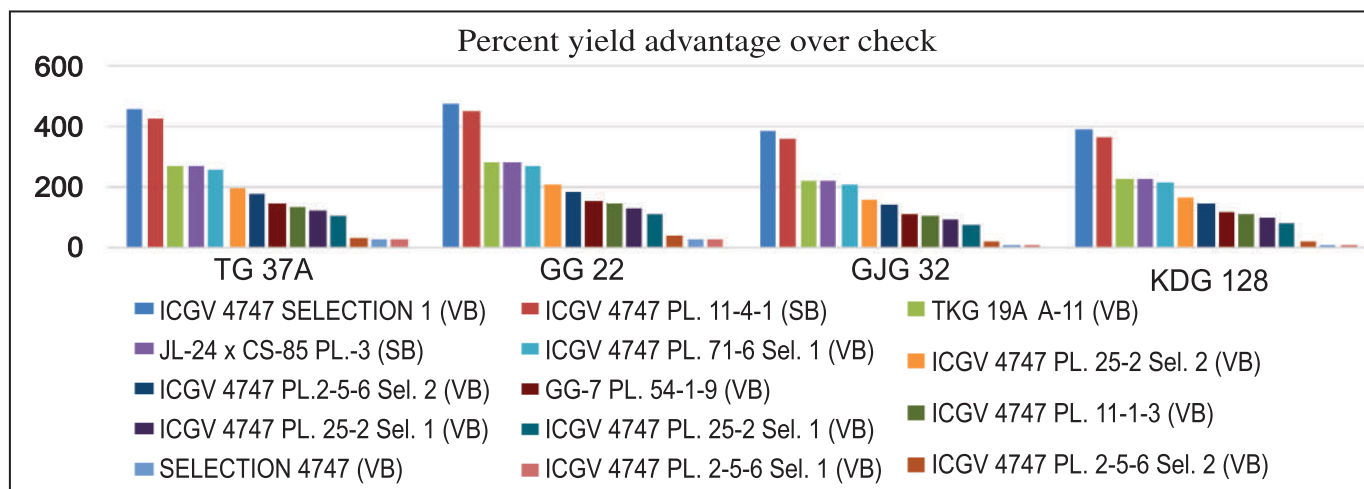


Fig. 6 Pod yield advantage of promising breeding lines over checks

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Table 9 Details of Spanish bunch breeding lines and their yield advantage over check

Genotype	Habit	Mean pod yield/250 plants (g)	GJG 22	KDG 128	KDG 123	TG 37A
HOS - 177	VB	825	-5	-36	-43	-16
HOS - 474	SB	876	1	-32	-39	-10
HOS - 152	VB	730	-16	-43	-49	-25
HOS - 724	VB	1818	109	41	27	86
HOS - 93	VB	905	4	-30	-37	-8
HOS - 395	VB	1033	19	-20	-28	5
GG 20 × CS 19 13-8	VB	854	-2	-34	-41	-13
GG 20 × CS 19 8-8	VB	0.875	0	-32	-39	-11

395 also recorded more than 10% yield advantage over different checks during 2020 summer season. HOS-724 will be further tested in AICRPG.

Screening of selected breeding lines for major foliar disease

There was heavy natural LLS and rust incidence in the experimental plots in 2019 *kharif* season. LLS scoring varied from 8-9 in almost all susceptible lines while maximum rust incidence of 5 was observed in susceptible lines. Looking in to heavy LLS and rust incidence under natural field conditions we selected breeding lines with low LLS and rust incidence in 2019 *kharif* season. A total of 46 breeding lines of different background were screened further during 2020 *kharif* season to confirm their resistance. There was heavy LLS and rust incidence also

under natural field conditions in 2020 *kharif* season due to continuous heavy rain during the entire crop period of June to October. In susceptible lines, LLS and rust incidence ranged from 7-8 and 4-5, respectively. While in breeding lines it ranged from

3-5 and 0-1, respectively (Table 10). Foliar disease resistance in these breeding lines will be confirmed further under hot spot conditions.



High oil content germplasm NRCGCS 635 (HOS-30) and NRCGCS 636 (HOS-89) registered

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Table 10 LLS and rust incidence of selected breeding lines

S No.	Genotype	LLS score	Rust score
1	ICGV - 181052	3	0
2	ICGV - 181050	3	1
3	ICGV - 181054	3	1
4	ICGV - 181034	3	0
5	ICGV - 181493	3	1
6	ICGV - 181041	3	1
7	ICGV - 181004	3	0
8	ICGV - 181039	3	1
9	ICGV - 181056	3	1
10	ICGV - 181060	3	1
11	ICGV - 181061	5	1
12	ICGV - 06420	3	1
13	S -13	3	1
14	S -64	3	1
15	(GG 20×CS 19)-12-3	3	0
16	(GG 20×CS 19)-15-13	5	1
17	(GG 20×CS 19)-11-2	2	1
18	(GG 20×CS 19)-12-4	3	1
19	(GG 20×CS 19)-12-6	3	1
20	(GG 20×CS 19)-2-14	3	0
21	(GG 20×CS 19)-2-6	3	1
22	(GG 20×CS 19)-18-8	3	1
23	(GG 20×CS 19)-8-9	3	1
24	(GG 20×CS 19)-18-9	3	1
25	(GG 20×CS 19)-11-3	3	1

S No.	Genotype	LLS score	Rust score
26	(GG 20×CS 19)-8-6	5	1
27	(GG 20×CS 19)-12-5	5	1
28	(GG 20×CS 19)-22-15	3	1
29	HOS - 117	3	0
30	HOS - 152	3	0
31	HOS - 93	3	1
32	(GG 7 × Sunoleic 95 R) -16-11-11	3	1
33	(GG 7 × Sunoleic 95 R) - 16-11-14	3	1
34	(GG 7×Sunoleic 95 R) - 29-42-4	3	1
35	(GG 7×Sunoleic 95 R) - 33-3-3	5	0
36	(GG 7×Sunoleic 95 R) - 33-3-8	3	1
37	(GG 7×Sunoleic 95 R) - 33-10-1	5	1
38	(GG 7×Sunoleic 95 R) - 30-10-4	3	0
39	(GG 7×Sunoleic 95 R) - 30-10-9	3	1
40	CS - 594	3	1
41	CS - 595	3	1
42	CS - 597	3	1
43	CS - 601	3	1

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Project : Genetic enhancement of nutritional traits in groundnut through genome editing and molecular approaches

PI: S Chandramohan

Co-PI: SK Bera, Kirti Rani and

V Papa Rao

- Screening of transgenic groundnut expressing defensin gene for Aflatoxin resistance.
- Four hundred and fifty transgenic groundnut lines expressing defensin gene (2 events) were sown in glass house. The DNA isolation of all the 400 plants was completed using CTAB method.
- The transgenic plants stored in cold storage were taken out for rejuvenation. The following are the details of transgenic groundnut.

Identification of homozygous double mutant for AhFAD2

gene in F₂ population of cross GJG-22 X Sunoleic 95R

A total of 1600 F₂ seeds were sown in pot under glasshouse condition among them 986 were germinated. The genomic DNA of all 1338 seedlings was isolated. A PCR was performed using Allele Specific (AS)-PCRs assay (Chen *et al.*, 2010) for AhFAD2B gene to detect homozygous mutant F₂ lines. Out of 1338 F₂ plants, 220 plants were confirmed homozygous for AhFAD2B gene.

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

PI: S Chandramohan

Co-PI: SK Bera

Generation advancement of development RIL population

The F₈ lines (1025 lines) of the cross GJG 17 x GPBD 4 were

sown in the field in *Kharif* 2018 and subsequently taken for generation advancement by single seed descent method (SSD). Similarly the F₇ lines (507 lines) of the cross GJG 22 x ICGV 86590 were sown in the field in *Kharif* 2018 and subsequently taken for generation advancement by single seed descent method (SSD). These lines will be used as RIL mapping population for LLs and rust and also for other morphologically important traits. Similarly F₃ lines (360 lines) of the cross TMV 2 x CS 196 were sown in the field in *Kharif* 2018 and subsequently taken for generation advancement by single seed descent method (SSD). The seeds were sown in the field and artificial disease epiphytic conditions were created by “spreader row technique” using susceptible lines (TMV 2).

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Fig. Single plants with good pod bearing selected from high oleic content breeding lines in 2020 summer season

Marker assisted selection for foliar disease resistance:

Sr. No.	Cross NamePlant	Population
1	TG 37A x BC ₃ F ₁ (TG 37A x GPBD 4)	445
2	GG 20 x BC ₃ F ₁ (GG 20 x GPBD 4)	445
3	BC ₂ F ₂ (TG 37A x GPBD 4)	136
4	BC ₂ F ₂ (GG 20 x GPBD 4)	194
	Total	1220

The F₉ lines (1025 lines) of the cross GJG 17 x GPBD 4 were sown in the field in *Kharif* 2019 and subsequently taken for generation advancement by single seed descent method (SSD). Similarly, the F₈ lines (507 lines) of the cross GJG 22 x ICGV 86590 were sown in the field in *Kharif* 2019 and subsequently taken for generation advancement by single seed descent method (SSD). These lines will be used as RIL mapping population for LLs and rust and also for other morphologically important traits. Similarly F₄ lines (360 lines) of the cross TMV 2 x

CS196 were sown in the field in *Kharif* 2019 and subsequently taken for generation advancement by single seed descent method (SSD). The seeds were sown in the field and artificial disease epiphytic conditions were created by “spreader row technique” using susceptible lines (TMV 2).

QTL mapping for foliar fungal disease resistance

Phenotyping data was recorded for both LLs and rust performed at the time of harvesting using modified 9-point scale from the cross GJG 17 x GPBD 4 (F₈

Transgenic Name	Seeds Sown	Plants Germinated
GBNV	741	502
MtID	655	633
PSNV	270	159
Cry 1	409	166
ZF	281	-

generation) and other important morphological traits for which parents were diverse viz. LLs, Rust, Leaf shape, Leaf tip, Stem color, Stem hairs, Pod constriction, Pod beak, Pod reticulation, Leaf size, Node interval, Stem thickness, Plant height, No. of Primary Branches, No. of Secondary branches, Dry pod weight, Kernel weight, No. of immature pods, No. of single seeded pods, No. of double seeded pods and Shelling percentage.

DNA isolation was carried out during the period. The recombinant inbred lines developed from the cross GPBD 4 x GJG 17, currently in F₈ generation was used for DNA extraction. The high-quality DNA extraction from 800 recombinant inbred lines was completed during the period.

Screening of groundnut germplasm for foliar disease resistance:

Screening of groundnut germplasm consisting of released varieties, CS lines and NRCG lines for foliar fungal

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diseases (LLS and Rust) was conducted during Kharif 2018 using spreader row technique. The released varieties which were screened for LLS and Rust were ALR 2, DH-4-3, KDG 123, JL 776, FDRS 79, AK 265, ALR 1, TG 26, RHRG 06083, KDG 128, VRI 5, ICGV 86590, R 2001-3, R 2001-2, JS 88, GPBD4, ALR 3, RS 138, SG 99, R 8808, VRI Gn 6, ICGV 00350, JL-24, FDRS 4, FDRS 10, TAG 24, TG 37A and TMV 2. All these varieties were scored on 9-point scale and ranged from 2 to 5 score and 7 score in TMV2. Selected CS lines were also included in the screening viz. CS 402, CS 303, CS 405, CS 160, CS 377, CS 285, CS 296, CS 19, CS 26, CS 364, CS 434, CS 42, CS 168, CS 168, CS 428, CS 409, CS 407, CS 323, CS 116 and CS 334. The score for LLS ranged from 3 to 6. The NRCG lines were also evaluated for LLS in *Kharif* viz. NRCG 6707, 288, 13171, 6517, 12236, 6678, 13105, 12205, 841, 4998, 4849, 4738, 11869, 6524, 666, 13027, 1179, 4857, 1177, 9130, 12053, 11580, 6529, 13052, 10043, 9747, 6519, 13079, 11586, 11879, 13119, 11581, 4734 and 13149. The score for LLS ranged from 3 to 5 on a 9 point modified scale. All the

lines will be repeated in *Kharif* 2019.

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

A total of 28 primers from LLS Rust resistance QTL region A03 and B10 and 70 primers from table were used for genotyping. All primers were used to perform PCR in 83 diverse peanut germplasm. The PCR products were run on PAGE and gels were documented to research for the presence of resistance alleles among 83 germplasm. Scoring of all primers is under progress.

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

A total of four Advanced backcrossed lines (ABLS_216, ABLs_2, ABLs_44, ABLs_36) as female and one high oleic acid content advance backcrossed line (ABLS_5841) as male were selected based on presence of linked markers for foliar disease resistant and high oleic acid content respectively. The hybridizations between four ABLs_216, ABLs_2, ABLs_44, ABLs_36 with ABLs_5841 were generated a total of 61 individual F_1 plants. Of which 41 (~67%) were confirm true hybrid based on CAPs marker. The true

intercross F_1 were selfed to generate intercross F_2 . A total of 343 F_2 plants from cross between ABLs_216, ABLs_2, ABLs_44, and ABLs_36 X ABLs_5841 were screened with CAPs marker to confirm homozygosity of both mutant alleles of FAD gene. Among 343 plants 40 were confirmed for homozygous double mutant for both alleles of FAD genes. These plants were also confirmed for the QTL regions on B03/A03 and B10/A02 by foreground screening with LLS and rust resistance-linked markers IPA HM103, GM2079, Seq8D09, GM2009, GM2301 and DGR-329. The biochemical and phenotypic evaluation was carried out of marker conformed F_2 introgression lines in *kharif* 2018. The seeds harvested from each positive plant were subjected to fatty acid profiling by gas chromatography. A total of 11 lines out of 40 lines were found to have oleic acid 79 per cent while estimated on Gas chromatography. However, the oleic acid content of the rest of 29 lines was ranged from 68-78 per cent. All these lines were subjected to generation advancement and phenotypic evaluation for the foliar diseases resistance in *kharif* 2018 since these lines also

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Marker Name	
DGR433, DGR453, DGR483, DGR503, DGR516, DGR607, DGR655, DGR662, pPGPseq2D12B, pPGSseq18E7, pPGPseq2G4, PM50, pPGSseq19D6, pPGPseq8H1, TC5A06, pPGPseq7G2, DGR693, DGR708, DGR784, DGR788, DGR1540, DGR1550, DGR2331, DGR2362, DGR2370, DGR2373, DGR2399, DGR2401, DGR2429, DGR2446, DGR2447, GM1839, GM1988, GM2032, GM2350, GM2584, IPAHM108, IPAHM356, IPAHM509, IPAHM569, PM377, PM384, PM45, PM50, Seq2B10, seq2E06, seq8D09, TC11H06, pPGSseq11H1, pPGPseq1B9, pPGSseq14F4, pPGSseq11G3, pPGSseq12E3, TC1E01, pPGSseq10D4, pPGPseq3B8, pPGPseq3A1, RN34A10, pPGPseq2A5, pPGSseq16G8, pPGSseq9B4, pPGPseq3E10, pPGSseq18C2, pPGSseq13A7	completed
DGR625, DGR666, GM1742, GM1996, GM2638, GM618, PM137, PM375, Ah4	Repeat

Marker Name	Reference
DGR259, DGR312, DGR329, DGR508, DGR800, DGR2409, DGR361, RS 5, RS 42, pPGPseq_16D11, RS 50, RS 51, RS 47, FRS 56, FRS 49, SSR_GO340445, RS 78, RS 74, RS 103, IPAHM103, GM2009, GM2301, GM1954, GM2079, Seq8D09, GM2032, GMRQ517, AhTE498	Bosamia <i>et al.</i> , 2015, Mondal <i>et al.</i> , 2018, Sujay <i>et al.</i> , 2012; khedikar <i>et al.</i> , 2010, Pandey <i>et al.</i> , 2017, Kolekar <i>et al.</i> , 2016

contained QTLs for foliar diseases resistance. These lines showed a significant level of resistance to ELS and LLS (score range 2-3) as compared to the susceptible check (score range 7-8).

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

A total of 17 BC₃F₁ backcrossed line and 71 BC₃F₄ advance backcrossed introgression lines were subjected to genotyping for background selection. A total of 76 polymorphic SSR markers were identified. These primers are evenly distributed in 20

chromosomes. All 76 primers were amplified and genotyped in introgression lines. Documentation and scoring of each primer were performed. Downstream analysis and genome recovery percentage is under progress.

MAS for foliar disease resistance in Groundnut

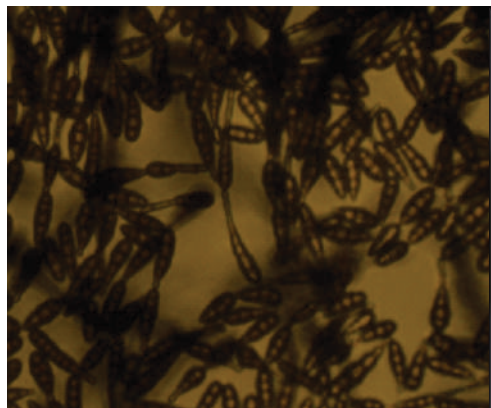
Two backcross populations (BC₃F₁) were raised in summer 2019 to identify positive disease resistant plant using molecular marker. A total 139 desirable single plants were identified in both the crosses GG 20 × GPBD 4 (65) and TG 37A × GPBD 4 (74). These BC₃F₁hybrids plants were selfed to produce BC₃F₂

populations and harvested 445 and 445 BC₂F₂ single plants in GG 20 and TG 37A respectively.

Two backcross populations (BC₃F₂) were raised to identify positive disease resistant plant using molecular marker in kharif 2019. A total 304 desirable single plants were identified in both the crosses GG 20 × GPBD 4 (113) and TG 37A × GPBD 4 (191). These BC₃F₂hybrids plants were selfed to produce BC₃F₃ populations and harvested 113 and 191 BC₂F₃ positive single plants of LLS and rust in GG 20 and TG 37A respectively.

2

Groundnut crop protection



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

PI: Harish

Co-PI: MV Nataraja and R Dey

1. Monitoring of insect pests of groundnut

Seasonal incidence of insect pests of groundnut was studied by sowing groundnut every month under unprotected condition. Sucking pests were estimated using sweep net catches. Thrips and leafhopper population was found throughout the year, but we observed two significant peaks of thrips population during 6th and 38th Standard week and leafhopper population had three peaks at 7th, 43rd and 45th Standard week. *Helicoverpa* incidence was low compared to *spodoptera*. Maximum trap catch of *Spodoptera* (25 moths per trap) and *Helicoverpa* (8 moths per trap) was recorded on 35th Standard meteorological week.

2. Biorational management of groundnut defoliator pests

Helicoverpa population was found lowest in the treatment T4- Chlorantraniliprole 18.5 SC @ 0.3 ml/l followed by T3- Quinalphos 25 EC @ 2 ml/l and T1 - Bt - 127 SC formulation @ 3 ml/l, which showed at par results with each other. The treatment T4- Chlorantraniliprole 18.5 SC @ 0.3 ml/l recorded highest pod yield (1866 kg/ha)

3. Management of bruchid beetle

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

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

4. Improved storage practices for managing *Caryedon serratus* in groundnut

An experiment was carried out ICAR- Directorate of Groundnut Research, Junagadh to improve the storability of groundnut pods using high density polythene bag (HDPE 160 micron), Purdue Improved Crop Storage (PICS) bag and gunny

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bags, twenty five kg of groundnut pods were stored with treatment combination of with and without release of adult *Caryedon serratus*. Groundnut pods were stored for Six months and observations were recorded at monthly interval on number of eggs laid by *Caryedon serratus* and per cent pod damage. HDPE bags, PICS bags and gunny bags were found on par and effective up to five months when there is no prior infestation. However, if there is a prior infestation with bruchids (5 pairs of adult beetles) HDPE bags and PICS bags were found significantly effective over gunny bags. Results also showed that there was no significant build-up of aflatoxin in HDPE and PICS bags. Cumulative mean of eggs laid in gunny bags with prior infestation after six months of storage was 1541 eggs per 100 g of pods. Pod damage of 84 per cent was recorded after six months of storage. In terms of economics 100 kg capacity PICS bag cost around 120 rupees per bag and HDPE bag 160 micron and gunny bags of 50 kg capacity costs around 30 rupees per bag. Hence HDPE bag of 160 micron was cost effective and improve the storability of groundnut compared to gunny

bags when stored under natural condition.

5. Study on incidence of nematodes in groundnut

Soil samples were collected from research plots of ICAR-DGR and nematodes were isolated through Cobb sieving and decanting method. Nematodes were then classified into Plant parasitic



Adult helicoverpa

and Free living. *Meloidogyne*, *Tylenchorynchus*, *Aphelenchus*, *Tylenchulus*, *Xiphinema*, *Helicotylenchus* genus were plant parasitic. *Dorylaimids*, *Chiloplacus*, *Acrobeloides*, *Paracrobeles*, *Cephalobus*, *Eucephalobus*, *Pseudacrobelus*, *Eucephalobus*, *Heterocephalobus*, *Rhabditida* genus of nematodes belong to free living group. When diversity of nematodes was calculated crop production plots were found to have high diversity due to conservation agriculture and less disturbance of soil.



Larve of Helicoverpa

Project : Epidemiology of Peanut Bud Necrosis and Tobacco Streak Viruses in groundnut and development of their rapid detection

PI: MV Nataraja /Ananth Kurella

Co-PI: Ajay BC, Harish G and VPapa Rao

- Maintenance of GBNV on cowpea, Groundnut (K-6) through mechanical sap inoculation.
- RNA extraction (10 samples) and their cDNA synthesis is in progress to validate existing protocols.

Project : Refinement and Validation of Management Module for Soil borne diseases of Groundnut

PI: Ram Dutta

Co-PI: PP Thirumalaisamay, Ananth Kurella, MK Mahatma and Narendra Kumar

Studying critical stages of stem rot infection:

Two groundnut varieties GG 20 and CS 319 were studied in order to identify the critical stage of infection of

2

Sclerotium rolfsii. Inoculations were done in three stages (40, 60 and 80DAS). Inoculations done at 40DAS showed 100% stem rot incidence followed by 60 and 80DAS in both the genotypes. Younger plants in both the varieties were found more susceptible to infection by *S. rolfsii* causing highest plant mortality results. Inoculations done at 60DAS showed disease incidence 84% in GG 20 and 83% in CS 319 respectively, but inoculations done at 80DAS showed less incidence in CS 319 (66%) than GG 20 (82%). Study needs to be confirmed with more number of varieties.

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

PI: PP Thirumalaisamy

Co-PI: Ram Dutta

Management of *Alternaria* leaf blight in groundnut

- Total of 77 isolates of *Alternaria* sp. associated with leaf blight disease of groundnut were collected from different agro-climatic regions of India could not be differentiated based on colony morphology, mycelial growth rate, and spore characters. However, differences in pathogenicity of *Alternaria* sp. isolates were recorded. Existence of genetic diversity among isolates of *Alternaria*

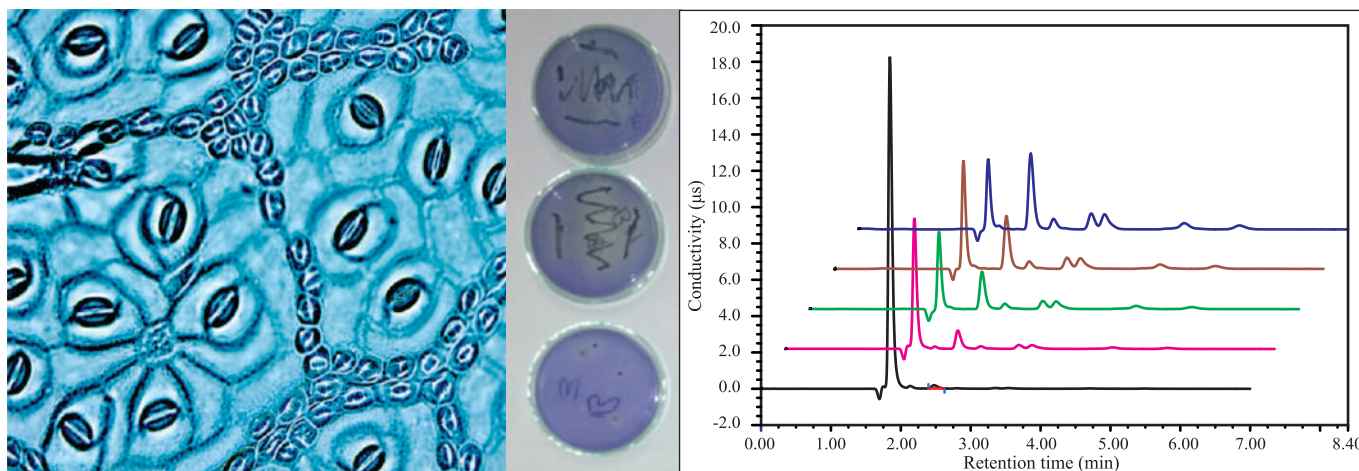
sp. was observed using RAPD and URP markers.

- Fungicides namely pyraclostrobin + metiram and tebuconazole were found to be effective to reduce the disease severity of ALB.
- Epidemiological factors - crop age of 70-110 days, relative humidity below 60% and temperature above 37 degree C, favoured occurrence of *Alternaria* leaf blight up-to 7 rating scale (max. 60% severity) of 1-9 scale. Water stress for 4 weeks or above, deficiencies of nitrogen, iron and zinc, damage of peanut by jassids and thrips, and peanut grown in the saline soil at 4 dsm-1 or above were favoured the *Alternaria* leaf blight.
- Cultivars RHRG 6083, KDG 128 and KDG 123 were identified as novel source of resistance to rust, *P. arachidis* and used as potential donor parent in groundnut breeding programme for developing variety resistant and also in the rust prevailing areas.
- Based on morphological and molecular characterization, the pathogen associated with leaf blight and wilt of peanut occurring at Bikaner and Jodhpur was identified as *Fusarium incarnatum*, the first confirmed report of *F. incarnatum* as pathogenic on peanut. Further, sequence analysis of TEF-1a gene, part of rpb2 gene and rDNA-ITS region of six representative isolates from peanut in areas where the disease prevails, and a search of the Fusarium-ID database showed > 98% nucleotide similarity with the *Fusarium incarnatum*-*F. equiseti* species complex (FIESC).



RHRG 6083

3 Basic Studies in groundnut in relation to plant health, nutrition, quality and abiotic stresses



Project : Managemnet of Salinity Stress in Groundnut

PI: KK Pal

Co-PI: Sushmita, KK Reddy, Praveen Kona and Aman Verma

A. Evaluation of CAM transited groundnut genotypes for salinity tolerance (collaboration with CCSRI, Mandvi, Bhuj; Dr. S Acharya; kharif2020)

During *kharif* 2020, a trial was conducted with six CAM-transited genotypes keeping TG37A, GG7, GG5 and GG2 as checks under salinity of 4.55 EC at harvest. The CAM genotypes gave >25% higher biomass yield than the best check TG 37A. Two CAM genotypes viz. DGRMB 5 and DGRMB 19 gave

significantly and 19.48% and 18.10% per cent higher pod yield than the best check TG 37A (3978 kg/ha). DGRMB5 also gave significant and 31.17 per cent higher nodules/plant than the check GG 7 (184.75). These genotypes will be evaluated further during summer 2021 with higher level of salinity.

B. Evaluation and multiplication of mini-core groundnut accessions under salinity condition (CCSRI, Mandvi)

One hundred mini-core germplasm genotypes were screened for salinity tolerance. The impact of salinity was evident as indicated by low biomass production and harvest index. Seventy-two and 78 genotypes gave higher pod yield. Seven genotypes viz, NRCG14334, NRCG14344, NRCG14345, NRCG14349, NRCG14412, NRCG14445 and NRCG

14482 were early and were found most promising from salinity point of view as they performed better for most of the traits like biomass, pods weight, number of pods and pod yield. The harvest index was extremely poor varying from 0- 44% with a breakup of 70, 73, 14 and 7 genotypes having harvest index < 10%, 11 to 20%, 21-30% and 30%, respectively. Seven genotypes viz, NRCG14391, NRCG 14401, NRCG14406, NRCG 14409, NRCG14414, NRCG 14506 and NRCG 14507 did not bear pod at all and hence were the most susceptible to salinity.

C. Multiplication of mini-core germplasm accessions at Junagadh

Total 180 minicore groundnut germplasm accessions seed multiplication was carried out during *Kharif*, 2020 at Junagadh. Out of 180

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genotypes, 81 belong to Virginia group and 99 belong to Spanish and Valencia group. Each accession was sown in five meter row length. The multiplied seed will be evaluated at hotspot locations for salinity tolerance.

D. Finger-printing of CAM variants

To differentiate CAM variants from TG37A, DNA finger printing of the genotypes were made using both EST and genomic based SSR markers. DGRMB5, DGRMB19, DGRMB24, DGRMB32 and DGRMB3 gave seven, three,

Project: Optimization of mineral nutrition in Groundnut for better human and soil health

PI: Sushmita Singh

Co-PI: AL Singh, Rinku Dey, Kiran Reddy and Aman Verma

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

100 groundnut cultivars were screened for their seed Zn and Fe content under rainfed condition. 35 out of 100 cultivars were identified as high Zn density cultivars (Zn content > 40 ppm). The phytic

B. Screening of advanced breeding lines of groundnut for iron chlorosis

114 advanced breeding lines were screened for their tolerance to iron chlorosis during *kharif* under rainfed condition. NRCG 7472 was used as susceptible while ICGV86031 as the tolerant checks. 14 advanced breeding lines with a constant Visual chlorotic rating of 1 were identified. Their physiological characterization recorded 25%, 10% and 15% higher values for chlorophyll content, maximum quantum yield of PSII and pod yield over the susceptible check (NRCG 7472).

C. Zinc bio-fortification through commercial and microbial Zn sources

10 groundnut cultivars were undertaken to study the effect of commercial and microbial Zn sources (ZnSO₄, Tag nano Zn granules, Tag nano chelated Zn liquid, BM6 and FP 82). ZnSO₄ and FP 82 caused maximum increase in chlorophyll content, quantum yield of PSII, 100 kernel weight, shelling percentage and pod yield, which was subsequently reflected by high Zn enrichment in kernels. The average increase in seed Zn content upon

Table 7. SSR markers showed polymorphism between TG37A, TAG24, TG51, TG26 and TG38 and CAM variants of TG37A

Variants	SSR markers								
	DGR 114	DGR 811	PM 137	pGPseq 18E7	pPGPseq 2G4	DGR 289	DGR 2474	DGR 2399	pPGPseq 1B9
DGRMB5	+	+	+	+	+	+	+	-	-
DGRMB19	+	+	+	-	-	-	-	-	-
DGRMB24	+	+	+	+	+	+	-	+	+
DGRMB32	+	+	+	-	-	-	-	-	-
DGRMB3	+	+	+	-	-	+	-	-	-
DGRMB31	+	+	+	-	-	-	-	-	-

eight, three, three and four polymorphic markers, respectively and proved that these genotypes are genetically different from TG37A, TG26, TG51, TG38, and TAG24 (Table 7).

acid content in these 35 cultivars ranged from 0.112 to 1.4 g 100 g⁻¹ with VRI 2, CO 4, GJG32 showing the least values (<0.5 g 100g⁻¹) while ICGV00350, VRI 7 and TMV10 showing highest values (1.3-1.4 g 100g⁻¹).

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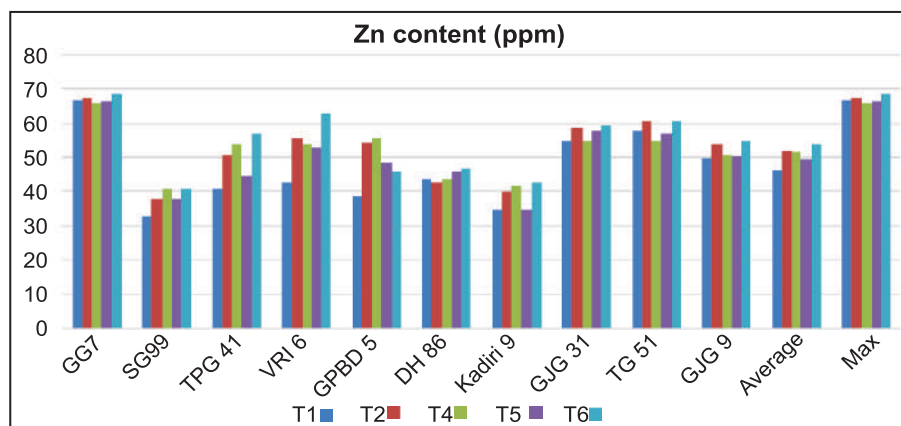


Fig 1. Effect of commercial and microbial Zn sources on seed Zn content

treatment with $ZnSO_4$ and FP 82 were 12% and 16% respectively, over control. TPG 41, VRI 6, GPBD 5 and GJG 9 were among the most responsive cultivars showing maximum percentage increase in pod yield and seed Zn content over control. GG7, in spite of being a high Zn density cultivar, showed a slight response to exogenous Zn application (Fig 1).

D. Nutrient management in groundnut through microbial solubilization and mobilization

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

Eleven new isolates of groundnut rhizobia, along with standard culture TAL 1000 were tested for their efficiency in increasing BNF and yield in groundnut in a field trial with cultivar TG37A

Table 1. Evaluation of competitive strains of groundnut rhizobia for enhancing BNF and yield of groundnut (cv TG37A) during *kharif* 2020

Treatment	PY (kg/ha)	HY (kg/ha)	HKW (g)	SOT (%)
Control	1270	1270	34.33	56.97
TAL1000	1273	1273	33.67	61.62
DGR23	1287	1287	34.87	61.50
DGR24	1550	1550	37.01	64.52
DGR25	1517	1517	37.32	63.81
DGR11	1283	1283	35.07	62.50
DGR19	1323	1323	34.90	62.18
DGR26	1553	1553	36.87	64.31
DGR17	1437	1437	34.97	62.63
DGR18	1370	1370	33.57	61.63
DGR20	1388	1388	34.67	62.17
DGR35	1557	1557	36.91	63.55
DGR10	1303	1303	34.53	63.70
CD (0.05)	140	252	2.05	2.85

during *kharif* 2020. Seed inoculation with 5 of the isolates (DGR 24, DGR 25, DGR 26, DGR 17 and DGR 35) resulted in significant enhancement of yield (13.1 – 22.6%). In general, these

isolates also resulted in increase in haulm yield, shelling out-turn, and hundred kernel mass (Table 1).

II. Evaluation of Zn- and K-solubilising microbial inoculants for their efficiency in increasing growth, and yield of groundnut and increasing Zn and K availability

Zn solubilization: Twenty-

seven new potential Zn-solubilizing bacterial isolates were identified by 16S rRNA sequencing and majority of the isolates were found to be different species of the genera *Enterobacter*, *Pseudomonas*,

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Table 2. Evaluation of Zn solubilizing bacteria on growth and yield of groundnut (cv TG37A) during summer 2020 (field trial)

Treatment	HY (kg/ha)	PY (kg/ha)	SOT (%)	HKW (g)
Control	1973	1240	59.20	30.20
<i>Acinetobacter oleivorans</i> strain ZM-12	2467	1527	62.43	33.20
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-3	2097	1347	60.00	31.33
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-6	2430	1477	62.70	33.47
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-7	2043	1213	59.57	30.70
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-9	2147	1300	59.77	31.03
CD (0.05)	261	148	2.20	2.23

Acinetobacter and *Microbacterium*. In a field trial conducted during *kharif* 2020, with 5 selected Zn-solubilising bacterial cultures, seed inoculation with two of the isolates *Acinetobacter oleivorans* strain ZM-12 (23%) and *Enterobacter*

cloacae subsp. *dissolvens* strain ZM-6 (19%) resulted in significant increase in pod yield (Table 2).

K-solubilization: Twelve newly isolated strains of K-solubilising bacteria were identified by 16S rRNA sequencing and majority of

the isolates were found to be belonging to the genera *Enterobacter*, *Pseudomonas* and *Acinetobacter*. Five efficient K-solubilising bacterial cultures were evaluated in a field trial during *kharif* 2020 to study the effects of inoculation of groundnut with K-mobilising bacterial cultures on growth, yield and K uptake. Seed inoculation with 3 isolates (*Acinetobacter lactuca* strain KM5-2, *Acinetobacter lactuca* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9) resulted in significant increase in pod yield ranging from 14.7 to 23.2% (Table 3).

E. Screening for P-use efficiency in cultivated varieties and advanced breeding lines

An experiment was conducted in *kharif*-2020 to study the P-use efficient and respondent lines in 36 Spanish bunch (SB), 40 Virginia cultivars and 73 advanced breeding lines by using two doses of phosphorus (0 and 75 kg P₂O₅/ha). Cultivars were grown in 5 m rows in 45 x 10 cm spacing. A rainfall of >1200mm was observed during the crop growth season.

Table 3. Evaluation of K- solubilizing bacteria on growth and yield of groundnut (cv TG37A) during *kharif* 2020 (field trial)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
Control	1423	2317	64.53	33.87
<i>Acinetobacter lactuca</i> strain KM5-2	1633	2377	64.26	34.28
<i>Acinetobacter oleivorans</i> strain KM6-1	1477	2253	64.73	33.47
<i>Acinetobacter lactuca</i> strain KM8-1	1480	2317	65.20	34.51
<i>Acinetobacter lactuca</i> strain KM8-2	1753	2643	67.02	36.82
<i>Pseudomonas taiwanensis</i> strain KM-9	1730	2610	66.80	36.07
CD (0.05)	153	230	1.94	1.59

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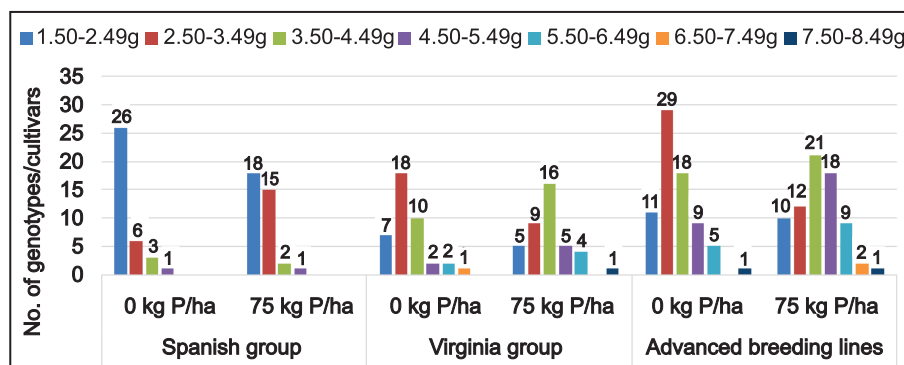


Fig. 2: Effect of different P doses on mean dry pod weight plant⁻¹ in groundnut cultivars/ genotypes of different habit type

I. Effect of different P doses on mean dry pod weight plant⁻¹

In P control plot (0 kg P₂O₅/ha), Out of 36 Spanish bunch varieties screened, ICGV-91114 recorded highest significant mean pod yield plant⁻¹ (4.8 g/plant). Out of 40 Virginia group varieties screened, highest significant mean pod yield plant⁻¹ was found in Kadiri-7 (6.9 g/plant). Out of 73 Advanced breeding lines (ABL's) screened, highest significant mean pod yield plant⁻¹ was found in PBS-29148 (7.6 g/plant). In P applied plot (75 kg P₂O₅/ha), CO3 recorded highest significant mean pod yield plant⁻¹ (4.7 g/plant) among the 36 SB varieties. Out of 40 Virginia group varieties screened, highest significant mean pod yield plant⁻¹ was found in CSMG 884 (7.7 g/plant). Out of 73 Advanced breeding lines (ABL's) screened, highest

significant mean pod yield plant⁻¹ was found in PBS-29138 (7.9 g/plant) (Fig. 2).

Spanish group-36 cultivars; Virginia group-40 cultivars; Advanced breeding lines-73 genotypes; mean dry pod weight plant⁻¹ of groundnut cultivars/genotypes is categorized into seven groups for classification; P-P₂O₅ applied through SSP

II. Effect of different P doses on mean shoot dry weight plant⁻¹

In P control plot (0 kg P₂O₅/ha), TKG 19A recorded highest significant mean shoot dry weight plant⁻¹ among the 36 SB varieties having shoot dry weight plant⁻¹ ranging from 3.50-14.30 g/plant. Out of 40 Virginia group varieties screened, highest significant mean haulm yield plant⁻¹ was found in Kadiri-7. Mean haulm yield plant⁻¹ of 40 Virginia cultivars ranged from 4.2-24.3 g/plant, with an

overall mean of 10.9g. Out of 73 Advanced breeding lines (ABL's) screened, highest significant mean haulm yield plant⁻¹ was found in PBS-29148. Mean pod yield plant⁻¹ of 73 genotypes ranged from 3.6-21.3 g/plant, with an overall mean of 10.9g. In P applied plot (75 kg P₂O₅/ha), RARS-1 indicated highest significant mean shoot dry weight plant⁻¹ among the 36 SB varieties. Out of 40 Virginia group varieties screened, highest significant mean haulm yield plant⁻¹ was found in M-137. Out of 73 Advanced breeding lines (ABL's) screened, highest significant mean pod yield plant⁻¹ was found in PBS-29179. Mean haulm yield plant⁻¹ of 73 genotypes ranged from 4.5-25.8 g/plant, with an overall mean of 11.0g (Fig. 3)

Spanish group-36 cultivars; Virginia group-40 cultivars; Advanced breeding lines-73 genotypes; mean dry shoot weight plant⁻¹ of groundnut cultivars/genotypes is categorized into seven groups for classification; P-P₂O₅ applied through SSP

III. Effect of different P doses on mean shoot height plant⁻¹

In P control plot (0 kg P₂O₅/ha), Kadiri-6 recorded highest significant shoot height plant⁻¹ among the 36 SB varieties. Out

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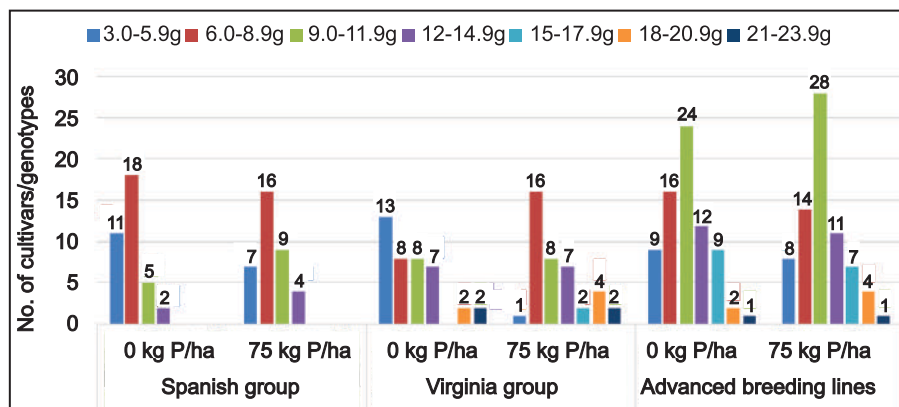


Fig. 3: Effect of different P doses on mean dry shoot weight plant⁻¹ in groundnut cultivars/ genotypes of different habit type

of 40 Virginia group varieties screened, highest significant shoot height plant⁻¹ was found in Kadiri-8. Out of 73 Advanced breeding lines (ABL's) screened, highest significant shoot height plant⁻¹ was found in PBS-29171.

In P applied plot (75 kg P₂O₅/ha), Out of 36 Spanish bunch varieties screened, highest significant shoot height plant⁻¹ was found in GJG-9. Out of 40 Virginia group

varieties screened, highest significant shoot height plant⁻¹ was found in GJG-22. Out of 73 Advanced breeding lines (ABL's) screened, highest significant shoot height plant⁻¹ was found in PBS-29229.

Spanish group-36 cultivars; Virginia group-40 cultivars; Advanced breeding lines-73 genotypes; mean plant height of groundnut cultivars/genotypes is categorized into six groups for classification;

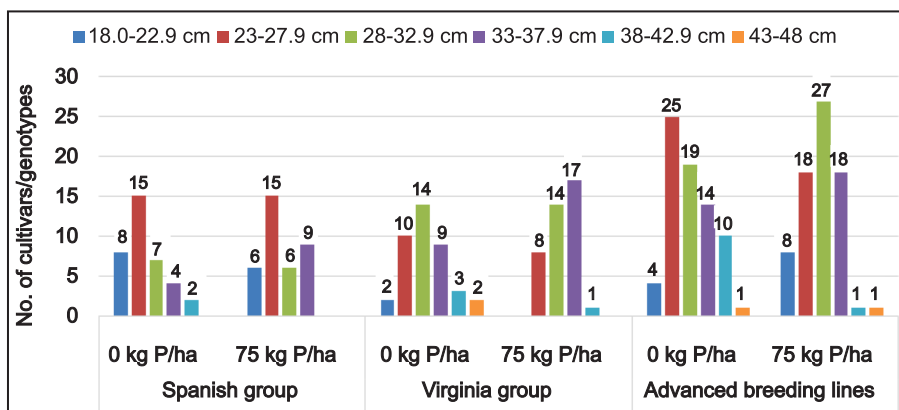


Fig.4: Effect of different P doses on mean plant height in groundnut cultivars/genotypes of different habit type

P-P₂O₅ applied through SSP

IV. Effect of different P doses on mean number of nodules plant⁻¹

In P control plot (0 kg P₂O₅/ha), highest significant mean nodules plant⁻¹ was found in Pratap Mungfali-2, out of 36 SB varieties, which ranged from 14.3-130.6 having a mean of 58.7. Out of 40 Virginia group varieties screened, highest significant nodules plant⁻¹ was found in CSMG-884. Nodules plant⁻¹ of 40 Virginia cultivars ranged from 45.3-182.6, with an overall mean of 97.3.

In P applied plot (75 kg P₂O₅/ha), Kadiri 9 (Out of 36 SB varieties) recorded highest significant mean nodules plant⁻¹. GJG 22 (Out of 40 Virginia group varieties) showed highest significant nodules plant⁻¹.

Spanish group-36 cultivars; Virginia group-40 cultivars; Advanced breeding lines-73 genotypes; mean number of nodules plant⁻¹ of groundnut cultivars/genotypes is categorized into eight groups for classification; P-P₂O₅ applied through SSP

V. Effect of different P doses on mean nodule dry weight plant⁻¹

In P control plot (0 kg P₂O₅/ha), TKG 19A recorded highest nodule dry weight

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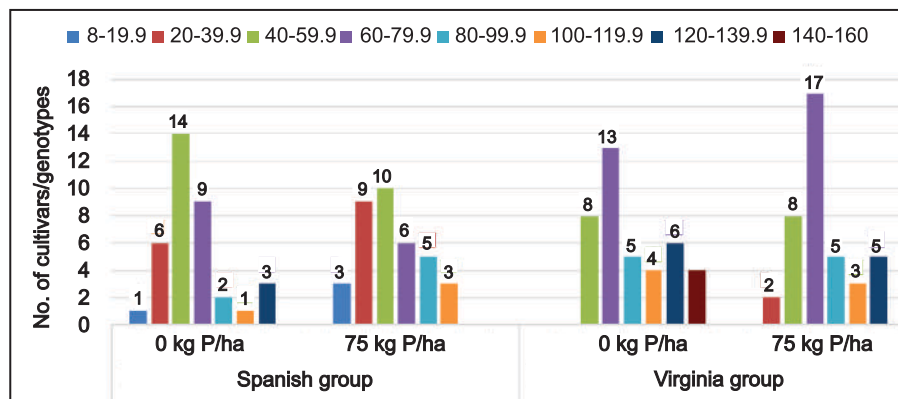


Fig.5: Effect of different P doses on mean number of nodules plant⁻¹ in groundnut cultivars/ genotypes of different habit type

plant⁻¹ which ranged from 32.6-357.5 mg, with an overall mean of 96.6 mg for 36 SB varieties. Out of 40 Virginia group varieties screened, a range from 42.5-320.3 mg with a mean of 134.8 mg was recorded with TMV 10 showing the highest significant nodule dry weight plant⁻¹. (**Fig. 6**).

In P applied plot (75 kg P₂O₅/ha), RARS-1 showed highest significant mean nodule dry weight plant⁻¹

among 36 SB varieties. CSMG- 884 recorded highest significant nodule dry weight plant⁻¹ among the 40 Virginia group varieties screened.

Spanish group-36 cultivars; Virginia group-40 cultivars; Advanced breeding lines-73 genotypes; mean nodule dry weight plant⁻¹ of groundnut cultivars/genotypes is categorized into eight groups for classification; P-P₂O₅ applied through SSP

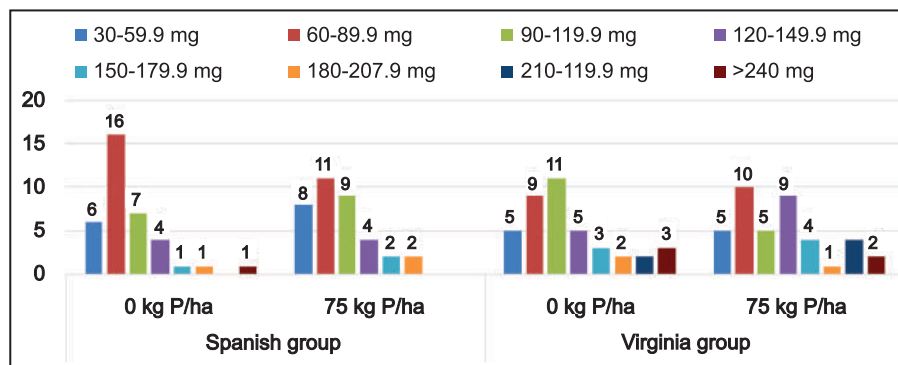


Fig.6: Effect of different P doses on mean nodule dry weight plant⁻¹ in groundnut cultivars/ genotypes of different habit type

VI. Impact of different P doses on overall mean plant growth and yield parameters

Overall mean dry pod yield plant⁻¹ of 36 Spanish bunch varieties under 0 kg P₂O₅/ha was 2.43g and under 75 kg P₂O₅/ha was 2.59g. Grand mean dry pod yield plant⁻¹ of 40 Virginia varieties under 0 kg P₂O₅/ha was 3.45g and under 75 kg P₂O₅/ha was 3.92g. Overall mean dry pod yield plant⁻¹ of 73 advanced breeding lines (ABL's) under 0 kg P₂O₅/ha was 3.60g and under 75 kg P₂O₅/ha was 4.15g (**Fig. 7**). At 75 kg P₂O₅/ha, there was a surge in average shoot height by 1.3 cm in Spanish bunch cultivars, compared to control (0 kg P₂O₅/ha). At high P doses, there is a reduction in average plant height by 0.5 cm, a drop of 20 nodule no./plant, a fall of 12 mg nodule wt./plant across Virginia cultivars compared to control, while different P doses did not pose significant changes in nodule no./plant and nodule dry wt./plant.

Spanish group-36 cultivars; Virginia group-40 cultivars; Advanced breeding lines-73 genotypes; P-P₂O₅ applied through SSP

VII. Optimization of NPK doses in groundnut cultivars

The experiment was conducted in *kharif*-2020,

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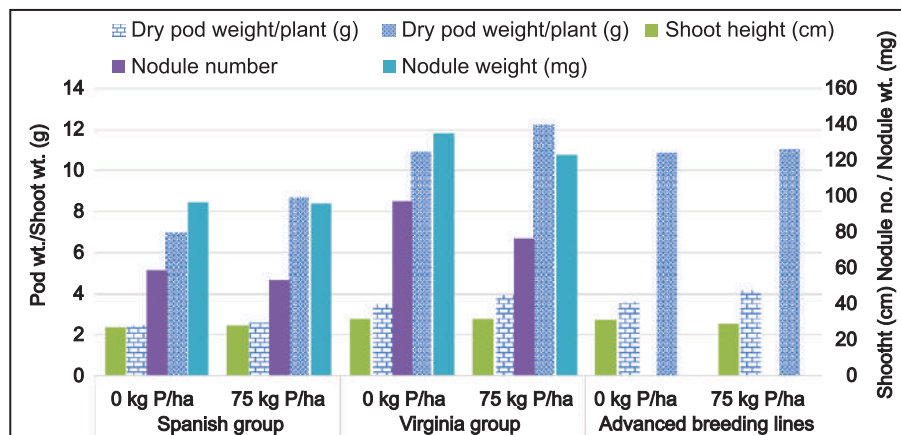


Fig.7: Effect of different P doses on overall mean plant growth and yield parameters Spanish group-36 cultivars; Virginia group-40 cultivars; Advanced breeding lines-73 genotypes; P-P₂O₅ applied through SSP

with two genotypes TLG-45 (Bold seeded, Spanish Bunch) and GJG-22 (Virginia Bunch) with 12 treatments (T1-N₄₀P₄₀K₅₀; T2-N₄₀P₆₀K₅₀; T3-N₄₀P₈₀K₅₀; T4-N₄₀P₄₀K₈₀; T5-N₄₀P₆₀K₈₀; T6-N₄₀P₈₀K₈₀; T7-N₆₀P₄₀K₅₀; T8-N₆₀P₆₀K₅₀; T9-N₆₀P₈₀K₅₀; T10-N₆₀P₄₀K₈₀; T11-N₆₀P₆₀K₈₀; T12-N₆₀P₈₀K₈₀) having two combinations of N (40, 60 kg/ha), 3 combinations of P (40, 60, 80 kg P₂O₅/ha) and 3 combinations of K (50, 80 kg K₂O/ha). In TLG-45, Pod yield at harvest was significantly high in T5-N₄₀P₆₀K₈₀ (1044 kg/ha), followed by T10, which was at par with T6 and T3 and it ranged from 835-1044 kg/ha between treatments. Haulm yield was found to be significantly high in T1-N₄₀P₄₀K₅₀ (2068 kg/ha) which was at par with T12 and

T6. In GJG-22, Pod yield at harvest was significantly high T11-N₆₀P₆₀K₈₀ (1753 kg/ha), followed by T9, which was at par with T7 and it ranged from 1246-1753 kg/ha between treatments. Haulm yield was found to be significantly high in T11-N₆₀P₆₀K₈₀ (3392 kg/ha) which was at par with T6 and T8. Due to heavy rainfall in the crop season (> 1500 mm), the pod development and growth got effected and thus had impact on yield

Project : Quality enhancement in groundnut and its product

PI: MK Mahatma

Co-PI: Aman Verma, Praveen Kona, BM Devani, MN Dabhi and BL Jani*

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Groundnut protein isolation from defatted groundnut flour

Groundnut Protein Isolates (GPI) was prepared by modifying iso-electric precipitation method incorporating enzymatic and Ultra-sonication as pretreatment. Defatted groundnut flour was dissolved in 1:20-25 ratio of water and protein was dissolved by adjusting pH from 8.0-10.0 using 1 N NaOH. Dissolved protein was precipitated by 1 N HCl at pH 4.5. Various treatments were incorporated to maximize protein recovery from defatted groundnut flour. Lipase and ultrasonication treatment improved protein recovery from 5-10%. Fat content of protein isolates was also decreased less than 1 % with combination of various pH and incubation time. Protein isolates were dried in oven at 40 °C and in lyophilizer at -40°C. Protein isolates dried in lyophilizer at -40°C had white-milky color and soft texture while oven dried product had brown color with compact texture (**Fig 1**). Protein isolates had 75-79 % crude protein content, 2-2.3% ash content.

Peroxide Value of roasted and Fresh Oil samples:

Peroxides are primary products of lipid oxidation and

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Fig. 1: Protein isolates (a) defatted flour, (b) Lyophilized or freeze drying, (c) Oven dried

the peroxide value (PV) is indicative of the extent to which oil, or other lipids, is oxidized. An experiment was conducted to study the impact of roasting on PV of groundnut oil extracted from 12 varieties. The seeds were roasted at 160°C for 12 min with two intermittent mixing in a hot air oven. Roasted seeds were stored at 4°C for six months. Oil was then extracted from roasted and fresh seeds and analyzed for PV value. The PV of the roasted samples were significantly higher (16-66 mEq/Kg) compared to the PV of the fresh oil samples (0.4-3.0 mEq/Kg). The most rancid oil found after roasting, was of ICG V-00348 (66 mEq/Kg) followed by Dharani (62 mEq/Kg) and Girnar-3 (52 mEq/Kg). High PV is an indication of presence of highly reactive peroxides which promote formation of aldehydes, alcoholic and other small

molecular weight compounds that deteriorates flavor and aroma of the groundnut oil. GJG19 variety showed the least PV (16 mEq/Kg) among the roasted samples which is close to the permissible limits of PV in edible oils. As per FSSAI lab manual (2015), fresh oils usually have PV below 10 mEq/Kg. A rancid taste often begins to be noticeable when the peroxide value is above 20 mEq/Kg and is considered unfit for consumption. PV of fresh oil samples ranged from 0.4 to 3.0 mEq/Kg, where least PV was found in RG-559-3 variety and highest in GJG-19.

Blanchability of Groundnut genotypes

A study was conducted to evaluate blanchability of 59 groundnut cultivars. Blanching was initiated by heating kernels, individually placed in paper trays, for 12 min in hot air oven that had been pre-

heated at 180 °C with two intermittent mixing, followed by cooling to room temperature. After cooling, samples were gently de-skinned by hands. Whole kernels and splits were considered blanched when <3 mm² testa remained on each kernel or split. The combined weight of blanched kernels and splits was recorded (blanched weight) for each sample by sorting the seeds post-processing into blanched and unblanched kernels. Blanching percentage was calculated as 100 x blanched weight/pre-blanching weight.

Based on the results, blanchability of groundnut cultivars has been categorized as low (< 50%), medium (51-75%) and high (> 75%).

Low blanchability: JL 501, Kadiri 7 Bold, GG 2, GG 11, GG 14, GUAG 10, GJG 18, GJG 19, GJG 22, GJG HPS-1, HNG 10 and BAU 13

Medium blanchability: TG 26, TG 38, TG 51, JL 776, TLG 45, Girnar 3, RG 510, Raj Mungfli 1, Kadiri 8 Bold, Kadiri 9, GG 12, GG 15, GG 20, GG 21, Smruti, GJG 9, GJG 32 and HNG 123

High blanchability: TKG 19A, AK159, TAG 24, VRI 2, TG 39, TG 37A, Dharani, Girnar 2, TPG 41, RG 559-3, RG-578, Kadiri-6, Kadiri-

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Harihandra, Kadiri-Amaravati, ICGV-00440, ICGV-91114, ICGV-00348, GG-3, GG-4, GG-5, GG-6, GG-7, Mallika, GPBD-4, KDG-123/P. Morno, GJG-31, GJG-33, A 12-159, Narayani, and P Warno ICDG-128

Hybridization program (*Kharif*, 2020)

Hybridization program

Total eight crosses were effected during *Kharif*, 2020 to improve the quality traits in groundnut related to seed size, oil, and protein content. Total

with a range from 16.58 to 41.45 %. The highest success rate was observed in K 1812 x K 7 bold (41.45 %) cross and lowest in K 7 bold x PBS 29146 (16.58 %) cross.

Generation advancement

Previous project segregating material was carried forward in this new project. Total 493 probable F_1 s selected from ten crosses during summer, 2020 were sowed to generate F_2 generation during *Kharif*, 2020. Total 1219 plants in ten crosses in F_2 generation were selected and forwarded to

individual plants were selected; 144 (F_6), and 17 (F_7) respectively. 23 new stable advanced breeding lines were selected from F_6 generation from four crosses and 17 lines in F_7 generation from five crosses. Nomenclature was given for the newly selected stable lines.

New Advanced Breeding Lines multiplication

Total 32 advanced breeding lines seeds were multiplied to conduct their evaluation trial of which 17 belong to Spanish group and 15 are Virginia group.

Evaluation of advanced breeding lines of groundnut

Forty advanced breeding lines with three check varieties were evaluated in randomized block design with three replications during *Kharif*, 2020 at two locations; ARC, Bikaner and ICAR-DGR, Junagadh. Significant genotypic and environment interaction was observed for hundred kernel weight (HKW), kernel length (KL), KG, shelling percentage (SP), number of pods/plant (NP/P), pod weight per plant (PW/P), oil and protein percent in two locations. In both locations PBS 29079 B recorded highest 100 KW (75g at Junagadh and 121.97 g at

S. No.	Name of Cross	Purpose	Bud pollinated	No. F_1 pods	Success (%)
1	J 95xPBS 29079 B	Large seed size	517	154	29.78
2	K 1812xK 7 bold	Large seed size	731	303	41.45
3	K 1812xGJG HPS 2	Large seed size	568	132	23.23
4	KDG 128xK 7 bold	Large seed size	851	343	40.30
5	K 1812xPBS 29146	Large seed, high protein and low oil	465	90	19.35
6	K 1812xPBS 29213	Large seed, high protein and low oil	665	246	36.99
7	K 7 boldxPBS 29146	Large seed, high protein and low oil	597	99	16.58
8	J 95xPBS 29146	Large seed, high protein and low oil	447	175	39.15

1542 mature crossed pods were harvested from eight crosses with a range of 90 (K 1812 x PBS 29213) to 343 (KDG 128 x K 7 Bold). The mean success rate of the hybridization programme in eight crosses was 30.85 %

next generation. 1074 single plants from eight crosses were selected based on pod and seed size in F_3 generation and forwarded to next generation. Twelve crosses of advanced generations were raised during *Kharif*, 2020 and 161

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S. No.	Trait	Junagadh	Bikaner
1	HKW (g)	25.14 (PBS 19013)-75 (PBS 29079 B)	62.2 (PBS 29232)-121.9 (PBS29079B)
2	SP (%)	45.3 (PBS 29143)-79.8 (PBS 29079B)	47.4 (PBS 29082)-73.2 (PBS 29211)
3	KL(cm)	1.1 (PBS 19018, PBS 29232)-1.7 (PBS 29079B)	1.66 (PBS 29232)-2.17 (PBS 29079B)
4	KG (cm)	0.62 (PBS 29219)-0.83 (PBS 29143)	0.85 (PBS 29232)-1.06 (PBS 29079B)
5	NP/P	7 (PBS 29212)-17.5 (PBS 29230)	10.6 (PBS 29212)-21 (PBS 29079B)
6	PW/P (g)	5.7 (PBS 29204)-15.2 (PBS 29137)	10.02(PBS 29212)-37.06 (PBS 29079B)
7	Oil (%)	43 (PBS 29069)-50.7 (PBS 29233)	44.8 (PBS 29082)-53.04 (PBS 29187)
8	Protein (%)	27.48 (PBS 29233)-33.98 (PBS 29069)	26.21 (PBS 29233)-33.04 (PBS 29082)

Bikaner). Five genotypes showed good combination of confectionery traits in two locations which can be promoted for AICRPG trials.

Evaluation of released groundnut varieties for sucrose content and blanchability traits

Total 185 released varieties of groundnut were raised during *Kharif* 2020 under alpha lattice design. Out of 185 varieties, 102 are SB, 44 are VB, 34 are VR and 5 are Valencia. The total sugars were estimated using NIR in all the varieties. Total 29 varieties recorded > 6% of total soluble sugars of which HNG 10 recorded highest (7.62 %) followed by Girnar 3 (7.19%) and MH 2 (7.12%). The sucrose content has to be estimated in these genotypes using Ion chromatography. These varieties need to be evaluated for blanching and sucrose content traits.

Project : Physiological studies in groundnut under drought and salinity

PI: AL Singh

Co-PI: Sushmita Singh and Aman Verma

Physiological efficiencies among Indian groundnut cultivars

A study comprising of 100 cultivars during *Kharif* and 40 cultivars during Summer season was undertaken to find out physiologically efficient cultivars in terms of photosynthesis (Pn), transpiration (E), stomatal conductance (gs), chlorophyll fluorescence, SCMR and water use efficiency which when taken altogether directly or indirectly influences pod yield. The study identified several photosynthetically efficient cultivars with high Pn and its positive correlation with gs, E both of which positively regulated water use efficiency ultimately showing positive effect on pod yield.

Elasticity of tolerance to various drought situations

During *kharif* season 40 recent groundnut cultivars were grown under protected (P), rainfed (RF), RF+ hydrogel as well as exposed to mid-season (MSD, 50-70 DAS) and late season drought (LSD, 70-90 DAS) and their elasticity of drought tolerance were studied. The study identified a few cultivars as being suitable during MSD and LSD

MSD: RG 578, RG 559-3, JL 501, GG 21, Kadiri harithandra, GJG 22, CSMG 9510, AK 303

LSD: RG 578, GG 7, Girnar 3, ICGV 00350, TG 37A, GJG 22, CSMG 9510.

However, the cultivars RG 578, CSMG 9510 and GJG 22 showed most elasticity and performed well under rainfed, LSD as well as MSD.

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Pod zone moisture contents influences yield, yield attributes and aflatoxin

Five treatments (T1> 19.5%, T2: 17.5- 19.5; T3: 14.9- 17.1; T4: 12.4- 14.8; T5< 12.5 %) of varying moisture percentage during pod filling stage were applied to 24 groundnut cultivars in order to study the effect on physiological, biochemical and yield attributes. Mild water stress during pod filling stage (T3) caused an increase in Total Chlorophyll content, carotenoid content and water use efficiency. However, maximum photochemical efficiency of PSII remained nearly uniform during mild stress and showed a drastic reduction in values during severe stress (T5).

Influence of growth regulators on seed size

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

Physiological Studies during salinity stress

Two levels of salinity viz., ECe 2 and ECe 4 were imposed to 60 cultivars of groundnut to study the effect of salinity stress on morpho-physiological and biochemical traits. The physiological characterization indicated an overall reduction in maximum photochemical efficiency, leaf relative water content and total chlorophyll content at both the salinity levels. Carotenoid content was increased by 4% during stress (at 4ECe). Although Chl- a and b content declined during both the salinity stress levels, the ratio Chl a/b showed 5-8% increase in their values over control. The yield attributes also showed a drastic reduction in number of pods, pod yield and 100 kernel weight at ECe 4. Sugar profiling indicated that the level of inositol increased at both EC 2 and EC4 while the level of glucose and fructose was sharply declined.

Evaluation of Nutritional and Bioactive compounds of Groundnut

PI: MK Mahatma

Co-PI: Aman Verma and AL Singh

Method for Vitamin E estimation in Groundnut Oil

A convenient analytic method was developed for measuring major vitamins E isomeric

forms (α , β , γ and δ -Tocopherol) in groundnut oil. A 5 μ m Polar Advantage II, 120 Å, C-18 column, with the dimensions of 4.6 $\times$ 150 mm and maintained at 25 °C, is used to resolve vitamin E. The separation starts with a 5.5 min composition hold with absolute methanol as mobile phase with flow rate of 1.0 ml/min, followed by reduction in flow rate i.e. 0.4 ml/min for up to 9.0 min and 0.6 ml/min for last one minute. Detection is accomplished using UV detector at wavelength 295 nm. The elution order of tocopherols in TG-51 genotype (**Fig 1**) is δ -tocopherol, (β + γ)- tocopherol and α -tocopherol with retention time of 4.87, 6.01 and 6.43 minutes respectively. The total tocopherol content in TG-51 was found to be 567 ppm with 49 ppm of δ -tocopherol, 109 ppm of β + γ -tocopherol and 409 ppm of α -tocopherol. Peaks of α , β , γ and δ -Tocopherol in groundnut oil were identified (**Fig 1**) by comparing their retention times with commercially available standards (Sigma-Aldrich, St. Louis, MO, USA).

Determination of tocopherol in raw and roasted groundnut

Tocopherol content of groundnut oil extracted from 30 cultivars was determined

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using Ion chromatography. There is large variability for total tocopherol content in groundnut cultivars (OG52-1: 27.8 mg/100 g oil to TG51: 56.7 mg/100 g oil). Girnar3 (54.1 mg) and GJG18 (51.3 mg) having more than 50.0 mg tocopherol/100 g oil. Twenty cultivars possess more than 40.0 mg tocopherol/100 g oil. Only two cultivars (OG52-1 and BAU 13) possess less than 30.0 mg tocopherol/100 g oil. The average content of these 30 cultivars is 42.3 mg/100 g. After roasting tocopherol content was altered in cultivars, it was increased in some cultivars while decreased in some cultivars.

Resistant starch in groundnut

Resistant starch is an unexplored metabolite in groundnut which like dietary fibers possesses multiple health benefits. RS is the undigested portion of total starch which is later on fermented by natural microbial flora of the colon to produce short chain fatty acids. The energy value of RS has been calculated as 8 kJ/g (2 kcal/g) and about 20 g per day of RS is recommended to have its health benefits. As a functional food ingredient, RS not only lowers calorific value but improves texture,

appearance, and organoleptic qualities of the foods as well. Thus a study was conducted to observe changes in the RS content during different processing techniques like soaking (8 h and 16 h), roasting and microwave (MW) irradiation. RS content was determined using RS assay kit (Megazyme, Ireland) with slight modifications. Results showed that among the treatments, roasting has increased RS content (33-62%) followed by 8 h soaking. Girnar 2 variety has shown highest increase in RS content by roasting (62%) and lowest by GJG 22. Extending soaking for 16 h resulted in decrease in RS content when compared to control samples. In terms of percent increase, the varietal performance of Kadiri 6, TG 37A and HNG 10 was found to be similar.

Identification of trait specific cultivars

Trait specific cultivars were identified, cultivar Dharani (low oil, high protein, Zn, K, phenol, catechin) GJG22 (High oil, oleic acid, phenol, Fe, low palmitic acid, and RFOs) GG 20 (High oil, oleic acid, resveratrol, sucrose, antioxidant and low palmitic acid) GG 7 (High blanching, Zn, mineral, resveratrol,

antioxidant and catechin) Girnar3 (High soluble sugars, sucrose, mineral, K and tocopherol) and TG51 (low oil, high protein, sugars, Fe, tocopherol and low RFOs) have more than 5 traits.

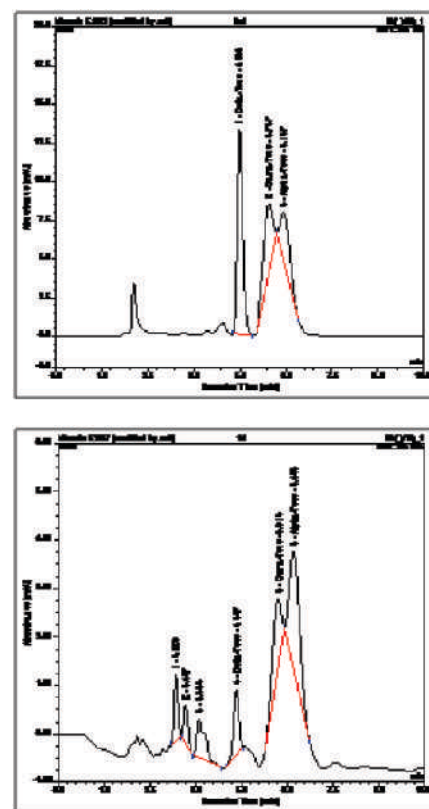


Fig1:

- Chromatogram showing separation of alpha-, gamma- and delta-tocopherol standard.
- Chromatogram showing separation of alpha-, gamma- and delta-tocopherol in TG51.

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Project: Studies on micro organisms in relation to plant health and nutrition in Groundnut (old project upto summer 2020)

PI: R Dey

Co. PI: KK Pal and

PP Thirumalaisamy

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

Eleven new isolates of groundnut rhizobia, along with

Table 1. Evaluation of competitive strains of groundnut rhizobia for enhancing BNF and yield of groundnut (cv TG 37A) during summer 2020

Treatment	PY (kg/ha)	HY/ (kg/ha)
Control	1820	3173
TAL 1000	1873	3023
DGR 23	2087	3270
DGR 24	2133	3620
DGR 25	2160	3687
DGR 11	1843	3083
DGR 19	1923	3133
DGR 26	2157	3567
DGR 17	1807	3130
DGR 18	1937	3157
DGR 20	1940	3217
DGR 35	2110	3600
DGR10	1860	3083
CD (0.05)	168	226

standard culture TAL 1000 were tested for their efficiency in increasing BNF and yield in groundnut in a field trial with cultivar TG37A during summer 2020. Seed inoculation with 5 of the isolates (DGR 23, DGR 24, DGR 25, DGR 26, and DGR 35) resulted in significant enhancement of yield (15 – 19%). These isolates also resulted in increase in haulm yield, shelling out-turn, and hundred kernel mass (**Table 1**).

B. Evaluation of available rhizobia for tolerance to different levels of nitrate and salinity

Forty-seven isolates of important groundnut rhizobial cultures available in the culture collection were screened for tolerance to different levels of salinity ranging from 0 to 3 M concentration of NaCl with

increments of 0.25M. While almost all the isolates could grow upto 0.5 M concentration, 7 isolates could not grow at 0.75 M concentration, 10 isolates could not grow at 1.0 M concentration, 27 isolates could not grow at 1.5 M concentration, 18 isolates showed tolerance upto 1.5 M concentration of NaCl. None of the isolates showed tolerance to 2 M or more concentration of NaCl. The cultures NRCG4, NRCG9, NC92, IGR6, etc. cultures showed salinity tolerance upto 1.5 M conc.

C. Evaluation of epiphytes for management of Alternaria leaf blight

Phyllosphere or epiphytic bacteria can be used as potential biological control agents for air-borne fungal pathogens. Five epiphytic

Table 2. Effect of application of epiphytes on suppression of Alternaria leaf blight and growth and yield of groundnut (cv. TG37A) during summer 2020

Treatment	PY (kg/ha)	HY (kg/ha)	Disease score (1-9 scale)
Control195026507			
<i>Bacillus subtilis</i> 1S1 (EPI-1)	2017	2613	5
<i>Bacillus subtilis</i> 5S1 (EPI-2)	2110	2670	5
<i>Bacillus subtilis</i> 7S2 (EPI-3)	1997	2687	5
<i>Bacillus amyloliquefaciens</i> 9S2 (EPI-4)	2277	2977	4
<i>Bacillus amyloliquefaciens</i> 13S3 (EPI-5)	2293	3013	5
CD (0.05)	209	279	

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bacteria viz. *Bacillus amyloliquefaciens* 13S3, *Bacillus subtilis* 1S1, *Bacillus subtilis* 5S1, *Bacillus subtilis* 7S2 and *Bacillus amyloliquefaciens* 9S2 were evaluated for their efficiency in minimizing the incidence of alternaria leaf blight in groundnut. The severity of leaf blight reduced from a score of 7.0 in uninoculated control to 4.0 when sprayed with *Bacillus amyloliquefaciens* 9S2 and 5.0 in treatments sprayed with *Bacillus subtilis* 1S1, 5S1, 7S2 and *Bacillus amyloliquefaciens* 13S3. The bacteria were sprayed onto the leaf of groundnut with the epiphytes five times at 15 days interval beginning 15 DAE. Application of *Bacillus amyloliquefaciens* 9S2 enhanced the pod yield by 16.8% and *Bacillus amyloliquefaciens* 13S3 by 17.6% (Table 2).

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

Zn solubilisation:

Twenty-four Zn-solubilising microbial cultures were tested in a pot trial in summer 2020

Table 3. Evaluation of zinc solubilizing bacteria in enhancing growth, yield and Zn uptake in groundnut (cv TG37A) during summer 2020 (pot trial)

Treatment	PB (g/p)	PY (g/p)
Control	8.67	4.64
Zn Control	9.22	4.96
<i>Enterobacter asburiae</i> strain ZM-1	9.86	5.31
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-2	9.62	5.39
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-3	9.68	5.45
<i>Acinetobacter pittii</i> strain ZM-4	9.49	5.51
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-5	8.98	4.83
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-6	9.77	5.48
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-7	10.60	5.58
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-8	11.13	5.36
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-9	9.98	5.42
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-10	9.13	5.34
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-11	8.70	4.76
<i>Acinetobacter oleivorans</i> strain ZM-12	10.33	6.53
<i>Pseudomonas aeruginosa</i> strain ZM-13	10.30	5.58
<i>Acinetobacter oleivorans</i> strain ZM-14	8.95	4.97
<i>Pseudomonas aeruginosa</i> strain ZM-15	10.20	5.57
<i>Pseudomonas aeruginosa</i> strain ZM-16	9.22	5.12
<i>Acinetobacter pittii</i> strain ZM-17	9.40	4.87
<i>Bacillus aryabhattai</i> strain ZM-18	9.97	5.38
<i>Acinetobacter lactucae</i> strain ZM-19	9.20	4.96
<i>Pseudomonas aeruginosa</i> strain ZM-29	9.13	4.80
<i>Pseudomonas benzenivorans</i> strain ZM-30	9.83	4.76
<i>Enterobacter hormaechei</i> subsp. <i>xiangfangensis</i> strain ZM-31	9.17	4.75
<i>Pseudomonas aeruginosa</i> strain ZM-34	9.13	4.75
<i>Acinetobacter calcoaceticus</i> strain ZM-35	10.10	5.69
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-71	0.60	5.58
CD 0.05	0.79	0.29

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to study the effects of inoculation of groundnut with Zn-mobilising bacterial cultures on growth, yield and Zn uptake. All the zinc solubilizers were identified by 16S rRNA sequencing and found to be different species of the genus *Enterobacter*, *Pseudomonas*, *Acinetobacter* and *Microbacterium*. Inoculation with 14 of the Zn-solubilising bacterial cultures resulted in significant increase in pod yield (g/p), ranging from 7-32%. The maximum increase in pod yield was obtained with *Acinetobacter oleivorans* strain ZM-12. Six of these isolates also resulted in significant increase in plant biomass (g/p), ranging from 9.5% to 20.7% (Table 3).

Field Trial:

Five efficient Zn-solubilising microbial cultures were evaluated in a field trial during summer 2020 to study the effects of inoculation of groundnut with Zn-mobilising bacterial cultures on growth, yield and Zn uptake. Seed inoculation with two of the isolates, *Acinetobacter oleivorans* strain ZM-12 and *Enterobacter cloacae* subsp. *dissolvens* strain ZM-9

Table 4. Evaluation of Zn solubilizing bacteria on growth and yield of groundnut (cv TG 37A) during summer 2020 (field trial)

Treatment	HY (kg/ha)	PY (kg/ha)	SOT (%)	HKW (g)
Control	2717	1943	65.92	40.15
<i>Acinetobacter oleivorans</i> strain ZM-12	3007	2203	68.60	43.50
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-3	2723	1910	65.55	40.94
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-6	2810	2053	65.34	41.34
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-7	2837	1967	65.29	40.20
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain ZM-9	3080	2193	67.89	43.46
CD (0.05)	275	195	1.71	NS

resulted in significant increase in pod yield of 13%. These two isolates also

resulted in enhancement of haulm yield and shelling outturn as compared to the

Table 5. Evaluation of potassium-solubilizing bacteria in potted conditions (summer 2020)

Treatments	PB (g/p)	PY (g/p)
Control	8.63	4.98
Control K	9.06	4.68
<i>Acinetobacter calcoaceticus</i> strain KM-1	9.39	4.82
<i>Enterobacter cloacae</i> subsp. <i>dissolvens</i> strain KM-2	9.20	5.18
<i>Streptomyces roseofulvus</i> KM3	9.21	5.07
<i>Pseudomonas boreopolis</i> strain KM5-1	9.33	4.91
<i>Acinetobacter lactucae</i> strain KM5-2	10.03	4.93
<i>Acinetobacter oleivorans</i> strain KM6-1	10.10	5.45
<i>Acinetobacter oleivorans</i> strain KM6-2	9.17	5.54
<i>Acinetobacter lactucae</i> strain KM8-1	10.28	4.86
<i>Acinetobacter lactucae</i> strain KM8-2	10.32	5.57
<i>Pseudomonas taiwanensis</i> strain KM-9	10.04	5.46
<i>Pseudomonas plecoglossicida</i> strain KM-10	9.24	5.03
<i>Flavobacterium anhuiense</i> strain KM-11	9.10	5.09
<i>Sinorhizobium meliloti</i> strain KM-12	9.16	5.16
<i>Bacillus wiedmannii</i> strain Af-4	9.10	5.61
CD (0.05)	0.33	0.32

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control. Inoculation with rest of the isolates resulted in pod yield at par with that of control (Table 4).

K-solubilization:

A pot trial was conducted during summer 2020 to evaluate the inoculation effects of potash-solubilizing bacterial isolates on growth, yield and K-mobilization in groundnut. Out of 14 K-mobilizing bacterial isolates tested, inoculation with 10 isolates resulted in significant increase in pod yield (g/p), ranging from 7.5 to 20%. The maximum increase was obtained with *Bacillus wiedmannii* strain Af-4, which was at par with *Acinetobacter oleivorans* strain KM6-1, KM6-2, *Acinetobacter lactucae* strain KM8-2, and *Pseudomonas taiwanensis* strain KM-9. All the K solubilizers were identified by 16S rRNA sequencing and found to be belonging to the genus *Enterobacter*, *Pseudomonas* and *Acinetobacter*. Inoculation with 6 of the isolates also resulted in significant increase in plant biomass formation in groundnut, ranging from 3.6 to 13.9% (Table 5).

Table 6. Evaluation of K- solubilizing bacteria on growth and yield of groundnut (cv TG37A) during summer 2020 (field trial)

Treatment	HY (kg/ha)	PY (kg/ha)	SOT (%)	HKW (g)
CONTROL	2663	1880	63.35	40.50
<i>Acinetobacter lactucae</i> strain KM5-2	2777	1853	65.38	42.87
<i>Acinetobacter oleivorans</i> strain KM6-1	2810	1997	64.23	42.07
<i>Acinetobacter lactucae</i> strain KM8-1	2748	2040	65.27	42.35
<i>Acinetobacter lactucae</i> strain KM8-2	3110	2187	67.39	44.83
<i>Pseudomonas taiwanensis</i> strain KM-9	3045	2163	66.70	43.62
CD (0.05)	119	242		2.18

Field Trial: Five efficient K-solubilising bacterial cultures were evaluated in a field trial during summer 2020 to study the effects of inoculation of groundnut with K-mobilising bacterial cultures on growth, yield and K uptake. Seed inoculation with two of the isolates, *Acinetobacter lactucae* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9 resulted in significant increase in pod yield of 16.3 and 15%, respectively. These two isolates also resulted in enhancement of haulm yield and hundred kernel weight as compared to the control. Inoculation with rest of the isolates resulted in pod yield at par with that of control (Table 6).

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

PI: KK Pal

Co. PI: R Dey, MK Mahatma, Harish G, Ajay BC and K Reddy

A. Evaluation of role of different endophytes for alleviation of drought stress and saving of irrigation water and mechanisms of alleviation (Summer 2020)

To ascertain whether substantial irrigation water can be saved by application of endophytic bacteria in summer groundnut, an experiment was conducted with five endophytes (*Bacillus firmus* J22, *Bacillus* sp. R51, *Pseudomonas pseudoalcaligenes* SEN29,

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Table 1. Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut (Summer 2020; TG37A)

Treatments	No of supplementary irrigations after emergence				Mean
	3	4	5	10	
Control	1378	2069	2193	2335	1994
REN47N*	1582	2218	2520	2502	2205
SEN29N*	1630	2167	2463	2505	2191
J20N*	1655	2157	2542	2462	2204
REN51N*	1582	2260	2557	2647	2261
J22N*	1778	2166	2551	2568	2266
Mean	1601	2173	2471	2503	2187
LSD (0.05)					
Treatment	74				
Irrigation	56				
Treatment X Irrigation	136				

*As per NCBI accession number and previously N was not added after the strain number

Acinetobacter junii J20 and *Pseudoxanthomonas mexicana* REN47) during summer 2020 with cultivar TG37A and with four different levels of irrigation (three, four, five, and 10 irrigations after emergence). Results indicated that application of endophytes and 5 irrigations can provide as much pod yield that can be obtained with 10 supplementary irrigations after emergence without endophytes. Inoculation of endophytes improved the pod and haulm yield of groundnut at all level of irrigations. Maximum benefit was

provided by *Bacillus firmus* J22 (Table 1).

Thus, it would be feasible to reduce quantity (30-50%) and frequency of irrigations (3-4

irrigations) substantially for raising summer groundnut with endophytes and there is possibility of horizontal spread in areas with the application of endophytes with the available quantity of irrigation water.

During summer 2020, a separate experiment was also conducted to ascertain the role of endophytes in alleviation of drought stress with two supplementary irrigations after emergence (55 DAE and 75 DAE) with cultivar TG37A. Inoculation with *Bacillus firmus* J22 and *Bacillus* sp. R51 resulted in significant increase in pod yield, 24% and 17%, respectively (Table 2).

The modulation of C3-CAM transition was also studied and it was found that there

Table 2. Application of endophytes for alleviation of drought stress in groundnut (cv TG37A), Summer 2020 (2 irrigations after emergence)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
Control	1237	2357	58.85	34.80
J20N*	1287	2660	59.33	34.32
J22N*	1540	2737	61.59	38.76
R47N*	1243	2610	58.43	35.80
R51N*	1443	2773	62.92	37.42
SEN29N*	1323	2527	59.47	34.80
CD (0.05)	142	271	1.83	2.24

*As per NCBI accession number and previously N was not added after the strain number

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was enhanced level of production of key enzymes of night-time carboxylation (malate dehydrogenase, phosphoenolpyruvate carboxylase, etc. upto 1.5 folds) and de-carboxylation modules (Pyruvate orthophosphate dikinase, NAD(P)-malic enzymes and phosphoenolpyruvate carboxykinase: upto 1.6 folds) of C3-CAM pathways due to inoculation of endophytes in groundnut during the period of drought stress in different treatments over uninoculated control.

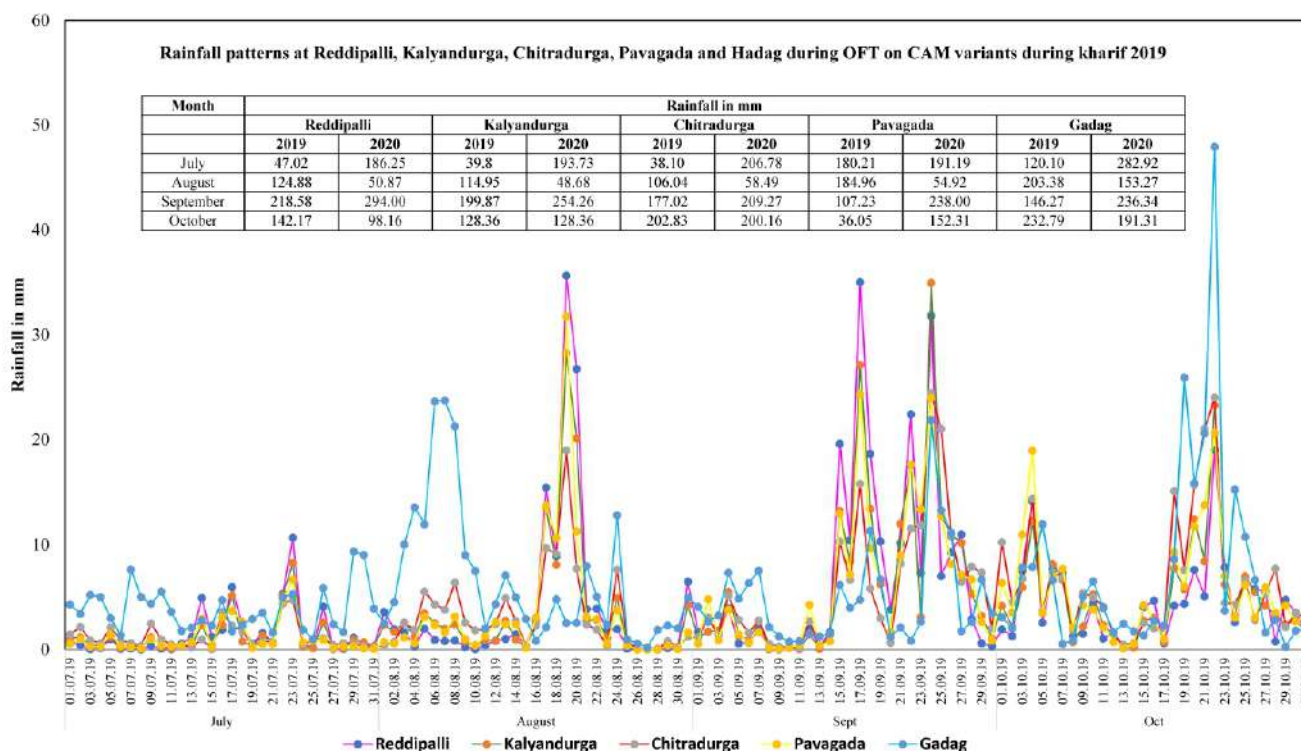
Table 3. Effect of endophytes in alleviation of salinity stress in groundnut (cv TG37A) during summer 2020 (Soil EC at harvest: 3.15)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
Control	1227	2327	62.48	40.33
J20N*	1467	2613	63.33	40.78
J22N*	1510	2653	64.73	43.42
REN47N*	1263	2347	62.99	40.37
REN51N*	1570	2677	64.75	44.44
SEN29N*	1428	2323	63.16	41.38
CD (0.05)	214	282	1.05	2.41

*As per NCBI accession number and previously N was not added after the strain number

Simultaneously, genes involved in carboxylation and decarboxylation modules of CAM like bca5, ppck2, ppc2,

mdh1, vha-a, almt14, tdt, nadme2, nadpme2, pck 1, and ppdk2 were also modulated with enhancement in



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Table 4. Effect of C3-CAM transition in imparting salinity tolerance in groundnut (Soil EC at harvest 3.95), summer 2020

Treatments	PY (kg/ha)			HY (kg/ha)			SP (%)			HKM (g)		
	1	2	Mean	1	2	Mean	1	2	Mean	1	2	Mean
DGRMB19	2543	1777	2160	4203	3177	3690	70.65	65.84	68.24	47.62	43.21	45.42
DGRMB5	2570	1757	2163	4193	2993	3593	70.46	64.90	67.68	47.63	43.68	45.66
TG 37A	2307	1183	1745	3972	2057	3014	69.55	58.70	64.13	46.56	39.38	42.97
Mean	2473	1572	2023	4123	2742	3433	70.22	63.15	66.68	47.27	42.09	44.68
LSD (0.05)												
Treatments (T)	85			54			0.82			1.29		
Salinity (S)	88			257			0.97			0.98		
TXS	152			445			1.68			1.71		

1= No salts; 2= salts applied

expression upto 1.4 folds in different treatments of endophytes against uninoculated control (results from samples collected during summer 2019).

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

Five endophytes (*Bacillus firmus* J22N, *Bacillus* sp. REN51N, *Pseudomonas pseudoalcaligenes* SEN29N, *Acinetobacter junii* J20N and *Pseudoxanthomonasmexican* aREN47N) were evaluated during summer 2020 with cultivar TG 37A for alleviation of salinity stress, if any, and with salinity level of around 3.15 at harvest. Soil EC beyond 4.0 could not be obtained because of

difficulties faced during summer 2020 owing to Covid-19. Results indicated that though there was drastic reduction in yield of groundnut with the application of saline water and at around 3.15 EC of soil salinity at harvest. Application of endophytes like *Acinetobacter junii* J20, *Bacillus firmus* J22, and *Bacillus* sp. REN51 prevented the reduction in yield losses by improving the yield by 19.5%, 23.0%, and 28.0%, respectively (1227 kg/ha in control, and 1467-1570 kg/ha with these endophytes) at soil EC of around 3.15 at harvest (**Table 3**). Attempt was made to understand whether there was modulation in the C3-CAM transition in salinity stress alleviation by these

besides other mechanisms. To do so, it was required first to understand whether C3-CAM transition occurs in cultivated groundnut under salinity stress.

To understand the phenomenon, a separate experiment was undertaken with TG37A and two of its C3-CAM transitioned and drought tolerant variants with soil salinity level of around 3.95 at harvest. It was found that while imposition of salinity at 3.95 of soil EC reduced the biomass production in the cultivar TG 37A by almost 48% (6279 kg/ha in normal soil condition to 3240 kg/ha in around 3.95 soil EC in TG 37A), the over-expressive C3-CAM transitioned variants of TG37A like DGRMB19 minimized the biomass reduction (6746 kg/ha

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on normal condition to 4954 kg/ha) and maintained at 26% level of reduction. In terms of pod yield, whereas pod yield of TG37A was reduced by 49%, it was restricted to 30% in case of DGRMB19. Both the CAM transited genotypes performed significantly superior than TG37A (Table 4).

The transition and expression of CAM modules were studied in TG 37A and CAM transited variants of TG 37A. Summary results of analysis of samples collected during summer 2018 and 2019 revealed that there was significant improvement in the expression of genes involved in night-time carboxylation (bca5, ppck2, ppc2, mdh1, vha-a, almt14, etc. upto 9.5 folds in different genes; rate of carboxylation at night upto 5 $\mu\text{mol}/\text{m}^2/\text{s}$; and enzyme activity upto 6.5 folds as compared to their corresponding controls) module of CAM. Similarly, the expression of genes involved in de-carboxylation modules viz. tdt, nadme2, nadpme2, pck 1, and ppdk2 were also expressed significantly (upto 6.8 folds in different genes) higher over their corresponding controls. Besides, mesophyll succulence and titratable

acidity was also improved overnight. In roots, there was over-expression of Na/K antiporter, ppdk2, mdh1, ppc2, and genes for isocitrate lyase and malate synthase (aceB) for uptake of bicarbonate from soil for carbon gain.

By application of endophytes, the expression of genes and production of enzymes involved in CAM transition were modulated further. Enzymes of carboxylation (PEP-carbo-xylase, malate dehydrogenase increased upto 1.7 folds in different treatments) and decarboxylation module

(pyruvate orthophosphate dikinase, NAD(P)-malic enzymes and phosphoenolpyruvate carboxykinase: upto 1.6 folds) of C3-CAM pathways due to inoculation of endophytes in groundnut. Besides, enzymes involved in ROS scavenging were also improved significantly (results from samples collected during summer 2018 and 2019).

C. Evaluation of endophytes for alleviation of salinity stress at Mandvi, Bhuj (in collaboration with Dr. S. Acharya, CCSRI, Mandvi)

Three endophytes (*Bacillus firmus* J22, *Pseudomonas*

Table 5. Evaluation of performance of CAM transited groundnut variants in normal and drought stress conditions (summer 2020)

Treatments	Pod Yield (kg/ha)			Haulm Yield (kg/ha)		
	2	10	Total	2	8	Total
TG 37A	1097	2243	1670	1883	3557	2720
DGRMB 13	1453	2553	2003	2570	3277	2923
DGRMB 17	1638	2677	2158	2648	3488	3068
DGRMB 19	1840	2833	2337	2815	3817	3316
DGRMB 29	1548	2593	2071	2673	3620	3147
DGRMB 3	1617	2708	2163	2360	3815	3088
DGRMB 31	1647	2643	2145	2718	3567	3143
DGRMB 5	1775	2773	2274	2670	3508	3089
Total	1577	2628	2103	2542	3581	3062
LSD (0.05)						
Treatment	67					
Irrigation Level	51					
TXL	145					

1= 2 irrigations after emergence (first after 55 days of emergence and 2nd on 75th days after emergence); 2= 10 irrigations after emergence

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pseudoalcaligenes SEN29 and *Bacillus* sp. REN51) were evaluated for ascertaining genotypes x endophytes interactions, land configuration interventions for establishment of microbes in solo or in combination with FYM. Among the microbes J22 was the best (827 kg/ha) and significantly increased the pod yield by 52.3 % over no microbe application (543 kg/ha). REN51 was at par with J22; while SEN29 was significantly inferior. Application of FYM in both raised bed (834 kg/ha) and flat bed (697 kg/ha) gave 68.1 and 21.4 per cent higher pod yield than their respective pod yield under raised bed (496 kg/ha) and flatbed (574 kg/ha) with no FYM application. The soil salinity was at 4.5 EC at harvest.

In genotypes x endophytes interaction studies for enhancing productivity of groundnut under salinity conditions, GG 7 gave significantly and 45.7 % higher yield (1440 kg/ha) than TG 37A (976 kg/ha) followed by GG 2 (1176 kg/ha) at soil salinity of 4.45 EC at harvest. All the microbes gave significantly higher yield varying from 19.9% in SEN 29 to 25.0% in J 22 than the check (1103 kg/ha).

D. Evaluation of C3-CAM transited variants of TG37A

The C3-CAM variants obtained from TG 37A were multiplied, without application of supplementary irrigation after emergence, for maintenance of genetic stock and also for further use. Moreover, seven drought tolerant variants of TG 37A (DGRMB3, DGRMB5, DGRMB13, DGRMB17, DGRMB19, DGRMB29 and DGRMB31) were evaluated alongside TG 37A with two

conditions. Least reduction in biomass was obtained with DGRMB5 (Table-5).

Expression of CAM modules, analysis of samples of summer 2017, 2018 and 2019 indicated that the expression of CAM genes began between 25-30 days of moisture-deficit stress and all modules (Carboxylation, decarboxylation, mesophyll succulence, invert stomatal behaviour) lead to transition from C3 to CAM mode of photosynthesis. It has also been found to have

Table 6. Effect of groundnut rhizobia on pod yield of groundnut in salinity (TG 37A); Salinity: 2.46 EC (summer 2020)

Treatment	HY (kg/ha)	PY (kg/ha)	SOT (%)	HKW (g)
Control	2147	1450	58.82	39.55
K508	2260	1537	60.72	39.28
K515	2167	1773	62.07	42.70
K521	2530	1760	63.57	42.03
K557	2923	1903	65.18	43.49
NC92	2213	1553	60.38	39.93
RH-29	2600	1663	61.30	41.90
CD (0.05)	319	189	1.58	1.75

levels of irrigations, two and full (10), after emergence. It was found that whereas reduction of biomass was around 47% in TG37A with two supplementary irrigations against normal condition, C3-CAM transited variants showed biomass reduction from 29-34% in similar

expression of different genes of CAM modules (night-time carboxylation: *bca5*, *ppck2*, *ppc2*, *mdh1*, *vha-a*, *almt14*, etc. upto 16 folds in different genes; rate of carboxylation at night upto 4.7 $\mu\text{mol}/\text{m}^2/\text{s}$; and enzyme activity upto 10 folds as compared to their corresponding irrigated

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controls). Variation among CAM variants have been found in terms of expression. Similarly, the expression of genes involved in decarboxylation modules viz. tdt, nadme2, nadpme2, pck 1, and ppdk2 were also significantly upto 12 folds over their corresponding irrigated control. Estimation of the enzymes also revealed upto 12 fold increase in enzyme activity involved in CAM expression with variation among the genotypes. Genes responsible for change in circadian rhythm are yet to be deciphered.

Salinity:

During summer 2020, five groundnut rhizobia viz., K508, K515, K521, K557, and RH29 along with standard isolate NC92 were evaluated at soil salinity of EC 2.46 at harvest. The tolerant strains can tolerate upto 7.5% of NaCl in growth media. Application of K515, K521, K557, and Rh29 enhanced the pod yield significantly, ranging from 15 to 31% (max. with K557). In general, these isolates also enhanced the haulm yield, nodulation, HKM, and shelling out-turn of groundnut (cv TG37A) (Table 6).

E. Submission of cDNA sequences of CAM genes of groundnut to NCBI and accession numbers

The cDNA obtained from mRNA population of the genes expressed in drought-stressed groundnut (TG37A and its variants) amplified with gene specific primers designed for a particular isoform were submitted to NCBI genbank and accession numbers along with translated protein IDs were obtained. The accession numbers and protein IDs for Pyruvate phosphate dikinase 2 (ppdk2), NAD-dependent malic enzyme 2 (nadme2), Phosphoenolpyruvate carboxylase kinase 2 (ppck2), Beta carbonic anhydrase 5 (bca5), V-type proton ATPase catalytic subunit A (vha-a), Malate synthase (aceB) glyoxysomal, Tonoplast dicarboxylate transporter (tdt), NADP-dependent malic enzyme 2 (nadpme2), Phosphoenolpyruvate carboxylase 2 (ppc2), and Aspartate aminotransferase (attB) were MT111719, MT111720, MT111721, MT111722, MT111723, MT111724, MT111725, MT111726, MT111727, and MT111728 for accession

numbers and QQD86569, QQD86570, QQD86571, QQD86572, QQD86573, QQD86574, QQD86575, QQD86576, QQD86577, and QQD86578 for protein IDs, respectively.

F. New CAM variants, male sterile and variegated mutants

Twenty-one new CAM variants able to tolerate beyond 5 EC soil salinity were obtained and multiplied for further studies. During studies of CAM (Crassulacean Acid Metabolism) transited variants of TG37A, tolerant to drought- and or salinity-stress, variegated leaf mutants (VLM) were obtained in stress conditions in TG37A and two of its CAM variants viz., DGRMB24 and DGRMB32. In these mutants, white-, yellow-, creamy- and golden-shades were found in combination with green patches in leaves in different generations of mutant population (M2-M4) with albinos. Albino plants die shortly after emergence because of absence of chlorophyll concomitant with exhaustion of food reserves in seeds. Analysis of the data of mutant populations revealed that in few instances, mutants

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do not follow Mendelian inheritance and variegated leaf mutants continue to produce normal, variegated and albino plants at different ratios in each generation and thus, the traits are unstable (probably results of transposon mediated mutations). However, few progenies produce only variegated plants in subsequent generations (M5 stage now and likely to become stable because of non-transposon mediated mutations in both nuclear and plastid genes). Once they get fixed, these stable variegated leaf mutants will be of great significance in using them as morphological and phenotypic markers in hybridization and selection of true hybrids in filial generations, and as a delineating border plot to separate different tests because of different leaf colours.

During further generation advancements of the variegated leaf mutants of TG37A (TG37AVLM1), DGRMB24 (DGR MB24 VLM1 and DGR MB24 VLM2) and DGRMB32 (DGRMB32VLM7), male sterile plants were found in M3 and M4 population of different mutants. Male sterility of the plants were confirmed by staining of the

pollens by 1% 2,3,5-triphenyl tetrazolium chloride (TTC) and pollen germination assays onto pollen germination medium. While fertile pollens were orange or red, infertile or non-viable pollens remained colourless even after 2 hours of incubation with TTC. In the pollen germination assay, the pollens of the sterile plants failed to germinate even after 6 hours of incubation at dark with maintenance of more than 90% relative humidity at room temperature ($28 \pm 2^\circ\text{C}$) onto pollen germination medium. The germination of pollens was confirmed under microscope by observing the development of germ tubes. So far, twenty-seven male sterile lines have been obtained from TG37AVLM1 (M4 generation); DGR MB24 VLM1 and DGR MB24 VLM2 (M3 generation) and DGRMB32VLM7 (M3 generation). All these plants will be confirmed to ascertain the type of male sterility viz. cytoplasmic (CMS), genetic (GMS), and cytoplasmic-genetic (CGMS). Identification of this male sterile system will brighten our efforts in developing hybrids in groundnut in future.

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Highlights of AICRP on Groundnut



I. Crop Improvement

1. Maintenance, multiplication and characterization of groundnut germplasm

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

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

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

2. Hybridization programme

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

- During *rabi*-summer progenies of 393 crosses were advanced to their respective next filial generation from which a very large number (4298) of selections were made.
- During *kharif* season; progenies of 1513 crosses were advanced to their respective next filial generation from which very large specific selections were made (14307). Of the total crosses, which were advanced to different filial generations, in *rabi*-summer, 309 crosses were in early generations (F_1 - F_3) and in *kharif* progenies of 1154 crosses were in early generations (F_1 - F_4) and the rest were in advanced generations (F_5 onwards).

3. Varietal evaluation at multi-location

- A three tier system of evaluation of groundnut entries under the nomenclature of Initial Varietal Trial, Stage I (IVT I); Initial Varietal Trial, Stage II (IVT II) and Advanced

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Varietal Trial (AVT) was adopted and the trials were allotted to 24 centers located in five agro-ecological zones of groundnut in *kharif* and 20 centers located in five agro-ecological zones *rabi*-summer.

- During *kharif* 2019, nine entries of Spanish Bunch; 10 entries of Virginia were tested in IVT-I at 25 locations across the five zones. The IVT-I trial will be repeated as such for second year as IVT-II in same locations for promotion of entries to AVT.
- A total of 16 SB entries, 10 genotypes of Virginia and 2 large seeded genotypes were tested in IVT-II across the five zones with appropriate checks.
- In *kharif* 2019, none of the test entries tested under IVT-II of Spanish and Virginia trials were promoted to AVT, while during *rabi*-summer, two entries (TG 81 and AG 2012-06) were promoted to AVT. TG 81 (Proposed by BARC) promoted to AVT in Zone I (Mainpuri and Ludhiana) with a high pod (4389 kg/ha) and kernel (3013 kg/ha) yield (10% higher kernel yield over the best check, TAG 24). Entry AG 2012-06 (Proposed by AU, Anand) promoted to AVT in Zone II (Gujarat and southern Rajasthan) with a high pod (3108 kg/ha) and

kernel (2088 kg/ha) yield (8% higher over the best check, TG37A) and Zone IIIa (Dharwad, Hiriya, Raichur, Rahuri, Shirgaon) with a high pod (3441 kg/ha) and kernel (2329 kg/ha) yield (10% higher over the best check, Kadiri Haritandhra) and are currently in verge of their evaluation.

- In ALSVT (Advanced Large Seeded Varietal Trial), two entries along with four checks varieties evaluated at five locations. None of the test genotype could surpass significantly over best check GJG-HPS-2 for pod (2560 kg/ha) and kernel yield (1750 kg/ha) and hence no identification.
- In AVT during *kharif* 2019, the Spanish bunch genotype K 1812 was found superior over the best check R 2001-2 in Zone V comprising Tamil Nadu, Andhra Pradesh and, Karnataka. Across different stages of testing from 2017 to 2019, the genotype, K 1812 (Proposed by ARS, Kadiri), recorded a high pod (3514 kg/ha) and kernel yield (2445 kg/ha) against the best zonal check variety, R 2001-2 with 3173 kg/ha of pod 2144 kg/ha of kernel yield. Over different check varieties, the increase in pod yield of K 1812 was 10.7% over R 2001-2; 44% over GPBD 4; and 17.4% over

R 2001-3 and 38.7% over VRI Gn.6. Increase in kernel yield of K 1812 over these check varieties was 14.1% over R 2001-2; 44.2% over GPBD 4; and 19.1% over R 2001-3 and 39.2% over VRI Gn.6, respectively. Oil content of K 1812 was 51%. Hence proposed for identification.

- In *rabi*-summer 2018-19, 15 entries were tested under Initial Varietal Trial; stage-I (IVT-I) at 20 location across five zones and trial has been repeated as IVT-II in *rabi*-summer 2020.
- In AVT during *rabi*-summer 2018-19, the genotype Dh 257 was found superior over the best check TAG 24 in Zone IIIa (Dharwad, Hiriya, Raichur, Rahuri, Shirgaon). Across different stages of testing from 2016-17 to 2018-19, the genotype, Dh 257 (Proposed by UAS, Dharwad), recorded a high pod (3397 kg/ha) and kernel yield (2453 kg/ha) against the best zonal check variety, TAG 24 with 2827 kg/ha of pod 2014 kg/ha of kernel yield. Over different check varieties, the increase in pod yield of Dh 257 was 20.2% over TAG 24; 42.9% over R 8808; and 16.9% over R 2001-3 and 27.3% over Kadiri Haritandhra. Increase in kernel yield of Dh 257 over these check varieties was 21.8% over TAG 24; 46.2%

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over R 8808; and 25.3% over R 2001-3 and 30.7% over Kadiri Haritandhra respectively. Oil content of Dh 257 was 48%. Hence proposed for identification.

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

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

5. Early Maturity Trial

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

6. Breeder Seed Production

- During *kharif* 2019, DAC indents to the tune of 9343.31q of breeder seeds were received for 50 groundnut varieties. Based on the availability of nucleus/breeder seed stage I, a production target of 8747.45q was assigned for 46 groundnut varieties to 19 centres. During

kharif 2019, a total quantity of 2914.93q breeder seed could be produced. To mitigate the short fall, a compensatory programme was undertaken during *rabi*-summer 2019-20 and the anticipated production is about 5894.30q. Thus, the total expected production of groundnut breeder seeds during 2019-20 would be 8809.23q.

Crop Production

Kharif 2019

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

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

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

The experiment was conducted for three years at Dharwad, Bhubaneswar and Hiriyur. At all the centres sole

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

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

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

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

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

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5. Identification of remunerative groundnut based cropping systems

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

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

The experiment was conducted at Dharwad, Durgapura, Gwalior, Jalgaon, Junagadh, Kadiri, Jhargram, Shirgaon and Tirupati for three years. At Dharwad, Gwalior and Junagadh, seed treatment with NPK liquid formulation + Zn solubilizing bacteria

resulted in reduction of RDF to the extent of 25%. At Durgapura, seed treatment with bio-grow gave resulted in reduction of RDF to the extent of 25%. At Jalgaon, Kadiri, shirgaon and Tirupati application of 100 % RDF along with bio-grow recorded significantly highest dry pod yield. At Jhargram, during *kharif* 2019, seed treatment with bio-formulation of NPK liquid grade fertilizer + Zn solubilizer (B2) along with 100% RDF gave the higher yield.

7. Integrated water management in rainfed groundnut

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

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

The trial was conducted at Jalgaon, Junagadh and Bikaner. At Jalgaon,

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

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

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

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

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

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

11. Integrated weed management in *kharif* groundnut

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

manual weedings at 25 and 40 DAS recorded significantly higher dry pod yield. At Gwalior, Puducherry and Palem, application of pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + quizafop – p-ethyl @ 50 g/ha at 15-20 DAS recorded significantly highest pod yield. At Tindivanam, significantly higher dry pod yield was recorded with application of Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + quizafop – p-ethyl @ 50 g/ha at 15-20 DAS.

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

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

calculated by considering HKW and recommended plant population. At Junagadh significantly higher pod yield was recorded by GJG 32 (Bunch type, 45cm x 10cm) (seed rate as calculated by considering HKW and recommended plant population).

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

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

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

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

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

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

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

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

17. Effect of paclobutrazole on productivity of groundnut

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

18. Agronomic management of AVT

- Agronomic practices for AVT entry (Girnar 4) : In Dharwad, AVT groundnut entry Girnar 4 recorded significantly higher dry pod yield over check KDG-123 under similar management i.e., recommended package practices. The

increment is to the extent of 8.96 per cent.

- Agronomic practices for AVT entry (K-1574) : In Dharwad, AVT groundnut entry K-1574 recorded significantly higher dry pod yield over check TGLPS-3 under similar management i.e., recommended package practices. The increment is to the extent of 24.47 per cent.
- Agronomic practices for AVT entry (ICGV06189) : In Dharwad, AVT groundnut entry ICGV06189 recorded significantly higher dry pod yield over check TGLPS-3 under similar management i.e., recommended package practices. The increment is to the extent of 10.91 per cent.
- Agronomic practices for AVT entry (DH-257) : In Junagadh, significantly higher pod yield recorded by GJG 32 as compared to DH 257.
- Agronomic practices for AVT entry (Girnar-5) : At Junagadh, no significant difference was observed in pod yield over check variety KDG 128.
- Agronomic practices for AVT entry (K1812) : In Kadiri, K 1812 recorded significantly higher pod yield over local check Kadiri-6 under similar management.

Recommendations (Kharif 2019)

1. Studies on tank mix application of post-

emergence herbicides for efficient weed control in groundnut

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

2. Identification of rainfed groundnut+millet inter-cropping system for red soils of Karnataka

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

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

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

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

- Seed treatment with NPK liquid formulation (250 ml ha⁻¹) + Zn solubilizing bacteria (125 ml ha⁻¹) + 75% RDF of

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respective center (Action : Dharwad, Gwalior and Junagadh)

- Seed treatment with Bio-grow(125 ml ha⁻¹) + 75% RDF of respective center (Action : Durgapura)
- Seed treatment with Bio-grow(125 ml ha⁻¹) + 100% RDF of respective center (Action : Jalgaon, Kadiri, shirgaon and Tirupati)

Rabi-summer 2018-19

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

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

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

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

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

The trial was allotted to

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

4. Irrigation management in potato-groundnut systems in light

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

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

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

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

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

weeding at 25 DAS (2151 kg ha⁻¹). Further, pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + One hand weeding at 25 DAS (2151 kg ha⁻¹) was at par with pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + quizalofop-p-ethyl 5% E.C. @ 50 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) (2066 kg ha⁻¹) and pendimethalin 30% E.C. @ 1.5 kg a.i. ha⁻¹ + imazethapyr 10% S.L. @ 75 g a.i. ha⁻¹ at 20-30 DAS (At 2-5 leaf stage weeds) (2062 kg ha⁻¹).

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

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

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

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to the rest of the herbicide combination treatments.

6 Agronomic practices for rice-fallow groundnut

The trial was conducted at Dharwad (Kumta), Kadiri (Vizianagaram), Mohanpur, Shirgaon, Tindivanam and Vriddhachalam during 2018-19 and all the centres except Kadiri (Vijayanagaram) have reported the results.

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

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

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

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

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

At Dharwad (Kumta), Mohanpur, Shirgaon, and Vriddhachalam application of 125 % RDF + *Rhizobium*

resulted in significantly higher pod yield. While at Tindivanam, application of 100 % RDF (25:50:75 NPK Kg/ha) along with *rhizobium* seed treatment recorded higher dry pod yield

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

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

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

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

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

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

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

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

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

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

This trial was allotted to

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Bhubaneswar, Hiriya, Junagadh, Jhargram, Puducherry, Tindivanam, Tirupati and Vriddachalam during 2018-19 and except Hiriya and Vriddachalam, all the centres were reported data. Vriddachalam not conducted this experiment due to scarcity of water. At Bhubaneswar, Jhargram and Puducherry, application of 60 Kg ha⁻¹ of P to Groundnut with DGRC culture strain treatment obtained higher yield and at Junagadh, Tindivanam and Tirupati application of 40 Kg ha⁻¹ of P with DGRC culture recorded higher pod yield.

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

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

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

This experiment was conducted at Palem during 2018-19. Highest pod yield

ha⁻¹ was obtained with irrigation scheduling at 1.0 IW/CPE (3141 kg ha⁻¹) and sowing on October 15th has recorded significantly higher pod yield (3701 kg ha⁻¹).

13. Optimization of seed rate in *rabi* groundnut

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

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

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

15. Agronomic management of AVT

At Ludhiana, New strain J 87 gave significantly higher pod yield than check variety TG 37A. The new strain J 87 gave significantly higher pod yield (3741 kg ha⁻¹) than check variety TG37A (2912 kg ha⁻¹). Among the other traits except shelling two genotypes significantly differ. The spacing geometry was different J 87 and TG37A. The new strain J 87 gave high pod

yield at 30 x 22.5 cm spacing while 30 x 15 cm was more congenial for TG37A. the ancillary traits such as days to maturity, pods per plant, sound mature kernels, plant height, 100 kernel weight and kernel yield gave significant difference at different spacing. Though, nutritional requirement RF 125% numerically gave higher productivity but it was non-significant than recommended fertility of package of practices. However, RF 75% gave significant low productivity than recommended levels of fertility for pod yield and other traits.

Rabi-summer 2018-19

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

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

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

- Recommendation of groundnut varieties namely TG 51, TAG 24 and TG 37A and application of NPK @ 200:150:150 kg ha⁻¹ to potato

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crop during previous season, no need to apply to groundnut crop which is in sequence under potato-groundnut cropping sequence (Action : Mohanpur)

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

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

4. Agronomic practices for rice-fallow groundnut

Varieties:

- Groundnut varieties Dh-101 and Dh-86 (Action : Dharwad-Kumta region)
- Groundnut varieties TAG 24 and TG 51 (Action : Mohanpur)

- Groundnut variety TKG Bold (Action : Shirgaon)
- Groundnut variety TMV 13 (Action : Tindivanam)
- Groundnut variety VRI 8 (Action : Vriddhachalam)

Nutrient management

- RDF (125%) + *Rhizobium* (Action : Dharwad (Kumta), Mohanpur, Shirgaon, and Vriddhachalam)
- RDF (100%) + *Rhizobium* (Action : Tindivanam)

Crop Protection

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

Entomology (Kharif)

• Insect-pests situation:

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

reported from Ludhiana (<18%).

• Occurrence of natural enemies:

Low to moderate incidence of predatory arthropods like, coccinellids, green lacewings and spiders were observed in groundnut. Parasitization by *Chelonussp.* was up to 11 percent in Raichur. Epizootics (up to 96 per cent) of *Metarhiziumrileyi* on all the larval stages of *Spodoptera* was observed in Dharwad. Long-legged predatory dipteran fly, *Chrysosomaleucopogon* was observed in Vriddhachalam (1.5-2.0/plant) in groundnut wherever, sorghum was grown as border row.

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

Peak *Spodoptera* moth catches was observed during 28th and 29th SMWs (4.4 moths/trap) at Dharwad, 32nd and 33rd SMWs (3.8 moths/trap) at Vriddhachalam, 40th SMW (90 moths/trap) at Latur and 45th SMW at Raichur (99.6 moths/trap). The peak *Helicoverpa* moth catch was observed during 39th (37.8 moths/trap) and 40th (45 moths/trap) SMWs respectively at Raichur and Latur. Similarly, leaf miner catches peaked during 38th (4.4 moths/trap) and 39th (25 moths/trap) SMWs

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respectively at Raichur and Latur. Peak catches of sucking pests like, thrips and leafhopper was observed respectively during 41st (8.2 thrips/trap) and 43rd (8.8 hopper/trap) SMWs at Raichur. Highest adult white grub catches (5 beetles/trap) in the light trap installed in groundnut adjacent to sugarcane field was reported from Vriddhachalam.

● Screening for resistance to insect pests:

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

● Management of root-feeders in groundnut:

At Ludhiana, lowest termite (4.0% damaged plants) and white grub (0.1% damaged plants) infestations were observed respectively with treatment T7 (i.e., seed treatment with imidacloprid 600FS @ 2 ml/kg followed by foliar spray of imidacloprid 40%+fipronil 40% @ 5 g/10 L at 60 DAS) and treatment T4 (i.e., seed treatment with imidacloprid 600FS @ 2 ml/kg followed by soil

drenching with imidacloprid 17.8SL @ 3 ml/10 L at 60 DAS). Pod yields with treatments T7 and T4 were 2583 and 2495 kg/ha, respectively. At Vriddhachalam, lowest earwig infestation (7% damaged pegs) was observed with treatment T1 (i.e., seed treatment with imidacloprid 18.5%+hexaconazole 1.5% @ 8 g/kg). Pod yield and ICBR were highest with treatment T1 (1408 kg/ha and 1: 7.6, respectively).

● Biorational management of groundnut defoliator pests:

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

● Host preference studies on fall armyworm under no choice conditions:

Efforts were made to rear fall armyworm (FAW), *Spodoptera frugiperda* an invasive pest on maize in the laboratory on groundnut at Vriddhachalam and Raichur with contrasting results. At

Vriddhachalam, FAW completed its life cycle on groundnut variety, VRI-2 whereas, it could not complete its life at Raichur. Hence, further validation is required before arriving at conclusion.

Pathology(Kharif)

● Diseases situation:

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

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(<26%), being at par at Vridhachalam and Kadiri (16%). PSND was reported from Kadiri (10%).

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

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

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

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

2019-7 showed resistance to rust at Aliyarnagar and Latur. Genotypes IVK-I-2019-10, IVK-I-2019-19 and IVK-I-2019-20 showed multiple disease resistance to LLS and rust at Aliyarnagar, and LLS at Latur. Genotype HOVT-SB-I-2019-2 showed multiple resistances to LLS and rust at Aliyarnagar and Latur. IVT I 2019-4 showed resistance to LLS and DRR at Raichur. Genotypes IVT I 2019-23 and HOVTVG-I-2019-2 showed resistance against LLS, stem rot and PBNB at Raichur. Similarly, genotypes ISK-I-2019-17, IVT-I-2019-4, IVT-I-2019-8, ALSVT-2019-1, ALSVT-2019-2, ALSVT-2019-3 and HOVT-SB-I-2019-3 showed resistance to LLS and stem rot at Raichur. ISK-I-2019-28 showed resistance to stem rot at Jalgaon and Raichur. ASK-2019-7 showed multiple resistance to stem rot and collar rot at Jalgaon, and PBNB at Raichur. Similarly, genotypes IVK-I-2019-20, IES-I-2019-1, ISK-II-2018-18 and ISK-II-2018-25 showed multiple resistance to stem rot and collar rot at Jalgaon.

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

GPBD-5 and G2-52 showed resistance to LLS (grade 1) at Dharwad. Four entries viz.,

VG17037, VG18097, VG19561 and VG19654 <2 score to LLS at Vridhachalam. GJG-32 was found with <5% stem rot at Junagadh.

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

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

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

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

{T₄ : Deep summer ploughing with mould board plough + Soil application of Trichoderma @ 4 kg/ ha enriched in 250 kg FYM/ha + Seed treatment with

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Tebuconazole 2DS @ 1.5 g/kg of seeds followed by seed treatment with PGPR @ 625 g for per ha of seeds + Soil application of Trichoderma @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 70 DAS and T₆: Popular Variety + Deep summer ploughing with mold board plough + Soil application of Trichoderma @ 4 kg/ha enriched in FYM + Seed treatment with Tebuconazole @ 1.5 g/kg of seed + Soil application of Trichoderma @ 4 kg/ha enriched in FYM at 35 DAS + Soil application of Trichoderma @ 4 kg/ha enriched in FYM at 70-80 DAS}

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

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

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

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

module 3 at Kadiri.

{Module 1: Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg seed + Border crop with bajra (3 or 4 rows) + Need based spray of Thiodicarb 75 WP @ 1 g/L for defoliator 50-70 DAS + Need based spray of Hexaconazole 5 EC @ 1 mL/L 50-70 DAS; Module 3: Seed treatment with Carboxin 37.5% + Thiram 37.5% @ 3 g/kg seed and with Thiamethoxam 5% FS @ 3 g/kg seed + Need based spray of Rynaxypyr 20% SC @ 100 ml/ha for defoliator 50-70 DAS + Need based spray of Propiconazole 13.9% or Difenconazole 13.9 % EC @ 1ml/L 50-70 DAS; Module 4: Soil application of Trichoderma @ 4 kg/ha enriched in 250 kg FYM/ha + Seed treatment with Trichoderma @ 4 g/kg seed + Spot drench with Carbendazim @ 1g /L for soil borne diseases + Foliar spray of Carbendazim 12% + Mancozeb 63% @ 2 g/L at 40 and 65 DAS + Foliar spray of Beauveria bassiana @ 10g/L at 40 and 65 DAS + Foliar spray of Rynaxypyr 20%EC @ 100 ml/ha for defoliator at 50-70 DAS}

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

T₄ (Carbendazim 12% + Mancozeb 63% WP (Saaf 75%

WP) (10 g saaf in 5L water for 100 sq m area).

Entomology (Rabi-Summer)

- **Insect-pests situation:**

Incidence of thrips (range: 1.9 to 26 thrips/terminal bud) and leafhoppers (range: 0.3 to 7 hoppers/top 3 leaves). Highest incidence of leafhoppers and thrips was observed in Pavagada at all crop stages. The foliar damage due to defoliator pests like, *Spodoptera*, *Helicoverpa* and leaf miner respectively ranged from 10 to 40, 11-20 and 10 to 20 per cent. Highest foliar damage caused by defoliator pests was witnessed in Vriddhachalam.

- **Occurrence of natural enemies:**

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

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

Peak *Spodoptera* moth catches was observed during 5th SMW at Raichur (77.4 moths/trap), 6th SMW at Vriddhachalam (12.8 moths/trap) and 9th SMW at Dharwad (26 moths/trap). Similarly, peak *Helicoverpa* and leaf miner moth catches were observed

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during 1st SMW (35.8 moths/trap) and 52nd SMW (4.4 moths/trap) at Raichur. Peak catches of sucking pests like, thrips and leafhopper was observed respectively during 2nd (10.8 thrips/trap) and 5th (8.2 hopper/trap) SMWs at Raichur.

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

Screening trials carried out in all the centres during *rabi*-summer season were not considered either due to low pest pressure (<7 on 1-9 scale) in the susceptible check or due to none of the entries scored below 2 on 1-9 scale.

PATHOLOGY(Rabi-Summer)

- **Diseases situation:**

Monitoring of major diseases at farmers' field and research stations was reported. Maximum Late leaf spot (LLS) was reported from Vridhachalam (9 scale) followed by Aliyarnagar and Jalgaon (7 scale). Maximum Early leaf spot (ELS) was reported from Dharwad (4 scale) followed by Aliyarnagar (1-4 scale). Rust was maximum at Aliyarnagar (7 scale) followed by Dharwad (5 scale) and Vridhachalam (4 scale). Maximum Alternaria leaf blight (ALB) was reported from Jalgaon (6 scale) followed by Dharwad (5 scale). PBNB was reported

from Raichur (<32%), Kadiri (<14%) and Pavagada (<19%). Collar rot was maximum at Raichur (34%) followed by Vridhachalam (<16%). Maximum stem rot incidence was reported from Aliyarnagar (<20%) followed by Pavagada (<16%) and Vridhachalam (<16%). Dry root rot was recorded high at Raichur and Kadiri (<19%).

Crop Protection

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

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

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

Incidence of PBNB reached to 34% at Raichur followed

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

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

As per pooled data for >2 seasons T₄ at Junagadh, Vridhachalam and Dharwad. T₂ at Jalgaon and Aliyarnagar. {T₄: Seed treatment with tebuconazole 2DS @ 1.5g /kg seeds + foliar spray of tebuconazole 50% + trifloxystrobin 25% WG @ 1.32 g / L on 40 and 65 DAS; T₂: Tebuconazole @ 1 ml / L at 40 and 65 DAS}

AICRP-G FLDs:

Kharif 2019

- During *Kharif*- 2019 FLDs were allotted in 9 states having 18 groundnut research FLD centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Manipur, Tamil Nadu and West Bengal.

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The FLDs were allotted on Whole Package (WP), Integrated pest management (IPM) and Improved Variety (IV). The FLDs allotted were 400 FLDs for 18 centers and results were received for 268 FLDs, from 12 centers which indicated 67 per cent of implementation.

- There were 11 new varieties' production potential and profitability were compared with 12 old ruling varieties which are cultivated with farmers' traditional cultivation practices.
- The average pod yield achieved was 2242 kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 1818 kg/ha with farmer's traditional practices. The yield increase observed was 26 per cent. The minimum yield difference observed was 13 percent and the maximum was 60 per cent.
- The average cost of cultivation with improved practice was Rs. 50021/ha in comparison with Rs. 47604/ha with farmer's practice. The maximum observed was Rs. 88367/ha in improved practice and Rs. 82733/ha with farmer's traditional practice.
- The average Gross Marginal Returns with improved practice was Rs.117675/ha

and Rs. 95562/ha with respect to traditional practices. Net returns observed was Rs. 67667/ha and Rs. 47958/ha for improved practice and farmer's practices respectively. The average B:C ratio was 2.28 and 1.96 for improved practice and farmer's practices respectively.

Rabi-summer 2018-19

- The *Rabi-Summer* 2018-19 FLDs were allotted in 7 states having 16 groundnut research FLD centers. The states in which FLDs conducted were Gujarat, Karnataka, Maharashtra, Rajasthan, Tamil Nadu, Puducherry, Odisha and West Bengal. The FLDs were allotted on Whole Package (WP). The FLDs allotted were 430 FLDs and the results were received for 250 FLDs, from 11 centers which indicated 58 per cent of implementation.
- There were 7 new varieties' production potential and profitability were compared with 11 old ruling varieties which are cultivated with farmers' traditional cultivation practices.
- The average pod yield achieved was 2536 kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 2028 kg/ha with

farmer's traditional practices. The yield increase observed was 26 per cent. The minimum yield difference observed was 14 percent and the maximum was 52 per cent.

- The average cost of cultivation with improved practice was Rs. 47294/ha in comparison with Rs. 44029/ha with farmer's practice. The maximum observed was Rs. 65072/ha in improved practice and Rs. 62544/ha with farmer's traditional practice.
- The average Gross Marginal Returns with improved practice was Rs.113074/ha and Rs.89679/ha with respect to traditional practices. Net returns observed was Rs.65734/ha and Rs.46327/ha for improved practice and farmer's practices respectively. The average B:C ratio was 2.48 and 2.09 for improved practice and farmer's practices respectively.

Externally funded projects



Project: ICAR Seed Project on Seed Production in Agricultural Crops

Nodal Officer:

Dr. Narendra Kumar, Senior
Scientist, Plant Breeding
(23.11.2015 to 18.11.2020)

Dr. Praveen Kona, Scientist,
Plant Breeding (from
19.11.2020)

Co-Nodal Officer :

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

Dr. Narendra Kumar, Senior
Scientist, ICAR-DGR-RRS,
Bikaner (From 19.11.2020)

Funding Agency:

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

Duration:

2020-2025

Fund outlay:

Total sanction 9.25 lakh/year

Summary

- Breeder seed production programme was undertaken in 1.6 ha of varieties Girnar-2 (0.5ha) and Girnar-3 (1.1ha.) at DGR, Junagadh during *kharif* 2020
- Nucleus seed production programme was under-taken in 1.6 ha of varieties Girnar-2 (1.0ha) and Girnar-3 (0.6ha.)

at DGR, Junagadh during
kharif2020

- Quality seed production programme was undertaken in 6.0 ha of varieties Girnar-2 at ARC, Bikaner during *kharif* 2020.
- Produced a total 246kg nucleus seed of variety Girnar-2 (90kg) and Girnar-3 (156kg) during *kharif* 2020.
- Produced a total 37.5q quality seed of variety Girnar-2 (36.9q) and Girnar-3 (0.6q) during *kharif* 2020.
- Supplied a total 5.10q breeder seed of variety Girnar-2 (2.05q), Girnar-3 (3.05q) to five indentors during 2020.

Table-1: Variety-wise seed of different classes produced under ISP during *kharif*-2020

Variety	Indent (q)		Area sown (ha.)			Total production (q)	Seed Production (Kg)		
	DAC	BSP-I	NS	BS	QS		Breeder Seed (BS)	Nucleus Seed (NS)	QS
Girnar-2	--	--	1.0	0.5	6.0	60.0	--	90.0	3690.0
Girnar-3	--	--	0.6	1.1	--	24.17	--	156.0	60.0
Total	--	--	1.6	1.6	6.0	84.17	--	246.0	3750.0

NS: nucleus seed, BS: breeder seed, QS: quality seed

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- Supplied a total 62.65q quality seed of variety Girnar-2 (49.65q), Girnar-3 (13.0q) to ten indentors during 2020.
- Generated revenue of rupees 641955.0 from selling of the groundnut breeder, quality seed and other general produce.
- A total 216q groundnut fodder of 6.0 ha. area of Girnar-2 was handed over to ICAR-CSWRI-ARC, Bikaner.
- Organized three Kisan Gosthi on techniques of groundnut seed production, in which 69 farmers from 3 villages of district Junagadh participated at ICAR-DGR Junagadh.

Breeder Seed Production Achievement

Kharif 2020: There was no DAC indent of breeder seed of Girnar-2 and Girnar-3 varieties for *kharif*-2021. Looking at the breeder seed demand of Girnar 2 and Girnar 3 during previous year, seed committee recommended to undertake breeder seed and nucleus seed production at ICAR-DGR, Junagadh. Looking at the demand of quality seed of variety Girnar 2, Director, ICAR-DGR recommended for taking up quality seed production of Girnar 2 at ICAR-DGR-RRS, Bikaner. Accordingly breeder seed production programme of varieties Girnar-2 (0.5ha) and Girnar-3 (1.1ha.) was under

taken in 1.6 ha and nucleus seed production programme was undertaken of varieties Girnar-2 (1.0ha) and Girnar-3 (0.6ha.) in 1.6ha. at ICAR-DGR, Junagadh. Quality seed production programme of Girnar 2 was undertaken in 6ha. area at Bikaner. Under this project, produced 48.0q and 17.57q (Seeds unit: 11.10q and Farm section: 6.47q) breeder seed and 12.0q and 6.6q nucleus seed of

over mature resulted in severe pod loss in form of rotting and breaking of pods resulting breeder seed was failed. Yield of quality seed of Girnar 2 was severely affected due to late sowing, low rainfall, with high incidence of collar rot and fusarium blight of groundnut.

Distribution of seed/planting material

During 2020, seed unit has supplied a total 5.10q breeder

Table 2: Details of seed materials supplied during 2020

S N	Variety	Breeder seed		Quality seed (q)		Resource generation (Rs.)	Provided on Gratis
		Indentor (no.)		Indentor (no.)	Quantity (q)		
1	Girnar-2	2	2.05	8	49.65	498805.0	670.0
2	Girnar-3	3	3.05	2	13.0		
3	Undersize seed	--	--	--	--	143150.0*	0.0
		5	5.10	10	62.65	641955.0	670.0

*Under size pod, seed and quality seed not lifted disposed-off as general produce.

Girnar 2 and Girnar 3 variety respectively. Due to severe rainfall at time of sowing breeder seed of Girnar 2 was failed to germinate even after two time gap filling. Due to continuous rainfall and water stagnation at the time of maturity, variety Girnar 3 was

seed of varieties Girnar-2 (2.05q) and Girnar-3 (3.05q) to five different indentors and a total 62.65q quality seed of varieties Girnar-2 (49.65q) and Girnar-3 (13.0q) to ten different indentors. Due to non-lifting of breeder seed of variety Girnar 2 (2.3q) and

Table 3: Details of HRD programme organized during 2020

SN	Programme name	Date	No of farmers	Place of farmers
1.	Kisan Gosthi	20.10.2020	21	Ivnagar
2.	Kisan Gosthi	21.10.2020	20	Bilkha
3.	Kisan Gosthi	04.11.2020	28	Sarod

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Girnar-3 (1.12q) was disposed-off as general produce in the local market with the approval of the Director, DGR, Junagadh (Table-2).

Resource generation

During 2020, seed unit has generated a total revenue of 641955.0 through supply of 5.10q breeder seed and 62.65q quality seed of varieties Girnar-2 and Girnar-3.

Capacity building and technology dissemination

During 2020, under HRD component of ICAR seed project organized three Kisan Gosthi for groundnut farmers at DGR, Junagadh, in which 69 farmers participated from 3 villages of Junagadh district. The aim this programme was to provide



Kisan Gosthi organized at ICAR-DGR, Junagadh

knowledge on seed production techniques of groundnut seed of varieties Girnar-2 and Girnar-3.



Visit of land assessment committee on 01.02.2020 for the establishment of Regional Research Station of ICAR-DGR at farm area of ICAR-CAZRI-RRS, Bikaner



Quality seed production of Girnar 2 at Bikaner



Nucleus seed production of Girnar 3 at DGR, Junagadh

Project: All India Network Project on Soil Biodiversity-Biofertilizers

PI: KK Pal

Co-PI: R. Dey

Funding agency: ICAR

Duration:

01.04.2017-31.03.2021

Fund:

Rs. 13.00 lakh

Objectives:

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

Achievements:

In summer 2020, four groundnut rhizobia viz. K508, K515, K521, K557 along with standard isolate NC92 were evaluated with application of irrigation at 15 days interval after emergence (total five irrigations after emergence). These rhizobia were capable of tolerating matric potential of -2.5 MPa to -3.5 MPa. Application of K521 and K557 significantly enhanced the pod yield (13% and 11% respectively), haulm yield, nodulation and shelling out-turn of groundnut (cv TG37A). The experiment will be repeated again (Table 1).

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Table 1. Evaluation of moisture-deficit stress tolerant groundnut rhizobia (summer 2020)

Treatment	Haulm Yield (kg/ha)	Pod yield (kg/ha)	Shelling out-turn (%)	Hundred Kernel Weight (g)
Control	2633	1597	62.28	39.61
K508	2863	1660	63.62	40.58
K515	2803	1630	62.46	40.08
K521	2973	1870	65.74	42.49
K557	2920	1890	66.12	43.53
NC92	2700	1617	62.83	40.75
CD (0.05)	252	137	1.65	2.00

Project: Exploring the Diversity of Extreme Halophiles by Functional and Comparative Genomics for Isolating Novel Genes and Alleles for Affording Salinity Tolerance to Crop Plants

PI: KK Pal

Co-PI: R. Dey

Funding agency: ICAR through AMAAS project

Duration:

01.04.2017-31.03.2021

Fund:

Rs. 42.50 lakh

Objectives:

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

exploitation in development of crops tolerant to salinity

Significant Achievements:

- Validated the expression of genes encoding sodium-hydrogen antiporter, carbonic anhydrase, PEPC, isocitrate lyase, phosphoserine aminotransferase, and serine hydroxymethyl amino-transferase involved in alternate route of carbon gain in *Bacillus* sp. SB49 (NaCl tolerance upto 30%), and *Virgibacillus* sp. MSP4-1 (salinity tolerance 8-23.5%). This is conformity with the alternate route of carbon gain and salinity tolerance in extreme halophilic haloarchaeon 3A1-DGR
- There was 2.7 to 6.4 fold increase in expression of different genes of alternate route of carbon gain in *Bacillus* sp. SB49 when

grown at 30% NaCl as compared when grown without salt. Similarly expression of the genes was 3.4-7.8 folds in different genes involved in alternate route of carbon gain in *Virgibacillus* sp. MSP4-1 when grown at 23.5% NaCl as compared when grown at 8% NaCl. Validation of expression of remaining genes are underway at present.

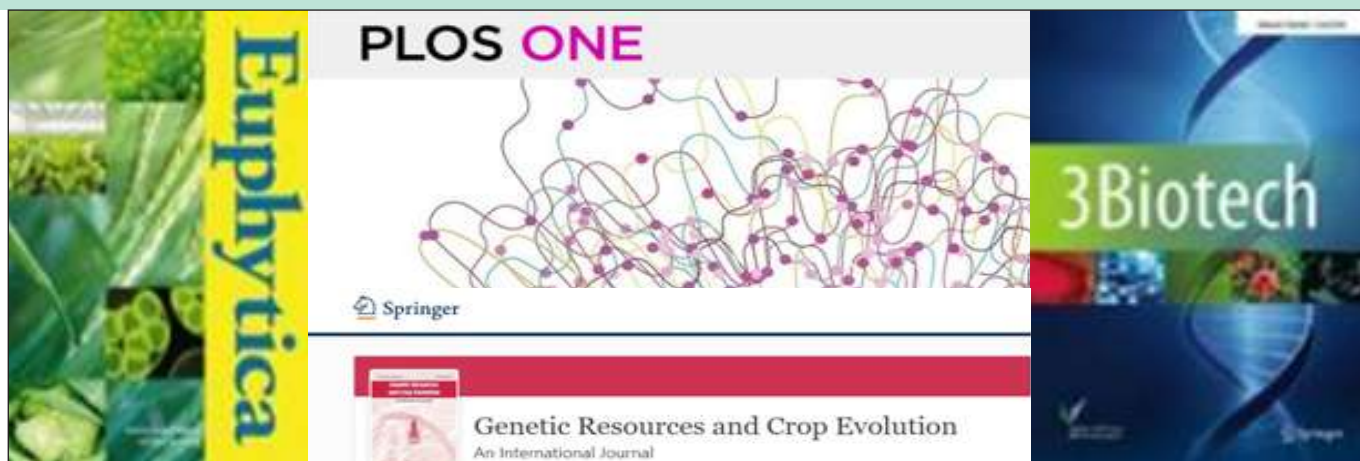
Evaluation of moisture-deficit and salinity- stress tolerant groundnut rhizobia for enhancing BNF

Drought:

In summer 2020, four groundnut rhizobia viz. K508, K515, K521, K557 along with standard isolate NC92 were evaluated with application of irrigation at 15 days interval after emergence (total five irrigations after emergence). These rhizobia were capable of tolerating matric potential of -2.5 MPa to -3.5 MPa. Application of K521 and K 557 significantly enhanced the pod yield (13% and 11% respectively), haulm yield, nodulation and shelling out-turn of groundnut (cv TG37A). The experiment will be repeated again (Table 6).

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Publications / work plan



Research articles

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9. મહેશ કુમાર મહાત્મા, અમન વર્મા, લોકેશ કુમાર “મગફળી નું ખાદ્ય પાક ના રૂપમા મહત્વ” Training Manual, ICAR-DGR Seed project 22-24.01.2020 page no. 59-68. <http://krishi.icar.gov.in/jspui/handle/123456789/36888>

10. નટરાજ વી. એમ., અનંત કુરેલ્લા, રાજરામ ચોધરી, સાવલીયા એસ. ડી., થીરુમલાઈસામી પી. પી., રૂપક જેના, હરીશ જી, રામદત્તા અને રાધાકૃષ્ણના ટી. (2019) મગફળીના પાકની સુરક્ષા માટે નોંધાયેલ અને ભલામણ કરવામાં આવેલ જંતુનાશક દવાઓની યાદી, ટેકનીકલ બુલેટીન નં. 1/2020 pp.1-12

11. Ram Dutta, Nataraja, M.V., Thirumalaisamy, P.P., Harish, G. and Radhakrishnan T. (2020). Crop protection technologies generated through AICRP-Groundnut. ICAR-Directorate of Groundnut Research, Ivnagar Road, PB No. 5, Junagadh 362 001, Gujarat. Technology bulletin 02/2020, 30p.
12. Sushmita Singh, AL Singh, MK Mahatma, Aman Verma, Sujit K Bishi, Vidya Chaudhari, CB Patel, LK Thawait & Archana Bharadava (2020) Phytic acid: An inevitable antinutrient in Groundnut. ICAR-Directorate of Groundnut Research, Junagadh, Gujarat. Folder, 4p.

Book Chapter

1. Abdul Fiyaz R, Ajay BC, Ramya KT, Aravind Kumar J, Sundaram RM, and Subba Rao LV 2020. Speed Breeding: Methods and Applications, In: Accelerated Plant Breeding Volume 1 cereal crops (eds. Satbir Singh Gosal and Shabir Hussain Wani). Springer publications, p 31-50

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Technical/Popular articles/ Technology Flyer/Folder

1. Abdul Fiyaz R, B Harika, K Chaitanya, D Shivani, M Chiranjeevi, HD Jawahar, MM Azam, A waris, Ramya KT, Manjunath T, BC Ajay, and LV Subbarao. Rice bran oil: Ruchiki ruchu mariyu arogyaniki atmbandhu. Vyavasayam 40: 44-45
2. कीर्ति रानी, अमन वर्मा राजा राम चौधरी, रूपक जेना एवं अनंत कुरेला (2020) बायोफोर्टिफिकेशन: सूक्ष्म पोषक तत्वों को बढ़ाने का विकल्प | खेती, वर्ष 73, अंक: 6, पेज: 14-1 <https://icar.org.in/sites/default/files/KHETI-OCT-2020.pdf>, <http://krishi.icar.gov.in/jspui/handle/123456789/43068>
3. Mithlesh Kumar and Kirti Rani. Molecular breeding for crop improvement. Food and Scientific Reports. ISSN 2582-5437. September 2020. 1(9). 74
4. Kirti Rani and Mithlesh Kumar. Germplasm to Genome Engineering. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32103. 2 (10) 308-310.
5. Mithlesh Kumar and Kirti Rani. Biparental QTL mapping approach: A boon for Plant Breeding. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32104. 2 (10): 311-314.
6. Mithlesh Kumar and Kirti Rani. High throughput Phenotyping for Crop Improvement. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32134. 2 (10): 395-397.
7. Mithlesh Kumar and Kirti Rani. Mapping Populations for Genomics and Crop Breeding. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32135. 2 (10): 398-400.
8. Mithlesh Kumar and Kirti Rani. Double Haploids Production Methods and their application in Genomics and Plant Breeding. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32136. 2 (10): 401-403.
9. Mithlesh Kumar and Kirti Rani. Quantitative Trait Loci mapping through Association Mapping: A Novel Tool for Crop Improvement. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32138. 2 (10): 407-410
10. Kirti Rani and Mithlesh Kumar. Speed breeding for crop improvement. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32519 2 (11) : 56-57.
11. Bulk Segregant Analysis: Rapid Discovery of DNA Markers and Quantitative Trait Mapping. Mithlesh Kumar and Kirti Rani. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 32520. 2 (11): 58-59.
12. Kirti Rani and Mithlesh Kumar. CRISPR-Cas9: A Novel Technique for Genome Engineering in Plants. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 33007 2 (12): 23-25.
13. Kirti Rani and Mithlesh Kumar. Role of tissue culture techniques in crop improvement. Agriculture & Food E-News Letter. ISSN 2581-8317. Article ID: 33009 2 (12): 29-31.
14. Kirti Rani, Sushmita, Aman Verma, Ananth Kurella, Rajaram Choudhary, Rupak Jena and Mithlesh Kumar. Biofortification: improving nutrition for combating micronutrients deficiencies. January, 2021. Kerala Karshakan. 8(7).
15. RA Jat, KK Reddy, Rajaram Choudhary, R Dey, KK Pal, Radhakrishnan T (2020). Improved crop production technologies for higher and sustained yield of groundnut (Technologies generated through AICRP on Groundnut)

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Work Plan 2020

New Projects (From April 2020 onwards)

Programme 1: Genetic improvement of groundnut

- ◆ **Management of stem and collar rot diseases of groundnut**
Narendra Kumar, SK Bera, MK Mahatma, Chandramohan Sangh, Ananth Kurella
- ◆ **Breeding groundnut for paddy and potato cropping systems**
K Gangadhara, KK Pal, MV Nataraja, KK Reddy, Praveen Kona., Kirti Rani and Rupak Jena
- ◆ **Management of drought stress in groundnut at Anantapur and adjacent areas**
Ajay BC, K Gangadhara, KK Pal, AL Singh, Sushmita Singh
- ◆ **Management of groundnut genetic resources, development of pre-breeding material and trait discovery**
SK Bera, K Gangadhara, MK Mahatma, Ananth Kurella, Narendra Kumar, Ajay BC, Harish G, Kirti Rani, Rupak Jena and Rajaram Choudhary
- ◆ **Genetic enhancement of nutritional traits in groundnut through genome editing and molecular approaches**
Sangh Chandramohan, SK Bera, Kirti Rani and V Papa Rao

Programme 2: Groundnut crop protection

- ◆ **Studies on white grub and bruchid beetle and their management in groundnut**
Harish G, MV Nataraja, Rinku Dey
- ◆ **Epidemiology of peanut bud necrosis and tobacco streak viruses in groundnut and development of their rapid detection**
MV Nataraja, Ananth Kurella, Ajay BC, Harish G and V Papa Rao

Programme 3: Basic studies in groundnut in relation to plant health, nutrition, quality and abiotic stresses

- ◆ **Management of salinity stress in groundnut**
KK Pal, Sushmita Singh, KK Reddy, Praveen Kona and Aman Verma
- ◆ **Optimization of mineral nutrition in groundnut for better human and soil health**
Sushmita Singh, AL Singh, Rinku Dey, Kiran Reddy and Aman Verma
- ◆ **Quality enhancement in groundnut and its product**
MK Mahatma, Aman Verma, Praveen Kona, BM Devani, MN Dabhi and B L Jani

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Old projects (till 31.03.2020)

Programme 1: Genetic improvement of groundnut

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

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

Programme 2: Groundnut crop protection

- ♦ **Refinement and validation of management module for soil borne diseases of groundnut**

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

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

PP Thirumalaisamy and Ram Dutta

Programme 3: Basic studies in groundnut in relation to plant health, nutrition, quality and abiotic stresses

- ♦ **Physiological studies in groundnut under water-deficit and salinity stresses**

AL Singh, Sushmita and Aman Verma

- ♦ **Evaluation of nutritional and bioactive compounds of groundnut**

MK Mahatma, Aman Verma and AL Singh

- ♦ **Studies on microorganisms in relation to plant health and nutrition in groundnut**

Rinku Dey, KK Pal and PP Thirumalaisamy

- ♦ **Application of microorganisms for management of biotic and abiotic stresses in groundnut**

KK Pal, Rinku Dey, MK Mahatma, Harish G, Ajay BC and KK Reddy

7 Training and Capacity building



Training programs attended

S. No.	Name of the Scientist	Training programme attended	Date
1.	Dr. KK Pal	Attended training on 'Orientation workshop and training program for ABI units' during on virtual mode, organized by ICAR-NAARM and IP & TM unit of ICAR	17-19 th August, 2020
		Attended Virtual Workshop cum Training Program on 'Intellectual Property Rights in Agricultural Research and Education in India' during jointly organized by National Agricultural Higher Education Project (NAHEP) and Intellectual Property and Technology Management (IP&TM) unit of ICAR Headquarters, New Delhi	2020
		Attended 'Online Training Workshop for Vigilance Officers of ICAR (Batch III 2020-21)' organized by NAARM from	5-7 th August, 2020 12-28 th September, 2020
2.	Dr. Harish G	Online Training on "Artificial Intelligence Tools: Butterfly Experience". College of Forestry, SIRSI, University of Agricultural Sciences, Dharwad	19 th September, 2020
3.	Dr. Kiran Reddy	Attended 3-week e-certification course under ICAR-NAHEP, organized by PJTSAU, Hyderabad on Massive Open Online Course on "Information Handling Skills for Teaching, Learning and Research"	26 th August-16 th September, 2020
4.	Dr. Kirti Rani	Online training on Analysis of Experimental Data using R by NAARM, Hyderabad, India	05-11 th August, 2020
5.	Dr. Rinku Dey	'MDP on Implementation of Access and Benefit Sharing Regulations in Agriculture Research: Awareness cum Sensitization Workshop (online), organised by NAARM	7-10 th July, 2020
6.	Dr. MV Nataraja, Dr. S Chandramohan, Dr. Kirti Rani	5 days online training on 'Hindi Translation' organized by Central Translation Bureau, Home Ministry, GOI, India with ICAR-DGR, Junagadh, Gujarat, India	21 st -25 th September, 2020
7.	All the staff of ICAR-DGR	Effective Health Management for Enhancing Work Efficiency of ICAR Employees at ICAR-DGR, Junagadh	2 nd -9 th September, 2020

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Webinar organized by ICAR-DGR on “Prospects of Genetic Improvement of Groundnut in the Genomics Era”

On the occasion of 41st Foundation day of ICAR-Directorate of Groundnut

also praised the dedication of Dr. Radhakrishnan T. Director of ICAR-DGR for groundnut research. In his presentation he highlighted the journey of groundnut genomics and how genomics can assist in breeding

programme and realization of crop production. The genomics data available so far can be used for genome editing for trait specific improvement. After presentation of Dr. Varshney a panel discussion was made and panelist Dr. JB Misra, Dr. JB Misra, Fomer Director, ICAR-DGR, Dr. KV Bhatt, NBPGR, Dr. B Chellapilla, IARI, Dr. V Dinesh Kumar, IIR, Dr. GP Mishra, IARI and Dr. S Bhatia, NIPGR discussed various issues on groundnut genomics and future crop breeding programme. Programme was closed with the vote of thanks by the Director of ICAR-DGR, Junagadh.



Research, Junagadh, a webinar was organized. The webinar was delivered by eminent scientist Dr. Rajeev Varshney on “Prospects of Genetic Improvement of Groundnut in the Genomics Era”. Before his presentation he appreciated ICAR-DGR efforts on development of Groundnut Research and mention DGR as outstanding partner in groundnut genomic research of ICRI, Hyderabad. He

Delivering research outputs



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Participation and papers presentation in Conferences/seminar/symposia/meetings/other forum

1. Aman Verma, MK Mahatma, Sushmita Singh, AL Singh and Lokesh K Thawait 2020. "Enhancement of Resistant Starch and Iron Content with Reduction in Phytic Acid Content in Groundnut – A Study with Technological Solution" paper presented in International Web Conference on "Global Research Initiatives for Sustainable Agriculture & Allied Sciences" (GRISAAS-2020) during December 28-30, 2020 organized by Astha Foundation, Meerut (U.P.) and Society for Scientific Development in Agriculture and Technology (SSDAT), Meerut.
2. Ananth Kurella, Nataraja M.V., Harish G. and Radhakrishnan T (2020), Bud Necrosis and Stem Necrosis Diseases of Groundnut: A Way Forward, Int. E – Conference on Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture, 6-9 October, organized by UHS and CoH, Bengaluru, India, pp 1
3. Harish, G (2020) Identification of agricultural stored-grain insect pests of South India using CO-I barcode specific sequences. XVII AZRA International Conference on "Frontier Research in Applied Zoology and Insect Pest Management Strategies: A way Forward for Food and Nutritional Security" 12 th - 14 th February, 2020 at UAS, Raichur. pp 24
4. Harish G, Narender Kumar, Mahesh MK, Ram Dutta, Savaliya SD (2020) Impact of varieties and storage conditions on Caryedon serratus in groundnut. XVII AZRA International Conference on "Frontier Research in Applied Zoology and Insect Pest Management Strategies: A way Forward for Food and Nutritional Security" 12 th - 14 th February, 2020 at UAS, Raichur. pp 47
5. Harish G, Nataraja MV, Ananth Kurella and Rupak Jena (2020) Diversity and conservation of natural enemies in peanut ecosystem. "International Virtual Conference on Biodiversity and Ecosystem services in a climate change perspective" 10-11th December, 2020 at Environmental Management and Policy Research Institute (EMPRI) Bengaluru. pp 4
6. Mahatma MK "Variation in quality traits of different seed sizes of groundnut" in the National Seminar on "Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security" held at ICAR-Indian Institute of Oil seeds Research, Hyderabad during 7-8 February, 2020.
7. PP Thirumalaisamy, Ram Dutta, Hari kishan Sudini, Jadon KS, Harish G and Radhakrishnan T (2020) Management of aflatoxin contamination in peanut through good production, processing and storage practices in India. 7th International conference Phytopathology in achieving UN Sustainable development goals. 16-20th January, 2020, New Delhi. pp 229.
8. Praveen K, Ananth Kurella, Reddy KK, Bera SK and Radhakrishnan T (2020), Phenotypic screening of released cultivars for resistance to late leaf spot and rust diseases in groundnut (Arachis hypogaea L.), International E – Conference on Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture, 6-9 October, organized by UHS and CoH, Bengaluru, India, pp 2
9. Rupak Jena, Harish G, Nataraja MV and Ananth Kurella (2020) Nematode diversity in the Groundnut research fields. International

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Virtual Conference on Biodiversity and Ecosystem services in a climate change perspective” 10-11th December, 2020 at Environmental Management and Policy Research Institute (EMPRI) Bangaluru. pp 15

10. Sushmita Singh, AL Singh, Gangadhara K, V Chaudhari, CB. Patel, MK Mahatma, A Verma, L Kumar and A Bharadava 2020. High Zn bioavailability in peanut (*Arachis hypogaea* L.) cultivars: An implication of phytic acid and mineral interactions in seeds. International Plant Physiology Virtual Conference “Prospects of Plant Physiology for Climate Proofing Agriculture” December, 6-7, 2020, organized by SKUAS & T, Jammu and Indian Society for Plant Physiology, New Delhi. pp 15. <http://krishi.icar.gov.in/jspui/handle/123456789/44555>

Conference/Seminars attended

Aman Verma

1. Attended National Webinar on “Technological Advances in Crop Production during COVID-19”, organized by Directorate of Research, SKRAU, Bikaner, Rajasthan, on 16.06.2020. Title of the abstract: Value addition of peanut by using processing techniques; Authors: Aman

Verma, Lokesh K Thawait, M. K. Mahatma, Sushmita Singh.

2. Attended National Webinar on “SPECTROSCOPIC TECHNIQUES” Jointly Organized by Department of Chemistry and Forensic Science and Internal Quality Assurance Cell (IQAC), Bhakta Kavi Narsinh Mehta University, Junagadh (Gujarat) in Collaboration with Toshvin Analytical Pvt. Ltd., Mumbai (Maharashtra) India, on 29-30.07.2020.
3. Attended International Webinar on “Looking At Life Differently: A Fall Out of Covid-19 Pandemic” Organized by Department of Biochemistry, Dr. Rammanohar Lohia Avadh University, Ayodhya, UP, India, on 06-08.08.2020
4. Attended National Webinar on “Biotechnological Interventions for Improvement of Pulse Crops” organized by Bihar Agriculture University, Sabour, Bhagalpur, Bihar, India, on 07.08.2020.
5. Attended International Webinar on “Women in Science and their role in Sculpting Modern Agriculture” organized by Bihar Agriculture University, Sabour, Bhagalpur, Bihar, India, on 26.08.2020.
6. Attended “National Oilseed Brainstorming Meet

(Research-Industry-Farmer Interface)” jointly organized by ICAR-IISR, Indore; ICAR-IIOR, Hyderabad; ICAR-IIOPR, Pedavegi; ICAR-DGR, Junagadh; ICAR-DRMR, Bharatpur on September 23-25, 2020.

7. Attended webinar on “Nutrition, Immunity and COVID-19” jointly organized by ICAR-Indian Agricultural Research Institute & Society of Plant Biochemistry and Biotechnology on 30.09.2020.
8. Attended webinar on “Prospects of Genetic Improvement of Groundnut in the Genomics Era” organized by ICAR-Directorate of Groundnut Research, Junagadh, Gujarat, India on 01.10.2020.

Ananth Kurella

1. “Prospects of Genetic Improvement of Groundnut in the Genomics Era”. Oct 1, 2020 ICAR-DGR Junagadh.
2. “Soil Borne Plant Pathogens - Management with emphasis on biocontrol agents” organized by College of Horticulture, Dr. YSRHU, Venkataramannagudem on 05-11-2020.
3. “Impact of Physio-Biochemical Research on Indian Agriculture-2020” (WIPBRIA-2020) organized by Bihar Agricultural University, Sabour, Bhagalpur held on July 28, 2020.

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Harish G.

1. Desert Locust Management: Current Status & Future Strategies". May 30, 2020 IARI New Delhi
2. Plant Health Management for Sustainable Agriculture' organized on the eve of International Year of Plant Health (IYPH2020) by National Institute of Plant Health Management, Hyderabad on 04th September, 2020.
3. Prospects of Genetic Improvement of Groundnut in the Genomics Era". Oct 1, 2020 ICAR-DGR Junagadh
4. Recent Trends in Vertebrate Pest Management' organized on the eve of International Year of Plant Health (IYPH2020) by National Institute of Plant Health Management, Hyderabad from 23rd November, 2020.
5. Translational genomics for achieving higher genetic gains in groundnut. International webinar organised by Bioingene.com on 4 December 2020.
3. Attended 'Online Training Workshop for Vigilance Officers of ICAR (Batch III 2020-21)' organized by NAARM from 5 – 7th August, 2020
4. Attended the 'Orientation workshop and training program for ABI units during August 17-19' 2020 on virtual mode, organized by ICAR-NAARM and IP & TM unit of ICAR
5. Attended 41st Foundation Day program of DGR and webinar on Prospects of Genetic Improvement of Groundnut in the Genomics Era
6. Participated in Virtual Workshop cum Training Program on 'Intellectual Property Rights in Agricultural Research and Education in India' during September 12-28, 2020 jointly organized by National Agricultural Higher Education Project (NAHEP) and Intellectual Property and Technology Management (IP&TM) unit of ICAR Headquarters, New Delhi
- Research on Indian Agriculture" Organized by B.A.U., Sabour (July 28, 2020)
3. Webinar on "Breeding of Oilseeds: A Challenge for Self Sufficiency". Organized by B.A.U., Sabour (July 29, 2020)
4. KLE International Webinar on "Intellectual Property Rights, An overview: Myth & Realities" held on June 6, 2020.
5. International Web Conference on Ensuring Food Safety, Security and Sustainability through Crop Protection" organized by Bihar Agricultural University, Sabour, Bhagalpur held on August 5-6, 2020.
6. National Webinar on Abiotic Stress in Agriculture: Geospatial Characterization and Management Options organized by ICAR-National Institute of Abiotic Stress Management, Baramati, India on August 27, 2020.
7. Two days webinar on : "Advances in Basic Plant Research in Relation to climate change" by NAHEP-CAAST-CSAWM, MPKV, Rahuri, India from October, 08-09, 2020.
8. International webinar on "Translational Genomics for achieving higher genetic gains in groundnut" on 4th December, 2020.

K. K. Pal

1. Attended a Hindi training programme on "Translation" organized at DGR from 21-25 September, 2020
2. Attended Annual Review Workshop for Network Project on AMAAS 2020 from 01-02 July, 2020 through VC

Kirti Rani

1. National webinar on Molecular markers: Tools for identification in Biology organized by School of Sciences, PP Savani University on 4th July 2020.
2. National Webinar on "Impact of Physio-Biochemical

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9. Attended a Hindi training programme on “Translation” organized at DGR from 21-25 September, 2020
10. Attended 41st Foundation Day program of DGR and webinar on Prospects of Genetic Improvement of Groundnut in the Genomics Era.

MK Mahatma

1. Attended a National Webinar on “SPECTROSCOPIC TECHNIQUES” organized by Department of Chemistry and Forensic Science and Internal Quality Assurance Cell (IQAC), BKNMU, Junagadh, India during 29-30th July, 2020.
2. Attended an International Webinar on “Plant Physiological Paradigms towards Agricultural Sustainability Under Climate Change” organized by Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India on 15th September, 2020.
3. Attended a Webinar on “Genomics Strategies for Improvement of Abiotic Stress Tolerance in Crop Plants” organized by ICAR-NIASM, Baramati, India on November 27, 2020

Praveen Kona

1. Attended the national seminar on "Technological Innovations in Oilseed Crops for

Enhancing Productivity, Profitability and Nutritional Security' on 7-8 February, 2020 at PJTSAU, Hyderabad.

2. Participated in the International E-Conference on “Multidisciplinary approaches for plant disease management for achieving sustainability in agriculture” organised by Department of Plant Pathology, College of Horticulture, Bangalore (University of Horticultural Sciences, Bagalkot), India during 6-9th October, 2020.
3. Attend a International webinar on 04th December, 2020 afternoon 2-4 pm on “Translational genomics for achieving higher genetic gains in groundnut” organised by Bioingene Webinars.
4. Attended 41st Foundation Day program of DGR and webinar on Prospects of Genetic Improvement of Groundnut in the Genomics Era

Rinku Dey

1. Attended 41st Foundation Day program of DGR and webinar on Prospects of Genetic Improvement of Groundnut in the Genomics Era
2. Attended 1 day Hindi Training workshop on 28-12-20

Sushmita

1. National Webinar on “SPECTROSCOPIC TECHNIQUES”, held on 29-30th July, 2020, by Department of Chemistry and Forensic Science and Internal Quality Assurance Cell (IQAC), BKNMU, Junagadh, India
2. Biotechnological Interventions for Improvement of Pulse Crops” organized by Bihar Agriculture University, Sabour, Bhagalpur, Bihar, India on 7th August, 2020
3. International Webinar on “Plant Physiological Paradigms towards Agricultural Sustainability Under Climate Change” organized by Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India on 15th September, 2020
4. “Women in Science and their role in Sculpting Modern Agriculture” organized by Bihar Agriculture University, Sabour, Bhagalpur, Bihar, India on 26th August, 2020
5. National Webinar on “SPECTROSCOPIC TECHNIQUES” organized by Department of Chemistry and Forensic Science and Internal Quality Assurance Cell (IQAC), BKNMU, Junagadh, India on 29-30th July, 2020

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Lectures delivered

Radhakrishnan T

1. Delivered a webinar on Molecular Markers- Tools for identification in biology, on the behest of the P PSavani University on July4, 2020
2. Delivered a webinar on DNA Markers - Types and applications, on the behest of the Sri Guru University on August 8, 2020
3. Delivered a lead lecture on Increasing Production and Profit in Groundnut Farming during National Oilseeds Brain Storming Meet held during 23-25 September 2020
4. Co-Chaired the session on the Crop Improvement during the Annual Sunflower workshop.
5. A 3 day training programme was organised from 22 to 25 January 2021 for the scheduled caste farmers. A total of 80 farmers from three villages were benefited.
6. Delivered a lead lecture on Aflatoxin in Groundnut, Current Status and Future Prospects, during the ICAR Industry day organised by the IARI on January 4, 2021

KK Pal

Delivered a lecture on 'Good laboratory practices and office management' on 02-09-2020, during a Virtual Training programme on Effective Health Management for Enhancing Work Efficiency of

ICAR Employees" from 2-9th September 2020 at ICAR-DGR, Junagadh

MK Mahatma

Delivered a lead lecture on Food and Nutritional Security Amid Covid-19 Situation" in National webinar organized by Kota Agriculture University, Kota, India on 16.09.2020.

Narendra Kumar

Key Speaker on seed production achievements of 2019-20 in the Joint Annual Group Meeting of National Seed Project (Crops) and XVth ICAR Seed project meeting during 14-15 May, 2020.

Meetings attended / Organized

Narendra Kumar

1. Attended XVth Annual Review Meeting of ICAR Seed Project- "Seed Production in Agricultural Crops" through video-conferencing held from 14-15 May, 2020.
2. Attended QRT meeting of ICAR Seed Project and discussed progress of ICAR-DGR, Junagadh on 15.12.2020 through video-conferencing.

KK Pal

1. Attended and organized ICAR-DGR and ISRO-SAC interaction VC meeting on 29-5-2020 for understanding

each others' area of work and finding out mutual areas of collaborative research and training

2. Attended varietal identification committee (VIC) meeting on 15th June 2020
3. Attended meeting on Futuristic Crop Planning for 2030/2050 as Nodal Officer from DGR on 25-6-20
4. Attended the 22nd IMC meeting of DGR on 10th July 2020 as member
5. Attended a meeting on 22-7-2020 on 'NABL Accreditation of ICAR laboratories'
6. Attended and participated in the EFC Meeting of DGR Junagadh, IIOR Hyderabad; and AICRPs of Linseed, Sesame & Niger, Groundnut on 19-8-20.
7. Attended Brainstorming meeting from 23-25 September 2020 for Atmanirbhar Bharat programme of oilseeds
8. Attended Virtual Workshop and Annual Review Meeting of ABIs/ ZTMCs/ ITMUs under ICAR Institutes of Crop Science Division held during 09-10 October, 2020.
9. Attended the virtual "Regional Expert Consultation on Agriculturally Important Microorganisms" (Expert Consultation), on October 28, 2020 organised by the Asia-

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Pacific Association of Agricultural Research Institutions (APAARI) under a program on Asia-Pacific Consortium on Agricultural Biotechnology and Biresources (APCoAB) and Indian Council of Agricultural Research (ICAR) with support from ICAR-National Bureau of Agriculturally Important Microorganisms (ICAR-NBAIM), India.

10. Attended the interactive discussion on the Status of progress and constraint of Oilseed production in India, and the strategies and action to be taken by the ICAR to make India self-sufficient in Oilseed production held online on 2nd November, 2020.
11. Attended the 15th IMC meeting of ICAR-NBAIM,

Mau on 24th November, 2020 through virtual mode.

Praveen Kona

Attended QRT meeting of ICAR Seed Project and discussed progress of ICAR-DGR, Junagadh on 15.12.2020 through video-conferencing.

Radhakrishnan T

1. Organized Foundation Day of ICAR-DGR, Junagadh on 1st October 2020
2. A National webinar on Prospects of Genetic Improvement of Groundnut in the Genomics Era was organised on 1st October, 2020. The webinar was delivered by eminent scientist Dr. Rajeev Varshney, ICRISAT, Hyderabad
3. Co-Chaired the session on the

Crop Improvement during the Annual Sunflower workshop.

4. A 3 day training programme was organised from 22 to 25 January 2021 for the scheduled caste farmers. A total of 80 farmers from three villages were benefited.
5. Organised the AICRPG workshop online for the first time in ICAR during 15th to 23rd April 2020
6. An Industry interface day was organised on December 7, 2020 to provide a platform to interact other stake holders with the processing and export industry
7. A special meeting was organised with the AICRP and other experts on May 20, 2020 to discuss and fine tune the test procedures for NILs

Meetings attended /conducted by Radhakrishnan T

1.	Directors conference	April 10, 2020
2.	AICRP Groundnut workshop -online	April 15-23, 2020
3.	CGIAR review meeting	May 4, 2020
4.	AGM of ICAR Seed project	May 14, 2020
5.	AGM of AICRP Soybean	May 26, 2020
6.	Meeting with ISRO, Ahmedabad	May 29, 2020
7.	Meeting to discuss points of ICAR By Laws	June 26, 2020
8.	Meeting of the Central Varietal Release Committee	July 10, 2020
9.	IMC meeting of DGR	July 10, 2020
10.	ICAR Foundation day	July 16, 2020
11.	Export Challenges and Mitigation Strategies for Fresh and Processed F&V in COVID-19 Times, webinar organised by Confederation of Indian Industry	August 8, 2020

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12.	AGM of AICRP Sunflower	August 13-14, 2020
13.	Meeting for EFC presentations	August 19, 2020
14.	Meeting of the TOLIC	August 27, 2020
15.	Lecture on Yoga and good lab practices	September 2, 2020
16.	Lecture on Health management during COVID-19	September 3, 2020
17.	Meeting of the RAC	Sept. 4-5, 2020
18.	Lecture on Stress management	September 7, 2020
19.	Lecture on Motivation	September 8, 2020
20.	Lecture on Positive thinking	September 9, 2020
21.	Meeting of the IBSC of CSMCRI, Bhavnagar	September 11, 2020
22.	Oilseed Brainstorming Meet, IISR, Indore	Sept. 23-25, 2020
23.	Germplasm registration committee meeting, NBPGR	September 29, 2020
24.	Foundation day	October 1, 2020
25.	Webinar on Prospects of Genetic Improvement of Groundnut in the Genomics Era	October 1, 2020
26.	Monitoring AICRP Groundnut trails- Crop Protection	October 15, 2020
27.	Monitoring AICRP Groundnut trails- Crop Production	October 17, 2020
28.	Meeting on developing seed production standards for high oleic groundnut	October 19, 2020
29.	Sensitisation on KRISHI portal by Director, IASRI	October 27, 2020
30.	Talk on Preventive Vigilance by Sh. KanhaiaChoudhary	October 27, 2020
31.	Talk on Purchase Procedures by Sh. Devendrakumar	October 29, 2020
32.	Talk on 'CCS (CCA) Rules' by Sh. SK Mitra	October 31, 2020
33.	Presentation to SMD on Making India self-sufficient in edible oils - Interactive discussions	November 2, 2020
34.	Meeting of the Central Varietal Release Committee	November 9, 2020
35.	Director Conference	December 5, 2020
36.	Industry interface day -DGR	December 7, 2020
37.	Foundation day, IISR, Indore	December 11, 2020
38.	Hindi workshop	December 28, 2020
39.	Hindi training	December 29, 2020
40.	Talk on Swachhata for prevention and combating COVID-19	December 30, 2020
41.	Concluding meeting of Swachh Bharat Abhiyan	December 31, 2020

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Participation at Global potato conclave 2020

ICAR-DGR actively participated in the Global potato conclave held at Gandhinagar, Gujarat from 28-31st January 2020. The chief guest of the conclave was Hon. Prime Minister Sh. Narendra Modi. He emphasized on using Artificial intelligence and robotics in agriculture. He also stressed upon doubling the farmers income by using the improved technologies. The other dignitaries of the function included CM of Gujarat Sh. Vijaybhairupani, Central minister of Agriculture and Farmers Welfare Sh. Narendra Singh Tomar, Director General, ICAR and DDG Horticulture etc., The DGR stall showcased newly released high oleic groundnut varieties to the farmers, Girnar-4 and Girnar-5 and also various microbial formulations like Nut Magic, Nut Boost and Nut Grow. Farmers also enquired about different potato fallow groundnut varieties like Dh-86, TAG-24 and TPG 41.

Awards/Recognition

Aman Verma

- Best Oral Presentation Award from Society for Scientific Development in Agriculture and Technology (SSDAT), Meerut during International Web Conference on “Global Research Initiatives for Sustainable Agriculture & Allied Sciences” (GRISAAS-2020) on December 28-30, 2020 for presenting abstract entitled “Enhancement of Resistant Starch and Iron Content with Reduction in Phytic Acid Content in Groundnut – A Study with Technological Solution”.
- Young Scientist award from Society for Scientific Development in Agriculture and Technology (SSDAT), Meerut during International Web Conference on “Global Research Initiatives for Sustainable Agriculture & Allied Sciences” (GRISAAS-2020) on December 28-30, 2020.

Harish G

- Outstanding scientist award-KIER awards 2020
- Best oral presentation-“International Virtual Conference on Biodiversity and Ecosystem services in a climate change perspective” at Environmental

Management and Policy Research Institute (EMPRI) Bengaluru during 10-11 December, 2020

- Best Oral Presentation Award from Society for Scientific Development in Agriculture and Technology (SSDAT) Meerut during 28-30 December, 2020
- Young Scientist award from Society for Scientific Development in Agriculture and Technology (SSDAT), Meerut during International Web Conference on “Global Research Initiatives for Sustainable Agriculture & Allied Sciences” (GRISAAS-2020) during 28-30 December, 2020

Kirti Rani

- Best article award for article ID: 32103 “Germplasm to Genome Engineering” published in Agriculture & Food: e-Newsletter
- Young Scientist Award during Astha Foundation, Meerut in collaboration with CSAUAT Kanpur U.P.; SKRAU Bikaner Rajasthan; BAU Sabour Bhagalpur Bihar; IGKV Raipur Chhattisgarh; U A H S Shivamogga Karnataka; Birsa Agricultural University Ranchi Jharkhand and Society for Scientific Development in Agriculture and Technology, Meerut, U.P.

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during a three days International Web Conference on “Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2020)” to be held during 28–30 December, 2020 at Astha Foundation Headquarter, Meerut (U.P.) India.

- Innovative article award for article ID: 33007 “CRISPR-Cas9: A Novel Technique for genome engineering in Plants” published in Agriculture & Food: e-Newsletter. Volume 2 (12).

Narendra Kumar

Awarded with Scientist of The Year in the International web conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS 2020) by the Society for Scientific Development in Agriculture and Technology (SSDAT) on 30.12.20.

Praveen Kona

"Young Scientist award" for Outstanding contribution in Genetics and Plant Breeding form the 'Society for Scientific Development in Agriculture and Technology' on the occasion of "International web conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS 2020)" during 28-30th December, 2020.

Radhakrishnan T

Recognized for outstanding partnership in the area of translational genomics by ICRISAT, Hyderabad

SK Bera

Recognized for outstanding partnership in the area of translational genomics by Centre of Excellence in Genomics & System Biology, ICRISAT.



8 Important events

Farmers fair and Exhibition

ICAR- Directorate of Groundnut Research - Junagadh, organized a *Kisan mela* and exhibition for the groundnut farmers of Saurashtra region on 4th February, 2020 with the

which was to provide information and guidance to the farmers about the use of various chemical fertilizers in groundnut crops on the basis of soil testing.

dignitaries present were Shri Jitendra Kumar, Assistant Commissioner, DAC, New Delhi, Dr. Pramod Mohanot, ADR, Junagadh Agricultural University, Junagadh, Dr. N.K. Gontia, Principal Agriculture Engineering Faculty Junagadh



financial support from DAC. The *mela* was attended by more than 850 farmers which included over 200 women farmers. The main emphasis

Dr. Chetan Trivedi, Vice Chancellor, Bhaktakavi Narasimh Mehta University, Junagadh, was the chief guest of the programme, and other

Agricultural University, Junagadh; Dr. Mohan A. Vadodariya, Principal, College of Agriculture, Junagadh Agricultural



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University, Junagadh; Shri Arjunbhai Parmar, Deputy Information Officer, and many scientists from the agriculture department and Junagadh Agricultural University.

In his opening remarks, Dr Radhakrishnan T., Director, ICAR-DGR elaborated the importance of use of groundnut as a food crop and the high oleic acid varieties Girnar-4 and Girnar-5, and also emphasized to farmers to adopt improved technologies to double the farm income. There was a special lecture on Soil test-based groundnut farming and its impact on soil health, which was delivered by Dr Lalit Vekhar, in which the farmers were explained about the importance of soil health cards and sustainable application of nutrients for improved plant growth. The progressive farmers narrated their experiences in deriving addition benefits from groundnut cultivation. Thirty-three innovative farmers were honored for their innovations. Twenty four stalls of various pesticide, fertilizer and machinery companies were also set up during the event. During the technical session, queries of farmers were addressed and resolved to their satisfaction. The program was successfully completed and concluded

with vote of thanks to all the guests, farmers visited and whole DGR staff for making this program successful.

XXII Research Advisory Meeting of ICAR- Directorate of Groundnut Research

The 22nd meeting of the Research Advisory Committee was held through

far. Dr. Mahesh Mahatma, Member Secretary, RAC presented the action taken report on the recommendations of the last meeting of RAC held on 12-13th September, 2019. Works done report of the ongoing projects were delivered before the committee for extensive



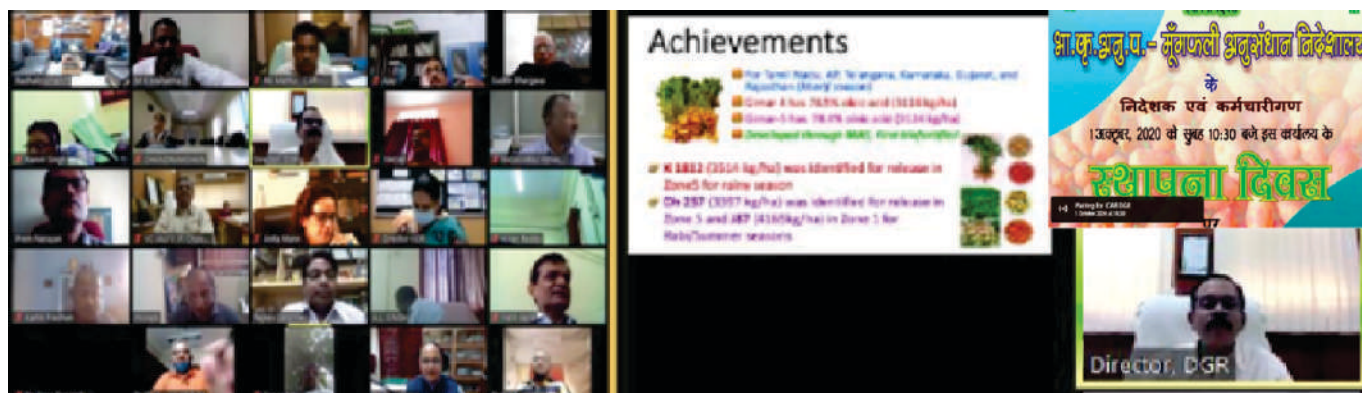
video conferencing at ICAR-DGR, Junagadh from 4-5th September 2020. The meeting was chaired by Dr. A Bandyopadhyay with RAC members Dr. IU Dhruj, Dr. BB Singh, Dr. LM Garnayak, Sh. Mahendrabhai Pithiya, Sh. Vrajlalbhairpara and Dr. Radhakrishnan T., Director, ICAR-DGR, Junagadh. The meeting started with the welcome of RAC members by the Dr. Radhakrishnan T, Director, ICAR-DGR, followed by a presentation on research programmes taken up and the major achievements made so

discussion and the future work plan was tweaked as per the suggestions of the research advisory committee.

DGR Foundation day

ICAR-Directorate of Groundnut Research, Junagadh celebrated its 41st Foundation day on 01.10.2020. Institute is the first crop commodity research unit under the National Research Centers under the ICAR and established on 01.10.1979. Virtual Foundation day programme was started with ICAR song. Dr. Radhakrishnan T., Director, welcomed all the

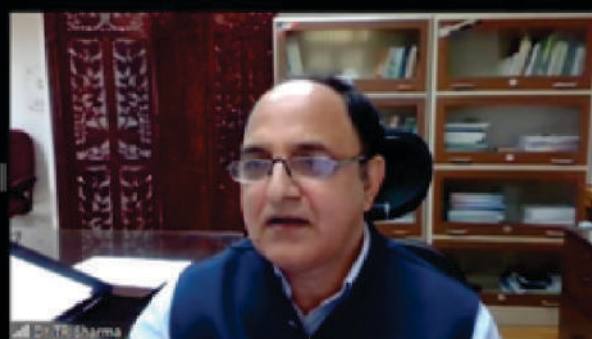
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dignitaries and participants in the foundation day programme and made brief presentation on the institute journey and achievements during last four decades. Dr. V.P. Chovatia, Hon. Vice Chancellor, Junagadh

Agricultural University, Junagadh, and Dr. Rajeev Varshney, Research Programme Director, Genetic Gains, ICRISAT was the guest of honour. Dr. V.P. Chovatia highlighted importance of groundnut crop in nutritional

security and Indian economy. He congratulated DGR for releasing high oleic groundnut genotypes. Dr. Rajeev Varshney highlighted the contribution of ICAR-Directorate of Groundnut Research, Junagadh in



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groundnut research and increasing productivity.

Dr. T.R. Sharma DDG (Crop Sciences), Chief Guest at this occasion delivered Foundation day Lecture on "We Need Innovations in Indian Agriculture to Sustain Food and Nutritional Security. He highlighted biotechnological interventions in food and nutritional security and urged Scientists to contribute more and more to achieve sustainable growth in agriculture.

On this auspicious occasion a technical bulletin "P4N : Peanut for Nutrition and leaflet "Phytic acid: an inevitable antinutrient in Groundnut were released. A Memorandum of Understanding (MoU) was also signed between ICAR-DGR (Lincensor); Om Laboratories, Junagadh (Licensee); and Agrinnovate India Limited (Facilitator) for transfer of a biofertilizer formulation called "NutMagic".

Employees of ICAR-DGR who are going to be retired from October, 2020 to September, 2021 due to superannuation were felicitated for their significant contribution. Former Directors and retired persons of ICAR-DGR, Directors of

various ICAR institutes Scientists and staff members were participated in the event. Programme was closed with the vote of thanks.

ICAR-DGR Inks MoU to Transfer NutMagic Technology

On the auspicious occasion of the 41st Foundation Day of ICAR-Directorate of Groundnut Research, a Memorandum of Understanding (MoU) was signed between ICAR-DGR (Lincensor); Om Laboratories, Junagadh (Licensee); and Agrinnovate India Limited (Facilitator) for transfer of a biofertilizer formulation called "NutMagic" on 1st October 2020 on non-exclusive basis, developed at ICAR-DGR, Junagadh. Dr. T. R. Sharma, DDG (CS) was the Chief Guest of the function. Besides, Dr. V. P. Chovatia, Vice-Chancellor of JAU,

Junagadh and Dr. Rajeev K. Varshney, ICRISAT were also present in addition to more than 150 participants. "NutMagic" is a consortium of beneficial bacteria of groundnut comprising plant growth promoting rhizobacteria ((PGPR: *Pseudomonas gessardii* BHU1, *Pseudomonas putida* S1(6)); phosphate solubilizing bacteria (PSB: *Enterobacter cloacae* BM8; *Bacillus* sp.) and competitive strains of groundnut rhizobia (*Sinorhizobium americanum* NRCG4 and *Rhizobium* sp. NRCG9) recommended for both irrigated and rainfed groundnut production system, after thorough multilocation evaluation.

Besides giving yield advantage of upto 20% on application of this formulation, it also improves soil health, nutrient



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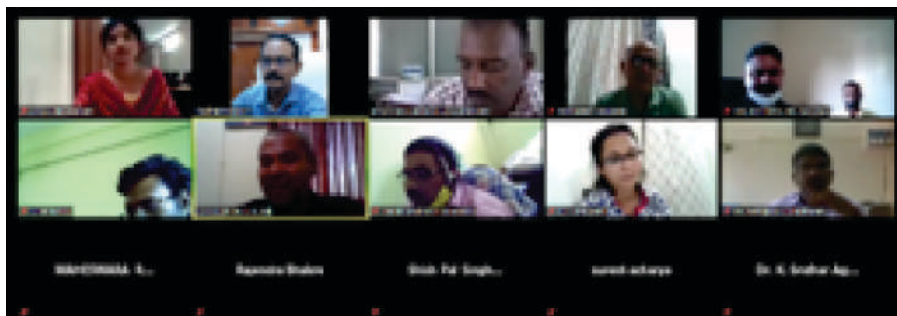
mobilization; and uptake of nutrients like P, K, N, Fe, Zn, etc. (also K, Mn, and Zn solubilizer and siderophore producers) by 7-10%. As consortium is having both efficiently nodulating and nitrogen fixing strains of groundnut rhizobia and equally efficient phosphate solubilizers, it can fix upto 200 kg N/ha/yr and thus dependence on nitrogenous, potassic, and phosphatic fertilizer can be reduced by 25-30%. This seed treating chemicals compatible consortium can be formulated in liquid, charcoal, FYM, peat, and talcum powder with shelf-life of more than one year at room temperature. The formulation is also compatible with all modes of applications (seed treatment, irrigation water, FYM, soil drenching and drip system). On behalf of ICAR-DGR, Junagadh, Dr. Radhakrishnan T., Director and on behalf of Om Laboratories, Junagadh, Dr. A. M. Parakhia, Partner, signed the MoU in presence of innovators (Dr. K. K. Pal and Dr. RinkuDey of ICAR-DGR) as witness. The technology will be formally transferred to M/s Om Laboratories on payment of one time licensing fees (4.0 lakh + GST) after completion of other codal formalities. This is a

significant step forward in making the low cost biofertilizer technology available to the needy groundnut farmers, to reduce input cost and improving productivity vis-à-vis income of the farmers and their livelihood.

Vigilance awareness week

Vigilance awareness week was celebrated at ICAR-DGR Junagadh from 27th October to 2nd November 2020. On 27th October 2020, vigilance pledge was taken through virtual mode. Three lectures were organized during the week viz. “Preventive

Vigilance” by Sh. Kanhaiya Choudhury, Former Director, Administration, ICAR; “Purchase Procedures” by Sh. Devendra Kumar, Former Director of Finance, ICAR; “CCS (CCA) rules” by S. K. Mitra, Former Director on Special Duty, ICAR. An Elocution competition on topic “Vigilant India, Prosperous India/ सतर्कभारत, समृद्धभारत” was held on 31.10.20, where 9 staff actively participated. A vigilance related quiz was (30 MCQ questions-Hindi) also organized on 02.11.20 on “vigilance awareness, CCS



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Rules, GFR rules, digitization to reduce corruption”, where 34 staff members had participated. A closing ceremony was held on 02.11.2020 at 04:30 PM, where the chairman of the Vigilance week, Dr. KK Pal gave the highlights of activities undertaken during the week and proposed vote of thanks. The Vigilance awareness week celebrations ended in a jubilant and sweet note

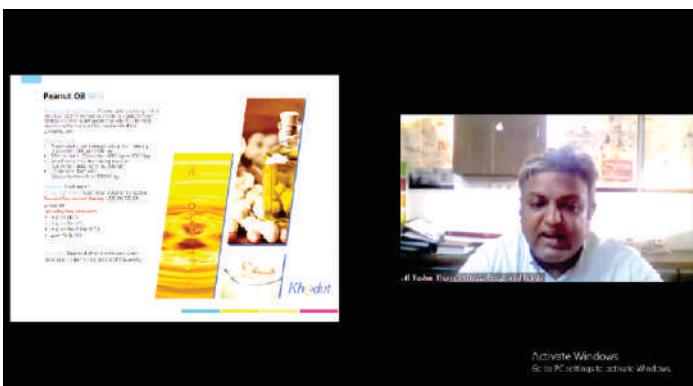
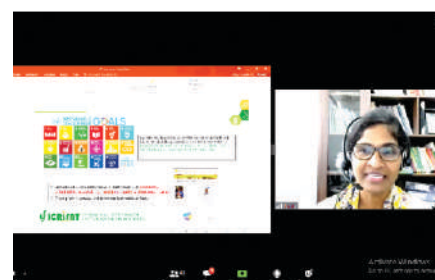
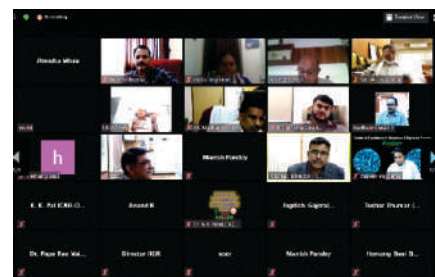
Industries Interface Meeting

Giving credence to the increasing importance and potentials of the Public-Private Partnerships in achieving higher groundnut productivity, efficiency, and diversification of value-added products and exports, and popularizing technologies, ICAR-Directorate of Groundnut Research has organized an online (virtual) Industries Interface meeting at this Directorate on 07 December, 2020. Dr. A. R. Pathak, Former Vice-Chancellor of Junagadh

Agricultural University was the chief guest and co-ordinated the meeting. Dr. K. K. Pal welcomed and introduced all the participants. Dr. Radhakrishnan T., Director, Presented brief overview of the programme. The participants include the researchers, and thirty representatives from different entrepreneurs from different parts of India and representative from the IOPEPC, SOMA, MARS. Specific comments were given by expert committee. The aim of this interface meeting was to address the issues concerning export, value addition, need of polarizing high oleic groundnut oil, need of application and popularization of low-cost biofertilizers for enhancing productivity of groundnut, etc. Problems faced by the groundnut confectionery industries (sound kernels, kernel shape, colour of testa, seed size, etc.), were covered

by distinguished speakers and participants.

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



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Staff List / General Information

As on 01.01.2020 to 31.12.2020

S.L.	Name of employees	Designation
1	Dr. T. Radhakrishnan	Director
2	Dr. AL Singh	Principal Scientist (Plant Physiology)
3	Dr. SK Bera	Principal Scientist (Cytogenetics)
4	Dr. KK Pal	Principal Scientist (Microbiology)
5	Dr. Rinku Dey	Principal Scientist (Microbiology)
6	Dr. Ram Dutta	Principal Scientist (Plant Pathology)
7	Dr. MK Mahatma	Principal Scientist (Plant Biochemistry)
8	Dr. PP Thirumalaisamy	Sr. Scientist (Plant Pathology)
9	Dr. Narendra Kumar	Sr. Scientist (Plant Breeding)
10	Dr. Harish G	Scientist (Senior Scale), Entomology
11	Dr. Ajay BC	Scientist (Senior Scale), Plant Breeding
12	Sh. MV Nataraja	Scientist (Senior Scale), Entomology
13	Dr. K Gangadhara	Scientist (Plant Breeding)
14	Dr. Sangh Chandramohan	Scientist (Plant Biotechnology)
15	Dr. Kiran Kumar Reddy	Scientist (Soil Science)
16	Dr. Sushmita	Scientist (Plant Physiology)
17	Dr. Kona Praveen	Scientist (Plant Breeding)
18	Sh. AnanthKurella	Scientist (Plant Pathology)
19	Sh. Rupak Jena	Scientist (Nematology)
20	Dr. AmanVerma	Scientist (Plant Biochemistry)
21	Dr. Raja Ram Choudhary	Scientist (Agronomy)
22	Dr. Kirti Rani	Scientist (Plant Breeding)
23	Dr. Papa Rao Vaikuntapa	Scientist (Plant Biotechnology)
24	Dr. DL Parmar	Chief Technical Officer
25	Sh. PK Bhalodia	Chief Technical Officer
26	Sh. PV Zala	Chief Technical Officer
27	Dr. JR Dobarra	Chief Technical Officer
28	Dr. MV Gedia	Assistant Chief Technical Officer
29	Sh. Ranvir Singh	Assistant Chief Technical Officer
30	Dr. SD Savaliya	Assistant Chief Technical Officer
31	Mrs. VS Chaudhari	Assistant Chief Technical Officer
32	Sh. BM Chikani	Assistant Chief Technical Officer
33	Sh. DR Bhatt	Assistant Chief Technical Officer

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34	Sh. RD Padvi	Technical Officer
35	Sh. HV Patel	Technical Officer
36	Sh. CB Patel	Technical Officer
37	Sh. NM Safi	TO (Driver)
38	Sh. BM Solanki	Sr. Technical Assistant (Tractor Driver)
39	Sh. Lokesh Kumar	Sr. Technical Assistant
40	Sh. Pitabas Das	Technical Assistant
41	Sh. MA Sheikh	Driver
42	Sh. DM Sachaniya	T-1
43	Sh. Indraraj Meena	Administrative Officer,
44	Sh. Amit Kumar	Finance & Account Officer,
45	Sh. RT Thakar	Assistant Administrative Officer
46	Sh. YS Kariya	Personal Assistant
47	Sh. LV Tilwani	Personal Assistant
48	Mrs. Santha Venugolan	Assistant
49	Mrs. MN Vaghasia	Assistant
50	Sh. MB Kher	Security Supervisor
51	Sh. CG Makawan	Assistant
52	Sh. PN Solanki	Upper Division Clerk
53	Sh. MB Shaikh	Skilled Support Staff
54	Sh. JG Agrawat	Skilled Support Staff
55	Sh. KT Kapadia	Skilled Support Staff
56	Sh. VN Kodiatar	Skilled Support Staff
57	Sh. RP Sondarwa	Skilled Support Staff
58	Sh. VM Chawada	Skilled Support Staff
59	Sh. GS Mori	Skilled Support Staff
60	Mrs. DS Sarvaiya	Skilled Support Staff
61	Sh. PM Solanki	Skilled Support Staff
62	Sh. NG Vadher	Skilled Support Staff
63	Sh. BJ Dabhi	Skilled Support Staff
64	Sh. CG Moradia	Skilled Support Staff
65	Sh. DA Makwana	Skilled Support Staff
66	Sh. Jay R Purohit	Skilled Support Staff
67	Sh. MB Kandoliya	Skilled Support Staff
68	Sh. Pola Haji	Skilled Support Staff

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1. Staff position as on 01.01.2020 to 31.12.2020

Category of	Sanctioned Strength as on 31.12.2020	Filled As on 31.12.20	Vacant As on 31.12.20
Scientific	35+01RMP	22+01	13
Technical	39	19	20
Admn.	17	10	07
SSS	16	16	00

2. DPC:

1.	DPC held on 12.10.2020 for Scientific staff	05 employees.
2.	DPC held on 12.02.2020 for Tech. staff	04 employees.
3.	DPC held on 07.09.2020 for Tech. staff	01 employees
4.	DPC held on 14.08.2020 for SSS to T-1,	01 employees.
5.	DPC (MACP) held on 01.09.2020 for Admn. Staff,	05 employees.

3. Retirement:-

1.	Dr. JR Dobaria,	Ex. CTO,	12.02.2020-Death
2.	Shri BM Solanki,	Ex. Tractor Driver,	31.05.2020.
3.	Shri BM Chikani,	Ex. ACTO,	15.09.2020-Death.
4.	Shri PK Bhalodia,	EX. CTO,	31.10.2020.
5.	Shri RP Sondrva,	EX. SSS,	31.10.2020
6.	Dr. DL Parmar,	Ex. CTO,	31.12.2020.
7.	Smt. MN Vaghasia,	Ex. Asst.,	31.12.2020.

4. Transfer:-

1.	Dr. Ram Dutta, Pr. Scientist, ICAR-DGR, Junagadh to ICAR-DOGR- Pune.
2.	Dr. PP Thirumalisamy, Scientist, ICAR-DGR, Junagadh to NBPGR, RRS, Thrissur, Kerala.

5. Contractual Staff

1.	RA	02	8.	Data Operator	01
2.	SRF	03	9.	Security Staff -Ex. Army	24
3.	JRF	03	10.	Office Asst. staff	06
4.	YP-2	01	11.	Cleaning Staff	07
5.	YP-1	17	12.	Farm Tractor Driver	03
6.	High Skilled worker	01	13.	Reception	02
7.	Skilled Helper	02	14.	Electrician	03

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6. IMC held on 10.07.2020.

Sr.	Institute Management Committee	Designation	Period
1.	Director ICAR-DGR, Junagadh	Chairman	Ex-officio
2.	Assistant Director General (OP), ICAR, KB, New Delhi	Member	06.08.2017 to 05.08.2020
3.	Director of Agriculture (Gujarat), Krishi Bhavan, Sector-10A, Gandhinagar, Gujarat	Member	06.09.2018 to 05.09.2021
4.	Director of Agriculture (Rajasthan), Pant Krishi Bhavan, Janpath-C, Scheme, Jaipur-302 005 (Rajasthan)	Member	06.09.2018 to 05.09.2021
5.	Dr. VP Chovatia, Director of Research, Junagadh Agricultural University, Jnagadh-362 001	Member	06.09.2018 to 05.09.2021
6.	Dr. SK Yadav, Principal Scientist, Biochemistry, CRIDA, Hyderabad-500 059	Member	06.08.2017 to 05.08.2020
7.	Dr. KS Geetha, Principal Scientist, DMAPR, Anand, Gujarat	Member	06.08.2017 to 05.08.2020
8.	Dr. IP Singh, Principal Scientist, ICAR-Central Citrus Research Institute, Nagpur-440 010	Member	06.08.2017 to 05.08.2020
9.	Dr. KK Pal, Principal Scientist, Microbiology, ICAR-DGR, Junagadh-362 001	Member	06.08.2017 to 05.08.2020
10.	Sh. Mahendrabhai Pithiya, At Gundran, Tauka Talala, Dist. Gir Somnath-362 150	Member	06.09.2018 to 05.09.2021
11.	Sh. Vrajilal Jivabhai Hirpara, Junagadh-362 001	Member	06.09.2018 to 05.09.2021
12.	Administrative officer, DGR, Junagadh	Member Secretary	Ex-officio

7. Institute Joint Staff Council:-

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

1.	Shri YS karia, Member CJSC
2.	Smt. MN Vaghasia, Secretary IJSC
3.	Shri RD Padvi, Member
4.	Shri P Dash, Member-Transfer
5.	Shri CG Moradia, Member
6.	Shri Jay R Purohit, Member

Members:- Office side

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

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8. Members of Research Advisory committee of ICAR-DGR

Chairman

Dr. A Bandyopadhyay

Former National Coordinator, NAIP, ICAR

Members

Assistant Director General (OP)

Indian Council of Agriculture Research Krishi Bhawan, New Delhi-110001

Director

ICAR- Directorate of Groundnut Research, Junagadh

Dr. BB Singh

Former ADG (O&P), ICAR

Dr. IU Dhruj

Retired Associate Director of Research JAU, Junagadh

Dr. LM Garnayak

Professor & Head

Department of Agronomy College of Agriculture, OUA&T, Bhubneswar

Professor PB Kirti

Faculty of Basic Sciences and Humanities

Rajendra Parasad Central Agricultural University Pusa- Samasthipur, Bihar, India

Director

ICAR-DGR, Junagadh

Shri Mahendrabhai Pithiya

At post- Gundaran-362150, Taluka- Talala, Dist- Gir Somnath

Shri Vrajlal (Vajubhai) Jivabhai Hirpara

A-107, Chanakya Apartment, Near Nehru Park, Junagadh-362001

Member Secretary

Dr. M.K. Mahatma

Principal Scientist (Plant Biochemistry) ICAR-DGR, Junagadh

9. Members of Institute Research Committee

Chairman

Director

ICAR-DGR, Junagadh

Members

All Scientists

Member Secretary

Dr. Rinku Dey

Principal Scientist (Microbiology) ICAR-DGR, Junagadh

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Finance & Accounts

Budget DGR Main Unit (Rs. in lakhs)	Allocation	Total Expenditure
Establishment charges	739.26	739.26
Wages	71.04	71.04
Administrative Expenses	268.48	263.68
Pension	331.66	331.60
T.A.	8.54	8.54
Research and Operational Expenses	194.39	194.38
HRD	0	0
Works	347.72	347.72
Equipment	4.51	4.51
Furniture	0.42	0.42
IT	2.11	2.11
Books	0	0
Vehicles	0	0
Miscellaneous	5.59	5.59
TSP	30.00	30.00
TOTAL (Rs. in lakhs)	2003.72	1998.85

AICRP-G (Rs. in Lakhs)	Allocation	Total Expenditure
Pay & Allowance	905.51	905.51
T.A.	13.90	13.90
Recurring Contingency & Need Based Research	191.10	191.10
TSP	46.00	46.00
TOTAL (Rs. in lakhs)	1156.51	1156.51

Revenue generation

Items	Seed/ planting material sale	Sale of other products
Revenue	1.34 lakh	14.77 Lakh



हर कदम, हर डगर
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