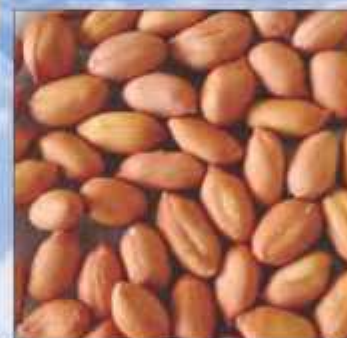

वार्षिक प्रतिवेदन
ANNUAL REPORT
2022

भाकृअनुप–मूँगफली अनुसंधान निदेशालय
(आई.एस.ओ 9001 : 2015 प्रमाणित संस्थान)
इवनगर रोड, पोस्ट बॉक्स नं. 5, जूनागढ़ 362 001, गुजरात, भारत

ICAR-Directorate of Groundnut Research
(An ISO 9001 : 2015 Certified Institute)
Ivnagar Road, PO Box No. 5, Junagadh-362 001, Gujarat, India

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- मूँगफली में उत्पादकता तथा गुणवत्ता सुधार के लिए आधारीय, नीतिगत तथा अनुकूल अनुसंधान।
- उपयुक्त किस्मों तथा प्रौद्योगिकियों के विकासार्थ जानकारियों ज्ञान तथा आनुवंशिक सामग्री को उपलब्ध करवाना।
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- 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 मूंगफली 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

I feel extremely happy in presenting the Annual Report of ICAR-DGR for year 2022. For the groundnut farmers, this was a good rainfall year as they reaped a bumper harvest. According to the tentative estimates there was a production of 10.1 million tons from an area of 5.74 million ha with a yield of 1759 kg/ha. For this year, the Govt. of India hiked the minimum support price for groundnut from 5500 to 5850 per quintal. During this fiscal year 5,14,180 metric tons of groundnut was exported which earned foreign exchange worth Rs. 4,697.10 crores.

In this year, GG-40 and Raj Mungfali-4 (RG-638) were released by Central Variety Release Committee for cultivation in kharif season. GG-40 is released for Rajasthan, Andhra Pradesh, Gujarat, Telangana, Tamil Nadu and Karnataka, while, RG-638 is released for Rajasthan, Uttar Pradesh and Punjab. In addition, GG 37, GG 38, DBG 3, DBG 4 and VRI 9 were released by State Variety Release Committee. GG 37 and GG 38 were released for Gujarat; DBG 3 and DBG 4 for Karnataka; VRI 9 for Tamil Nadu. Moreover, Kadiri Lepakshi (K1812) is identified for area expansion in Karnataka and Maharashtra for cultivation during *rabi*-summer season.

During the year, a total of 8732.40 q breeder seeds of 60 varieties were produced. Six hundred and thirty-seven front line demonstrations were conducted across the country to demonstrate the new varieties and improved production technologies for groundnut. Seven groundnut seed hubs produced 3914.02 q of Certified and Truthful seeds of 34 varieties. The Directorate produced 367.85 q of Breeder seeds of its two varieties Girnar 4 and Girnar 5 biofortified with ≥78% oleic acid in PPP mode for the first time.

Utilization of the grants was to the tune of 1632.23 lakhs for DGR and 881.75 lakhs for AICRP-Groundnut, a nearly cent per cent utilization. In addition, the funds received through the externally funded projects were also utilized effectively. During 2022, one scientist completed his PhD from North Carolina State University, Raleigh, North Carolina, USA.

All the scientists and a few other officials have contributed the material for compilation of this report. Dr. R. Dey, Dr. Sushmita, Dr. Rajanna, Dr. Raja Ram Choudhary and Sh. Lokesh Kumar took upon their shoulders the arduous task of compiling, editing and overseeing the printing. I sincerely appreciate their efforts in bringing out this report. I thank all the scientists of ICAR-DGR as well as those of AICRP-G and Administration for their hard work towards generating the data reported in this volume.

I shall be grateful to receive comments from the readers on the content and style of presentation of this report.

S. K. Bera

Director

कार्यकारी सारांश

फसल सुधार

- नया पूर्व-प्रजनन लाइनों को विकसित करने के लिए तीन नए अंतर-विशिष्ट क्रॉस किए गए।
- चार द्विगुणित सिंथेटिक्स के साथ बुवाई की गई मूँगफली के क्रॉस के माध्यम से कुल 449 पूर्व-प्रजनन लाइनें (एफ 2-3 और एफ 5-6) विकसित की गईं।
- चौदह पूर्व-प्रजनन लाइनों को पहले वर्ष की स्क्रीनिंग के दौरान 20% से कम मृत्यु दर के साथ कॉलर रॉट रोग के लिए प्रतिरोधी पाया गया।
- पहले वर्ष की स्क्रीनिंग के दौरान 20% से कम मृत्यु दर के साथ 45 आरआईएल स्टेम रॉट रोग के लिए प्रतिरोधी पाए गए।
- चौतीस वैलेंसिया जर्मप्लाज्म लाइनों को प्रति पौधे 40% से अधिक तीन बीज वाले फली के लिए दो मौसमों में पहचाना गया।
- चार उच्च उपज वाली उन्नत प्रजनन लाइनों (एनआरसीजीसीएस 658, एनआरसीजीसीएस 663, एनआरसीजीसीएस 656 और एनआरसीजीसीएस 657) को केडीजी 123 की तुलना में 10 प्रतिशत अधिक फली उपज (10% से 24%) के साथ विकसित किया गया। इनमें 69-70 प्रतिशत छीलन और 30-35 ग्राम 100 बीज वजन पाई गई।
- हाल ही में जारी उच्च उपज वाली किस्मों में उच्च ओलिक अम्ल को स्थानांतरित करने के लिए पंद्रह नए क्रॉस बनाए गए।
- चार नए स्पेनिश बंच को उच्च ओलिक अम्ल के लिए आशाजनक जीनोटाइप के रूप में पहचाना गया।
- दस नए वर्जीनिया बंच को उच्च ओलिक अम्ल के लिए आशाजनक जीनोटाइप के रूप में पहचाना गया।
- रैपिड जनरेशन एडवांसमेंट (आरजीए) को एक ही वर्ष में 250 से अधिक एकल पौधों की संततियों को एफ4 से एफ6 पीढ़ियों तक आगे बढ़ाने के लिए नियोजित किया गया।
- 125 स्पेनिश और 110 वर्जीनिया उन्नत प्रजनन लाइनों के प्रारंभिक उपज मूल्यांकन ने 15 स्पेनिश और 65 वर्जीनिया प्रजनन लाइनों को चेकों से बेहतर पाया।
- गहरी जुताई + कम्पार्टमेंटल बंड (डीटीसीबी) जैसी इन-सीटू नमी संरक्षण तकनीकों को अपनाने से किसानों के कृषि-पद्धतियों की तुलना में फली की पैदावार और बीज उपज लगभग 11.7% तक वृद्धि दर्ज की गई।
- 2 टन प्रति हेक्टेयर की दर से वर्मीकम्पोस्ट के साथ गहरे जुताई + कंपार्टमेंटल बंड (डीटीसीबी) के संयोजन ने किसानों के कृषि-पद्धतियों + नियंत्रण भूखंडों की तुलना में 40.1-47.5% अधिक फली और बीज उपज का प्रदर्शन किया।
- गहरी जुताई और किसानों के कृषि-पद्धतियों की तुलना में कंपार्टमेंटल बंड में वर्षा जल की इन-सीटू हार्वेस्टिंग और प्रतिधारण के कारण मूँगफली की फसल के विकास के सभी चरणों के दौरान गहरी जुताई + कंपार्टमेंटल बंड (डीटीसीबी) को अपनाने से मिट्टी की नमी अधिक बनी रही।
- एसपीजी-1118 हाइड्रोजेल द्वारा बीज उपचार तकनीक को अपनाने से उच्च अंकुरण प्रतिशत के कारण नियंत्रण भूखंडों की तुलना में लगभग 25.7% तक फली और बीज उपज में वृद्धि हुई।
- एसपीजी-1118 हाइड्रोजेल के उपयोग से मिट्टी की नमी में वृद्धि हुई, जिसके परिणामस्वरूप नियंत्रण भूखंडों पर मूँगफली की पैदावार में भी वृद्धि हुई।
- खरीफ, 2022 के दौरान बड़े बीज आकार (>60 ग्राम एचकेडब्ल्यू), उच्च प्रोटीन (>30%), कम तेल (45-48%), उच्च ब्लैंचिंग (>90%), उच्च सुक्रोज (>6%), छोटी अवधि (90 दिन), और नए बीज प्रसुप्ति (3 सप्ताह) को ध्यान में रखते हुए सोलह क्रॉस तैयार किए गए, जिससे 751 परिपक्व संभावित हाइब्रिड फली प्राप्त हुई।
- एफ 2 पीढ़ी में नौ क्रॉस से कुल 345 एकल पौधे, एफ 3 में नौ क्रॉस से 582 एकल पौधे, एफ 4 में 10 क्रॉस से 547 एकल पौधे, एफ 5 में आठ क्रॉस से 519 एकल पौधे और 2 बल्क लाइन और एफ 7 में छह क्रॉस से 22 एकल पौधे/बल्क लाइन चयन किया गया और मेल पैरेंट के आधार पर गुणवत्ता लक्षणों में सुधार हेतू अगली पीढ़ी में उन्नत किया गया।

- एफ 2 से एफ 3 पीढ़ी तक 430 एकल पौधों का चयन करके प्रारंभिक परिपक्वता और नए बीज प्रसुप्ति जैसे लक्षणों के लिए कुल 26 क्रॉस, एफ 3 से एफ 4 पीढ़ी तक
- 100 एकल पौधों का चयन करके दो क्रॉस और एफ 4 से एफ 5 पीढ़ी में 14 क्रॉस से 446 एकल पौधों का चयन करके उन्नत किया गया।
- चार मौसमों (ग्रीष्म 2021, खरीफ 2021, ग्रीष्म 2022 और खरीफ 2022) से पूल किए गए विश्लेषण में, पीबीएस 29256, पीबीएस 29267 और पीबीएस 29269 जीनोटाइप ने सर्वोत्तम जांच से बेहतर सौ बीज वजन (>85%) दर्ज किया।
- कुल 7 अग्रिम प्रजनन लाइनों (पीबीएस 16004, 16015, 16021, 16031, 16037, 16039, 16041) ने 21 दिनों तक 100% बीज प्रसुप्ति दर्ज की।
- स्पेनिश बंच लाइनों (पीबीएस 19040, पीबीएस 19041, पीबीएस 19050, और पीबीएस 19052) ने >11 ग्राम फली उपज/पौधे दर्ज की और गुणवत्ता लक्षणों के अच्छे संयोजन के मामले में सबसे अच्छी जांच टीकेजी19ए (8.7 ग्राम) से बेहतर पाई गई। वर्जीनिया लाइनें (पीबीएस 29243, पीबीएस 29239, पीबीएस 29247, पीबीएस 29248 और पीबीएस 29250) गुणवत्ता लक्षणों के अच्छे संयोजन के साथ >12 ग्राम फली उपज/पौधे दर्ज की, जो सबसे अच्छी जांच जीजेजी एचपीएस 2 (10.25 ग्राम) से बेहतर पाई गईं।
- बीआरआई 4 में उन्नतम 9.14 ग्राम/100 ग्राम, कुल घुलनशील शर्करा दर्ज की गई एवं अन्य 11 किस्मों (धरणी, जीजेजी-9, एसबी इम्प्रूव्ड 1, जीजेजी 33, जीपीबीडी-4, जी 2-52, प्रताप मुंगफाली-2, कादिरी हरितांड्रा, तिरुपति-2, जीपीबीडी-5 और डीएच-86) में ग्रीष्म ऋतु के दौरान >90% ब्लैंचबिलिटी दर्ज की गई।
- प्लास्मिड पृथक्करण एडजीन रिपॉजिटरी से प्राप्त वैक्टर से किया गया। प्रमोटर और स्केफोल्ड क्षेत्र को इन वैक्टर से प्रवर्धित किया गया। वेक्टर को एसपीई-I एंजाइम से उपचार करके विश्लेषण के लिए उपयोग किया गया। एनपीटी-II जीन का उपयोग करके स्क्रीनिंग के लिए 310 ट्रांसजेनिक टी4 पौधों का उपयोग किया गया, इनमें सकारात्मक परिणाम नजर आए। सभी नमूनों में जीन विशिष्ट मार्कर (Tfgd2-F और RsAFP2-R) का उपयोग स्क्रीनिंग के लिए किया गया जिसमें नकारात्मक परिणाम प्राप्त हुए।
- किट के उपयोग द्वारा पांच डेफेंसिन लाइनों का आरएनए पृथक्करण करके तीन नमूनों का सीडीएनए तैयार किया गया। जीन विशिष्ट प्राइमर और एक्टिन प्राइमर के साथ टेम्पलेट के रूप में सीडीएनए का उपयोग करके पीसीआर किया गया। जीन विशिष्ट प्राइमर के साथ कोई प्रवर्धन नहीं पाया गया, लेकिन एक्टिन प्राइमर के साथ सकारात्मक परिणाम प्राप्त हुआ।
- नया बीज प्रसुप्ति को नियंत्रित करने वाले क्षेत्रों से 110 प्राइमरों का निर्माण किया गया। 30 प्राइमरों ने 96 जीनोटाइप के बीच प्रति मार्कर 4.633 एलील की औसत आवृत्ति के साथ बहुरूपता दिखाई।
- स्टेम रॉट प्रतिरोध को नियंत्रित करने वाले क्षेत्रों से 43 प्राइमरों का निर्माण किया गया। 22 प्राइमरों ने 0.5 पीआईसी से अधिक दिखाया और शेष 21 प्राइमरों में पीआईसी 0.5 से कम प्राप्त हुआ। परिणाम बताते हैं कि बनाई गई प्राइमर जर्मप्लाज्म को अलग करने में दक्ष साबित हुई।
- पीबीएस 22040 और 29192 मिट्टी में आयरन की कमी की स्थिति में सबसे अच्छा प्रदर्शन करने वाली उन्नत प्रजनन लाइनें हैं।
- क्यूआरटी-पीसीआर द्वारा आयरन ट्रांसपोर्टरों की जीन अभिव्यक्ति आँकी गई। पीबीएस 22040 और 29192 में वाईएसएल 3 की 2-3 गुना अधिक अभिव्यक्ति प्राप्त हुई, जबकि अतिसंवेदनशील चेक एनआरसीजी 7472 के तुलना में पीबीएस 22040 और पीबीएस 29192 की जड़ों की पेरिप्लाज्मिक झिल्ली में एनआरएएमपी 3 की 1.5 गुना अधिक अभिव्यक्ति प्राप्त हुई।
- $ZnSO_4$+BM 6 और $ZnSO_4$+FP 82 के उपयोग से बीज में जिंक की मात्रा में उल्लेखनीय वृद्धि दर्ज हुई, लेकिन पत्तियों में जिंक की मात्रा में कोई महत्वपूर्ण वृद्धि या कमी नियंत्रण की तुलना में नहीं दिखाई दिया।
- मिट्टी में आयरन की कमी द्वारा मूँगफली की फसल जीजेजी 32 (8.6 पीपीएम), जीजेजीएचपीएस 2 (9.2 पीपीएम), केडीजी 128 (11.5 पीपीएम) और

जीजेजी 9 (7.3 पीपीएम) के बीज में रेस्वेराट्रोल की मात्रा अतिसंवेदनशील जांच एनआरसीजी 7472 (3.6 पीपीएम) के तुलना में बढ़ गया।

- चार कुशल जिंक-घुलनशील आइसोलेट्स, एंटरोबैक्टर क्लोएसी जेडएम-3,एंटरोबैक्टर क्लोएसी उप-प्रजाति डिसॉल्वेंस स्ट्रेन जेडएम-7, एंटरोबैक्टर क्लोएसी उप-प्रजाति डिसॉल्वेंस स्ट्रेन जेडएम-9 और एसिनेटोबैक्टर ऑलिअरिन्स स्ट्रेन जेडएम-12 के साथ बीज संरोपण के परिणामस्वरूप फली उपज में महत्वपूर्ण वृद्धि हुई (जेडएम-12 के साथ 17.5 प्रतिशत, जेडएम-3, जेडएम-7 और जेडएम-9 के बराबर)।
- तीन कुशल पोटैसियम - घुलनशील आइसोलेट्स, एसिनेटोबैक्टर लैक्टुसी स्ट्रेन केएम5-2, एसिनेटोबैक्टर लैक्टुसी स्ट्रेन केएम8-2 और स्यूडोमोनास ताइवानेंसिस स्ट्रेन केएम-9 के साथ बीज उपचार के परिणामस्वरूप फली उपज में अधिकतम केएम-9 (16%) में महत्वपूर्ण वृद्धि हुई।
- 50 किलोग्राम P_2O_5/हेक्टेयर + डीजीआरसी कल्चर के उपयोग से अधिक फली उपज (1795 किलोग्राम/हेक्टेयर) प्राप्त की गई। केवल 25 किलोग्राम P_2O_5/हेक्टेयर के तुलना में डीजीआरसी कल्चर को 25 किलोग्राम P_2O_5/हेक्टेयर के साथ उपयोग करने से लैबाइल-फास्फोरस पूल में 47% की वृद्धि प्राप्त हुई।
- डीएपी + बायोस्टिमुलेंट के प्रयोग से 25 किग्रा P_2O_5/हेक्टेयर के साथ उल्लेखनीय रूप से उच्च फली उपज (18.5 किग्रा/हेक्टेयर) देखी गई। बायोस्टिमुलेंट के उपयोग से लैबाइल-फास्फोरस पूल में 38% की वृद्धि दर्ज की गई।
- 50 किग्रा P_2O_5 + 20 किग्रा सल्फर + डीजीआरसी 1 के साथ अधिक फली उपज (1805 किग्रा/हेक्टेयर) दर्ज की गई। डीजीआरसी 1 को उच्च सल्फर की मात्रा (40 किग्रा/हेक्टेयर) के साथ उपयोग करने से लैबाइल-फास्फोरस पूल में 36% की वृद्धि देखी गई।
- बुवाई के 30,45 और 60 दिन बाद 25 किग्रा P_2O_5 + 0:52:34 ($N:P_2O_5:K_2O$) @ 0.5% की दर से पर्णीय छिड़काव करने पर उल्लेखनीय रूप से उच्च फली उपज (1977 किग्रा/हेक्टेयर) प्राप्त हुई। पर्णीय छिड़काव करने पर लेबाइल-फास्फोरस पूल में 29% की वृद्धि नोट की गई।
- जूनागढ़ (7) और बीकानेर (6) में कॉलर रॉट प्रतिरोधता वाली उन्नत किस्मों को विकसित करने के लिए खरीफ 2022 में तेरह क्रॉस किए गए और इसकी सफलता दर क्रमशः 10.2% और 50.3% प्राप्त हुई।
- ग्रीष्म 2022 के दौरान 10 क्रॉस से कॉलर रॉट प्रतिरोध के कुल 49 एकल पादप संकरों की पहचान की गई।
- खरीफ 2022 के दौरान 57 क्रॉस की कुल 782 संततियों को विभिन्न संतानीय पीढ़ियों (F2-F6) में उन्नत किया गया।
- खरीफ 2022 के दौरान पांच नई उच्च उपज वाली उन्नत प्रजनन लाइनें विकसित की गई।
- फली उपज, बीज उपज और एसओटी (%) के लिए सर्वोत्तम जांच किस्म टीजी37ए की तुलना में दो उन्नत प्रजनन लाइनों (पीबीएस-12232(32%) और पीबीएस 12231 (27%)) की पहचान की गई।
- खरीफ 2022 के दौरान स्टेम और कॉलर रॉट हेतु स्थान विशिष्ट चयन के लिए एआईसीआरपी-जी केंद्रों को 11 अलग-अलग क्रॉस की आपूर्ति की गई।

फसल उत्पादन

- भारत में 2022 मानसून के समय 1 जून से 30 सितंबर के दौरान दक्षिणी पश्चिमी मौसमी मानसून वर्षा सामान्य से अधिक रही और 1971-2020 के आंकड़ों के आधार पर दीर्घावधि के औसत 87.0 सेमी वर्षा कि तुलना में मात्रात्मक रूप से यह 92.5 सेमी (दीर्घावधि के औसत का 106%) रही। यह उत्तर पश्चिम भारत, गुजरात और आसपास के क्षेत्रों (101%) में सामान्य और केवल पूर्व और पूर्वोत्तर भारत (82%) में सामान्य से नीचे दर्ज किया गया।
- खरीफ और ग्रीष्म (ज्यादातर शुष्क) मूँगफली का उत्पादन गुजरात में कुछ स्थानों पर अधिक वर्षा के परिणामस्वरूप बाढ़ (खरीफ के दौरान) और बीमारियों (पत्ती धब्बा और जड़ सड़न आदि) से होने वाले हानिकारक प्रभाव को छोड़कर सामान्य था।

फिर भी, खरीफ 2022-23 के दौरान मूँगफली का उत्पादन (83.69 लाख टन) हुआ। गुजरात में प्रचलित कृषि-पारिस्थितिकी तंत्र में गुजरात के दक्षिणी सौराष्ट्र कृषि-जलवायु क्षेत्र (नीति आयोग का गुजरात मैदानी और पहाड़ी क्षेत्र) में मध्यम काली चूने वाली मिट्टी पाई जाती है।

- प्रक्षेत्र प्रयोग के पहले ही वर्ष 2022 में प्राकृतिक खेती में खरीफ मूँगफली कि प्रतिक्रिया देखी गई, हालांकि पारंपरिक खेती की तुलना में उपज में 19% की कमी आई। पारंपरिक खेती में फसल की आवश्यकता के अनुसार रासायनिक उर्वरकों, गोबर खाद और कीटनाशकों की पर्याप्त आपूर्ति के कारण अनुकूल वृद्धि और विकास होने से प्राकृतिक खेती व जैविक खेती की तुलना में अधिक उपज व शुद्ध लाभ प्राप्त हुआ।
- खेती के प्रकार के प्रभाव की दृष्टि से देखे गये मापदंड सार्थक रूप से अग्रलिखित क्रम में पाए गये; पारंपरिक खेती> जैविक खेती> प्राकृतिक खेती; जबकि फसल की किस्म की दृष्टि से सार्थक रूप से अधिक उत्पादकता जीजेजी 22 (वर्जिनिया बंच) कि तुलना में टीजी 37 ए (स्पेनिश बंच) में दर्ज की गई।
- उपज को उन्नत कृषि-प्रौद्योगिकी द्वारा बढ़ाने हेतु किये गये प्रयोग में, स्पैनिश बंच किस्म 'टीजी 37ए' में, क्रमशः ग्रीष्म और खरीफ दोनों ऋतुओं के दौरान फली उपज (2925 और 2064 किग्रा/हेक्टेयर), शेलिंग प्रतिशत (66.2 और 69.4%), सीड इंडेक्स (35.0 और 32.1) के साथ-साथ अधिक शुद्ध लाभ (129875 रुपये और 83641 रुपये) और लाभ-लागत अनुपात (2.48 और 1.74) उन्नत क्रियाओं के साथ प्राप्त किए गए।
- इसी प्रकार वर्जिनिया बंच किस्म केडीजी 128 में क्रमशः दोनों ऋतुओं के दौरान फली कि उपज (3625 और 3221 किग्रा/हेक्टेयर), शेलिंग प्रतिशत (72.4 और 68.7%), सीड इंडेक्स (33.3 और ३3.6 ग्राम) के साथ अधिक शुद्ध लाभ (182453 रुपये और 155303 रुपये) और लाभ-लागत अनुपात (3.41 और 3.13) उन्नत क्रियाओं के साथ प्राप्त हुए। इस प्रकार निष्कर्ष यह है कि मूँगफली में अधिक और स्थिर पैदावार प्राप्त करने के लिए उन्नत क्रियाओं को अपनाना है क्योंकि इसकी पुष्टि सभी ऋतुओं/किस्मों से की गई है।
- प्रभावी खरपतवार नियंत्रण प्रक्षेत्र प्रयोग में, दक्षिणी सौराष्ट्र क्षेत्र में पाई जाने वाली प्रमुख खरपतवार प्रजातियों में सेज (साइप्रस रोटेंडस और साइप्रस एस्कुलेंटस) पायी गयी। घास में साइप्रस रोटेंडस, इकाईनोक्लोआ कोलोनम और ब्रेचियरिया स्पीशीज, और कुछ चौड़ी पत्ती वाले खरपतवार (जैसे डाइजेरा आर्वेन्सिस, वर्नोनिया सिनेरिया, फाइलेन्थस स्पीशीज, फाइसेलिस मिनिमा, जंगली मूंग (विग्ना स्पीशीज), एक्लिप्टा अल्बा, अल्टरनेनथेरा स्पीशीज, 8. अम्मानिया बेसीफेरा, यूफोरबिया हिर्टा और कोमेलिना बेंघालेंसिस) भी पाए गये।
- खरपतवार नियंत्रण पर एक साल के अध्ययन में "डाइक्लोसुलम 26 ग्राम/हेक्टेयर प्रीइमेरजेंस के रूप में उसके बाद फेनोक्साप्रोप-पी-एथिल 78 ग्राम/हेक्टेयर" पोस्ट-इमेरजेंस के रूप (टी4) में सीजन भर के खरपतवार नियंत्रण के लिए के लिए प्रभावी पाया गया क्योंकि इससे गुजरात के दक्षिणी सौराष्ट्र क्षेत्र में अधिक उपज और आर्थिक लाभ हो सकता है। इसके बाद अगला सबसे अच्छा उपचार "ऑक्सीफ्लोरफेन 200 ग्राम / हेक्टेयर प्रीइमेरजेंस उसके बाद फेनोक्साप्रोप-पी-एथिल 78 ग्राम/हे पोस्ट-इमेरजेंस के रूप में (टी6), मैनुअल वीडिंग + इंटरकल्चर की तुलना में पाया गया।
- मूँगफली में सिंचाई शेड्यूलिंग पर यह पाया गया कि आईडब्ल्यू/सीपीई अनुपात-आधारित सिंचाई उपचार खरीफ मौसम के दौरान फसल के प्रदर्शन पर आपस में अंतर नहीं कर सके क्योंकि मौसम के दौरान पानी की कमी लगातार वर्षा के कारण उपस्थित नही थी। इस प्रकार उपरोक्त स्थिति के तहत न्यूनतम सिंचाई (0.6 IW/CPE पर निर्धारित यानी 83.3 मिमी पैन वाष्पीकरण पर) इष्टतम है।
- एक साल के अध्ययन में गुजरात के दक्षिणी सौराष्ट्र क्षेत्र के तहत मूँगफली में अधिक उपज और लाभ की प्राप्ति के लिए केवल सल्फर कि मध्यम खुराक (15 किग्रा / हेक्टेयर) मिट्टी में अनुप्रयोग हेतु प्रभावी पायी गयी।

- देर से बुवाई (डी३) (0.6-1.4 मिलीग्राम जी-1 ऊतक) पर पत्ती एपिक्यूटिकुलर मोम में वृद्धि हुई, जबकि शीघ्र (डी1) और समय पर बोई गई (डी2) स्थितियों में समान औसत (0.94 मिलीग्राम जी-1 ऊतक) दर्ज किया गया।
- बेसिलस फर्मस जे22एन का बीज उपचार के रूप में और उसके बाद 10 टन/हेक्टेयर की दर से गेहूं के चारे का प्रयोग करने से मूँगफली की उपज में कंट्रोल ट्रीटमेंट कि तुलना में 500-550 किलोग्राम/हेक्टेयर की वृद्धि हुई।
- राइजोबिया (K515, K521, K557, और Rh29) का अनुप्रयोग, जो ग्रोथ मीडिया में 7.5% तक NaCl सहन कर सकता है, इसमें 3.87 के ECe पर फली और हल्म उपज, नोड्यूल संख्या, शेलिंग आउटटर्न और सौ कर्नेल द्रव्यमान में काफी वृद्धि पाई गई।
- DGRMB5 और DGRMB19 के K1812 के साथ क्रॉसिंग के परिणामस्वरूप 12 F1s प्राप्त हुआ। इसी तरह, DGRMB5 X RG638 और DGRMB19X Dh 256 के बीच क्रॉस के परिणामस्वरूप 73 और 55 F1s प्राप्त हुए।
- सीएएम वेरिएंट्स (डीजीआरएमबी5 और डीजीआरएमबी1 9) ने सीएएम प्रकाश संश्लेषक ट्राजिसन की अति-अभिव्यक्ति के कारण 3.95 के ईसीई पर इन वेरिएंट्स में टीजी37ए (लवणता के प्रति संवेदनशील) में बायोमास उत्पादन को 48% से घटाकर 30% कर दिया।
- $CaCl_2$ के अनुप्रयोग से लवणता तनाव (दोनों 2.0 और 4.0 के ECe पर) की प्रतिक्रिया में संवेदनशील मूँगफली जीनोटाइप की तुलना में टॉलेरेंट मूँगफली जीनोटाइप में बेहतर ओस्मोटिक समायोजन का पता चला।
- टी 6 (डीजीआर एंडोफाइट 2 बीज उपचार + बुवाई के समय सॉइल एप्लिकेशन और बुवाई के 45 दिन बाद) + गेहूं का भूसा @ 10 टन / हेक्टेयर) के उपचार के साथ उच्चतम सार्थक फली की उपज मिली, जो टी 5 (डीजीआर एंडोफाइट 2 बीज उपचार + बुवाई के 45 दिन बाद सॉइल एप्लिकेशन) + गेहूं का भूसा @ 10 टन/हेक्टेयर) के बराबर थी। एंडोफाइट्स के साथ मल्चिंग से मूँगफली की उपज में 500-550 किलोग्राम / हेक्टेयर नियंत्रण पर सुधार हुआ।
- K515, K521, K557, और Rh29 के अनुप्रयोग ने मिट्टी की लवणता (ECe 3.87) के दौरान फली और पतवार की उपज, नोड्यूल संख्या, शेलिंग आउटटर्न और सौ कर्नेल द्रव्यमान में काफी वृद्धि की।
- अल्टरनेरिया लीफ ब्लाइट के प्रबंधन के लिए 2022 की ग्रीष्म के दौरान एपिफाइट्स के मूल्यांकन से पाया कि बेसिलस सबटिलिस ५एस१, बेसिलस सबटिलिस 7एस2, और बैसिलस एमिलोलिक्विफेशियन्स 9S2 के छिड़काव से पत्ती झुलसा की गंभीरता नियंत्रण उपचार में 6.0 (1-9 स्केल) के स्कोर से घटकर 4.0 हो गई।
- ग्रीष्म 2022 के दौरान 20 क्रॉस (F4 और F6) की कुल 187 संततियों को अगली फिलियल पीढ़ियों के लिए उन्नत किया गया।
- खरीफ 2022 के दौरान 53 क्रॉस (F2 से F6) की कुल 642 संततियों को अगली फिलियल पीढ़ियों के लिए उन्नत किया गया।
- तेरह नई उच्च उपज वाली उन्नत प्रजनन लाइनें विकसित की गई
- खरीफ 2022 के दौरान लीफ स्पॉट और रस्ट और अल्टरनेरिया लीफ ब्लाइट के लिए स्थान विशिष्ट चयन के लिए एआईसीआरपी-जी केंद्रों को आपूर्ति करने के लिए चार सेग्रेगेटिंग पीढ़ियों (एफ3 से एफ6 पीढ़ी) से कुल 21 विभिन्न क्रॉस का चयन किया गया।

फसल संरक्षण

- थ्रिप्स और लीफहॉपर की आबादी पूरे वर्ष पाई गई थी, लेकिन हमने 8 वें मानक सप्ताह के दौरान थ्रिप्स और लीफहॉपर आबादी का एक महत्वपूर्ण शिखर देखा।
- चूसने वाले कीटकों के प्रबंधन के लिए इमिडाक्लोप्रिड + स्प्रेडर्स को नियंत्रण के तुलना में प्रभावी पाया गया।
- चूसने वाले कीटकों के प्रबंधन में एसिफेट 50% + इमिडाक्लोप्रिड 1.8% एसपी को प्रभावी पाया गया।

Executive Summary

Crop Improvement

- Three fresh interspecific crosses were made to develop fresh pre-breeding lines.
- A total of 449 pre-breeding lines (F2-3 and F5-6) were developed through hybridization of cultivated groundnut with four diploid synthetics
- Fourteen pre-breeding lines were found resistant to collar rot disease with less than 20% mortality during first year screening
- Forty-five RILs were found resistant to stem rot disease with less than 20 per cent mortality during first year screening
- Thirty-four Valencia germplasm lines were characterized with more than 40% three seeded pods per plant over two seasons
- Four high yielding advanced breeding lines, NRCGCS 658, NRCGCS 663, NRCGCS 656 and NRCGCS 657 were developed with 10 per cent higher pod yield (10% to 24%) than KDG 123. These lines also had 69-70 per cent shelling and 100 kernels weight of 30-35g.
- Fifteen fresh crosses were made to transfer high oleic traits in recently released high yielding varieties.
- Fresh four Spanish bunch promising high oleic genotypes were identified.
- Fresh 10 Virginia bunch promising high oleic genotypes were identified.
- Rapid Generation Advancement (RGA) was employed for advancing more than 250 single plant progenies from F_4 to F_6 generations in a single year.
- Preliminary yield evaluation of 125 Spanish and 110 Virginia Advanced breeding lines identified 15 Spanish and 65 Virginia breeding lines superior over the checks.
- Adoption of in-situ moisture conservation techniques like deep tillage + compartmental bunds (DTCB) recorded significantly higher pod yield and kernel yield by ~11.7 over farmers' practice.
- Combination of deep tillage + compartmental bunds (DTCB) along with vermicompost @ 2 t ha^{-1} applied plots exhibited 40.1-47.5% higher pod yield and kernel yield over farmer practice + control plots.
- Adoption of deep tillage + compartmental bunds (DTCB) retained significantly higher soil moisture during all the groundnut crop growth stages due to in-situ harvesting and retention of rain water in the compartmental bunds as compared to deep tillage and farmer's practice.
- Adoption of seed treatment technique for SPG-1118 hydrogel exhibited significantly higher pod yield and kernel yield by ~25.7% as compared to control plots due to higher germination percentage.
- Application of SPG-1118 hydrogel retained slightly higher soil moisture in their profile resulted in enhanced groundnut yields over control plots.
- Sixteen crosses were effected targeting quality traits [Large seed size (>60gm HKW), high protein (>30%), low oil (45-48%), high blanching (>90%), high sucrose (>6%)], short duration (90days), and fresh seed dormancy (atleast 3 weeks) during *Kharif*, 2022 and 751 mature probable hybrid pods were harvested.
- Total 345 single plants from nine crosses in F_2 generation, 582 single plants from nine crosses in F_3 generation, 547 single plants from 10 crosses in F_4 generation, 519 single plants and 2 line bulks from eight crosses in F_5 generations and 22 single plants/line bulks from six crosses in F_7 generation were selected and advanced to next generation based on male parent characters for quality traits

improvement.

- Total 26 crosses targeting early maturity and fresh seed dormancy are advanced by selecting 430 single plants from F_2 to F_3 generation, two crosses by selecting 100 single plants from F_3 to F_4 generation and 446 single plants from 14 crosses in F_4 to F_5 generation.
- In the pooled analysis of four seasons (summer 2021, *Kharif* 2021, summer 2022 and *Kharif* 2022), genotypes viz., PBS 29256, PBS 29267 and PBS 29269 recorded >85% of Hundred Kernel Weight and found superior over the best checks.
- Total 7 ABLs (PBS 16004, 16015, 16021, 16031, 16037, 16039, 16041) recorded 100% dormancy up to 21 days from date of harvesting
- Spanish bunch lines viz., PBS 19040, PBS 19041, PBS 19050, and PBS 19052 lines found superior over best check TKG 19A (8.7g) in terms of pod yield/plant recording >11g/plant and having good combination of quality characters. Virginia lines viz., PBS 29243, PBS 29239, PBS 29247, PBS 29248 and PBS 29250 lines found superior over best check GJG HPS 2 (10.25g) in terms of pod yield/plant recording >12g/plant with good combination of quality traits.
- VRI 4 recorded highest total soluble sugars as 9.14g/100g and 11 varieties viz., Dharani, GJG-9, SB Improved 1, GJG 33, GPBD-4, G2-52, Pratap Mungphali-2, Kadiri Haritandra, Tirupati-2, GPBD-5 and Dh-86 recorded >90% blanchability during summer 2022.
- Plasmid isolation was carried out from the vectors obtained from Addgene repository. The promoter and Scaffold region was amplified from these vectors. Vector digestion was carried out using SpeI enzyme and used for further analysis. 310 transgenic T_4 plants were used for screening using npt-II gene and showed positive results. The same was used for screening using gene specific marker (Tfgd2-F & RsAFP2-R) and tested negative in all samples.
- RNA isolation of five defensin lines was carried out using kit method and cDNA was prepared for three samples. PCR was carried out using cDNA as template with gene specific primer and actin primer. No amplification found with gene specific primer but found positive result with actin primer.
- 110 primers mined from the regions governing fresh seed dormancy. 30 primers showed polymorphisms with an average frequency of 4.633 alleles per marker among 96 cultivated genotypes.
- 43 primers mined from the regions governing stem rot resistance. Twenty two primers showed PIC value of greater than 0.5 and remaining 21 primers have the PIC value of less than 0.5. The results indicate that the primer pair designed were efficient in differentiating the germplasm.
- PBS lines 22040 and 29192 were the best performing advanced breeding lines under Fe deficit conditions in the soil.
- The qRT-PCR for the gene expression of Fe transporters revealed 2-3-fold over-expression of *YSL 3* in PBS 22040 and 29192 while *NRAMP3* recorded 1.5-fold over-expression in the periplasmic membrane of roots of PBS 22040 and PBS 29192 over the susceptible check NRCG 7472.
- The application of $ZnSO_4$+ BM 6 and $ZnSO_4$+ FP 82 recorded a significant increase in kernel Zn content but the leaves did not show any significant increase or decrease in Zn content when compared to the control.
- The Fe deficit conditions in the soil greatly

elevated the resveratrol content in kernels of groundnut cultivars GJG 32 (8.6 ppm), GJGHPS2 (9.2 ppm), KDG 128 (11.5 ppm) and GJG 9 (7.3 ppm) over the susceptible check NRCG 7472 (3.6 ppm).

- Seed inoculation with four efficient Zn-solubilising isolates, *Enterobacter cloacae* ZM-3, *Enterobacter cloacae* subsp. *dissolvens strain* ZM-7, *Enterobacter cloacae* subsp. *dissolvens* strain ZM-9 and *Acinetobacter oleivorans* strain ZM-12 resulted in significant increase in pod yield (17.5% with ZM-12, at par with ZM-3, ZM-7 and ZM-9).
- Seed inoculation with three efficient K-solubilising isolates, *Acinetobacter lactucae* strain KM5-2, *Acinetobacter lactucae* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9 resulted in significant increase in pod yield, the maximum with KM-9 (16%).
- Significantly higher pod yield (1795 kg/ha) was obtained with when 50 kg P_2O_5/ha + DGRC Culture was applied. A 47% increase in labile-P pool is noted when DGRC culture is applied along with 25 kg P_2O_5/ha over 25 kg P_2O_5/ha alone
- Significantly higher pod yield (1805 kg/ha) was observed with application of 25 kg P_2O_5/ha through DAP + Biostimulant. A 38% increase in labile-P pool is noted when biostimulant is applied
- Significantly higher pod yield (1805 kg/ha) was registered with 50 kg P_2O_5+20 kg S+ DGRC1. A 36% increase in labile-P pool is noticed when DGRC 1 is applied with higher S dose i.e., 40 kg/ha
- Significantly higher pod yield (1977 kg/ha) was achieved when 25 kg P_2O_5 + 0:52:34 N: P_2O_5: K_2O (foliar spray) @ 0.5% at 30, 45 and 60 DAS was given. A 29% increase in labile-P pool is noted when foliar spray is applied over its non-application.
- Thirteen crosses were effected in *kharif* 2022 to develop improved varieties resistance of collar rot at Junagadh (7) and Bikaner (6) and success rate of hybridization was 10.2% and 50.3%, respectively.
- A total 49 single plant hybrids of resistance to collar rot have been identified from 10 crosses during summer 2022.
- A total 782 progenies of 57 crosses were advanced to different filial generations (F2-F6) during *kharif* 2022.
- Developed five new high yielding advanced breeding lines during *kharif* 2022.
- Identified two advanced breeding lines viz., PBS-12232 (32%) and PBS 12231 (27%) superior over best check variety TG 37A for pod and kernel yield and SOT(%).
- Supply 11 different crosses to AICRP-G centres for location specific selections for stem rot and collar rot resistance during *kharif* 2022.

Crop Production

- Salient features of Monsoon 2022 in India indicated that SW seasonal monsoon rainfall during 1st June to 30th September for the country as a whole has been above normal and quantitatively it has been 92.5 cm (106% of its Long Period Average, LPA) against long period average of 87.0 cm rainfall based on data of 1971-2020. It was Normal over Northwest India (101%) covering Gujarat and adjoining region (and Below Normal only over East & NE India (82%).
- Both *kharif* and summer (mostly dry) groundnut production were normal except some detrimental effect caused by high rainfall events resulting in flooding (during *kharif*), occurrences of diseases (leaf spot and root rot etc.) in some locations in Gujarat. Nevertheless, a production (83.69 lakh

tonnes) of groundnuts was made during *kharif* 2022-23. The prevailing agro-ecosystem in Gujarat involved medium black calcareous soil under Southern Saurashtra Agro-climatic Zone of Gujarat (Niti Ayog's Gujarat Plain and hill region).

- *Kharif* groundnut responded to Natural Farming (NF) in the very first year (2022) of field experiment although with 19% reduction in yield compared to Conventional Farming practices. However, Conventional (Improved) Farming (CF) practice comprising of chemical fertilizers, FYM and pesticides (BMPs) was far superior in realizing higher yield/return due to obvious reasons of adequate input supply as per crop requirement accompanied with favorable crop growth and development compared to NF and OF practices (organic Farming).
- On the effect of Farming practice, significantly higher values of observed parameters were recorded in the following order: CF > OF > NF; while on varietal front, significantly greater productivity was recorded under TG 37A (Spanish Bunch) compared to GJG 22 (Virginia Bunch).
- On bridging the yield gap through improved agro-technology, higher values of yield and its attributes in Spanish Bunch cultivar 'TG 37A' viz., pod yield (2925 & 2064 kg/ha), shelling per cent (66.2 & 69.4 %), seed index (35.0 & 32.1) along with favorable economics such as higher net return (INR 129875 & 83641) and BCR (2.48 & 1.74) were realized with improved practices undertaken during both spring-summer and *kharif* seasons, respectively.
- Similar was in the case of Virginia Bunch cultivar 'KDG 128' with pod yield of 3625 & 3221 kg/ha, shelling per cent of 72.4 & 68.7%, seed index of 33.3 & 33.6g, net return of INR 182453 & 155303, and BCR of 3.41 & 3.13 during both the seasons, respectively. Thus, the study concludes for adoption improved practice for realization of higher and stable yields in groundnut as it is confirmed from across the seasons/varieties.
- On efficient weed control strategy, the dominant weed species found in this Southern Saurashtra region includes Sedges (*Cyperus rotandus*, and *Cyperus Esculentus*). Few grasses including *Cyperus rotandus*, *Echinochloa colonum* and *Brachiaria* spp., and some broad leaved weeds (viz., *Digera arvensis, Vernonia cinerea, Phyllanthus* spp., *Physalis minima*, Wild moong bean (Vigna spp.), *Eclipta alba, Alternanthera* spp, *Ammania bacifera, Euphorbia hirta*, and *Commelina benghalensis*) were also present.
- One-year study on weed control indicated the proven efficacy of "Diclosulam 26 g/ha as PRE fb Fenoxaprop-p-ethyl 78 g/ha" as PoE (T_4) for season long weed control as this could result in higher yield and economics under Southern Saurashtra region of Gujarat. This was followed by the next best treatment where "Oxyflourfen 200 g/ha as PRE fb Fenoxaprop-p-ethyl 78 g/ha as PoE (T_6) was applied to the crop compared to manual weeding + interculture.
- On irrigation scheduling in groundnut, it showed that IW/CPE ratio-based irrigation treatments could not differentiate among themselves on the crop performance during *kharif* season since water deficit during the season was non-existent due to more or less well distributed and frequent rainfall events occurred at the location. Thus, under the above situation, minimum irrigation (scheduled at 0.6 IW/CPE i.e., at 83.3 mm pan evaporation) is optimum.

- One-year study indicated the efficacy of soil application of sulphur only at moderate doses (15 kg/ha) for realization of higher yield and economics in groundnut under Southern Saurashtra region of Gujarat.
- The leaf epicuticular wax content was increased upon late sowing (15.02.23) (0.6-1.4 mg g^{-1} tissue) while early (25.01.23) and timely sown (5.02.23) conditions recorded similar mean value (0.94 mg g^{-1} tissue).
- Application of *Bacillus firmus* J22N as seed treatment followed by furrow application along with wheat straw mulch @ 10 t/ha improved yield of groundnut by 500-550 kg/ha over uninoculated control.
- Application of rhizobia (K515, K521, K557, and Rh29), which can tolerate upto 7.5% of NaCl in growth media, enhanced the pod and haulm yield, nodule numbers, shelling outturn and hundred kernel mass significantly at soil ECe of 3.87.
- Crossing of DGRMB5 and DGRMB19 with K1812 resulted in generation of 12 F_1s. similarly, cross between DGRMB5 X RG638 and DGRMB19 X Dh 256 resulted in 73 and 55 F_1s
- CAM variants (DGRMB5 and DGRMB19) reduced the biomass production from 48% in TG37A (susceptible to salinity) to 30% in these variants at ECe of 3.95 because of over-expression of CAM photosynthetic transition.
- External application of $CaCl_2$ revealed better osmotic adjustment in tolerant groundnut genotypes than susceptible ones in response of salinity stress (both at ECe of 2.0 and 4.0).
- The highest significant pod yield was found with treatment T6 (DGR endophyte 2 seed treatment + furrow soil application at sowing and 45 DAS + Wheat straw mulch @ 10 t/ha) which was at par with T5 (DGR endophyte 2 seed treatment+ furrow soil application at sowing and 45 DAS + Wheat straw mulch @ 10 t/ha).
- Application of K515, K521, K557, and Rh29 enhanced the pod and haulm yield, nodule numbers, shelling outturn and hundred kernel mass significantly during soil salinity (ECe 3.87).
- Evaluation of epiphytes during summer 2022 for management of *Alternaria* leaf blight indicated that the severity of leaf blight reduced from a score of 6.0 (1-9 scale) in uninoculated control to 4.0 when sprayed with *Bacillus subtilis* 5S1, *Bacillus subtilis* 7S2, and *Bacillus amyloliquefaciens* 9S2.
- A total of 187 progenies of 20 crosses (F_4 and F_6) were advanced to next filial generations during summer 2022.
- A total of 642 progenies of 53 crosses (F_2 to F_6) were advanced to next filial generations during *kharif* 2022.
- Thirteen new high yielding advanced breeding lines were developed
- A total of 21 different crosses from four segregating generations (F3 to F6 generation) were selected during *kharif* 2022 to supply to AICRP-G centres for location specific selections for leaf spot and rust and *Alternaria* leaf blight.

Crop protection

- Thrips and leafhopper population was found throughout the year, but we observed one significant peak of thrips and leafhopper population during 8th Standard week.
- Imidacloprid + Spreaders was found to be effective in managing sucking pests over control.
- Acephate 50% + Imidacloprid 1.8% SP was found effective in managing the sucking pests.

1 Crop Improvement

PROJECT 01: DEVELOPMENT OF GROUNDNUT PRODUCTION TECHNOLOGIES FOR ARID REGION OF RAJASTHAN

(NARENDRA KUMAR, KIRTI RANI, RAJARAM CHOUDHARY, BDS NATHAWAT)*

*Associated up to 28th October 2022

Hybridization

Seven crosses were effected to develop improved groundnut varieties resistant to collar rot during *kharif* 2022 at Junagadh. The number of harvested crossed pods varied from 6 (RG 510 × J 11) to 20 (Girnar 2 × J 11). The mean success rate (%) of the hybridization programme was 10.2% **(Table 1.1)**. Six crosses were effected to develop improved groundnut varieties resistant to collar rot during *kharif* 2022 at Bikaner. The number of harvested crossed pods varied from 84 (OG 52-1 × Girnar-2) to 260 (Girnar 2 × J 11). The mean success rate (%) of the hybridization programme was 50.3% **(Table 1.1)**.

Table 1.1. Crosses effected in *kharif* 2022

SN	Cross	Objective	Pollination	Pod (no)	Success (%)
A.	**Junagadh**				
1	Girnar 2 × OG 52-1	Study genetics of resistance of collar rot	65	17	26.15
2	OG 52-1 × Girnar-2	Study genetics of resistance of collar rot	30	9	30.0
3	Girnar 2 × J 11	Study genetics of resistance of collar rot	166	20	12.0
4	HNG 69 × OG 52-1	High yield with resistance of collar rot	103	12	11.6
5	Mallika × J 11	High yield with resistance of collar rot	151	12	7.9
6	RG 510 × J 11	High yield with resistance of collar rot	145	6	4.13
7	RG 638 × J 11	High yield with resistance of collar rot	167	9	5.4
			827	**85**	**10.2**
B.	**Bikaner**				
1	Girnar 2 × OG 52-1	High yield with resistance of collar rot	221	77	34.8
2	OG 52-1 × Girnar-2	High yield with resistance of collar rot	349	84	24.0
3	Girnar 2 × J 11	High yield with resistance of collar rot	337	260	77.1
4	J-11 × Girnar -2	High yield with resistance of collar rot	426	137	32.1
5	OG 52-1× J-11	High yield with resistance of collar rot	218	203	93.0
6	RG 638 × OG 52-1	High yield with resistance of collar rot	200	120	60.0
			1751	**881**	**50.3**

Identification of hybrids

Ten different crosses were raised in summer 2022 to identify F_1's effected for developing high yielding genotypes with collar rot resistance. A total 49 single plants have been identified as hybrids, wherein the score ranged from 2-8.

Advancement of different filial generations

A total 782 progenies from 57 crosses effected for high yield with resistance to stem rot and collar rot were advanced in *kharif* 2022 at RRS, Bikaner to different filial generations (F_1:2, F_2:16, F_3:19, F_4:6, F_5: 10, F_6: 4). Among them 43 crosses are in early generation (up to F_4) and rest 14 crosses in advanced generations. During selection 275 progenies were rejected at the time of harvesting due to large proportion of poor recombinants and


Selections in breeding materials at RRS, Bikaner during *kharif* 2022

Table 1.2. Details of segregating materials forwarded and rejected at Junagadh in *kharif* 2022

SN	Cross	Harvest pod Generation	Sown SPP	SPP-Selection
1	TG 37 A × CS 319	F_2	6	7
2	TG 37 A × PBS 18037		7	16
			13	23
1	TG 37 A × PBS 18037	F_3	25	18
2	GG 20 × PBS 18037		17	13
3	TG 37 A × CS 19		35	27
4	TG 37 A × CS 319		32	24
5	Girnar 2 × OG 52-1		8	3
6	OG 52-1 × Girnar-2		8	7
7	Girnar 2 × J 11		4	3
8	J-11 × Girnar -2		5	4
9	J-11 × SGL 4233		6	4
10	SGL 4233 × J 11		2	2
11	OG 52-1 × SGL-4233		3	2
12	SGL-4233 x PBS 22092		8	8
13	RG 510 × SGL 4233		3	0
14	HNG 69 × SGL-4233		2	2
15	TG 37 A × CS 19		5	5
16	GG 20 × PBS 18037		9	4
			172	**126**
1	TG 37 A × PBS 18037	F_4	18	0
2	GG 20 × PBS 18037		17	14
3	TG 37 A × CS 19		54	24
4	TG 37 A × CS 319		61	27
5	Girnar 2 × OG52-1		5	4
6	OG 52-1 × Girnar 2		8	3

Cont..

7	Girnar 2 × J 11		9	6
8	J 11× Girnar 2		5	3
9	PBS 22092 × F1 (OG 52-1 × J11)		9	5
10	J 11× F1 (OG 52-1 × PBS 22092)		10	8
11	K 1812 × Dh 257		38	29
12	Dh 256 × Dh 257		23	16
13	GJG 31 × PBS 22040		15	12
14	PBS 22040 × GJG 31		22	16
15	Girnar 2 × OG52-1		10	6
16	OG52-1 × Girnar 2		4	3
17	OG52-1 × PBS 22092		5	2
18	OG52-1 × KDG 128		15	12
19	TG 37A × OG52-1		8	0
			336	**190**
1	ICGV 00351× Kadiri Haritandhra	F_5	19	16
2	GJG 34 × ICGS 44		15	11
3	GJG-33 × K.Chitravathi		20	13
4	Dh 256 × K.Chitravathi		21	10
5	GJG-32 × TCGS-894		23	15
6	PBS 18037 × CS 319		4	5
			102	**70**
1	TG 37 A × PBS 18037	F_6	4	4
2	GG 20 × CS 19		11	11
3	TG 37 A × CS 19		6	4
4	KDG 128 × CS 19		16	13
5	KDG 128 × PBS 18037		9	8
6	TG 37 A × CS 319		7	6
7	TG 37 A × PBS 18037		10	5
8	GG 20 × PBS 18037		9	7
9	CS 19 × PBS 18037		4	2
10	KDG 128 × CS 19		59	33
			135	**93**
1	JL 776 × OG 52-1	F_7	11	PBS 12251
2	KDG 128 × J 11		4	PBS 22176 PBS 22177
3	CS 319 × TG 37 A		1	PBS 22178
4	KDG 123 × J 11		8	PBS 22181
57			**782**	**507**

absence of desirable trait in the recombinants and 507 progenies were advanced to next filial generation. Single plant progenies of four cross were raised in F_6 generation and identified five new advanced breeding lines comprising of one Spanish bunch and four Virginia bunch.

Yield evaluation of advanced breeding lines

A. Summer 2022

A total 17 Spanish bunch advanced breeding lines with three checks (TG-37A, Dh 86, GJG 31) were evaluated in RBD with three replications for yield and its component traits during summer 2022. Based on the two-year testing, advanced breeding lines *viz*., PBS-12232 (32%) followed by PBS 12231 (27%) were found at par with best check variety TG 37A for pod and kernel yield and SOT (%). This breeding line may be proposed for testing under AICRP-G trials during summer season.

B. *Kharif* 2022

A total of 30 Virginia bunch advanced breeding lines with six checks (KDG 123, KDG 128, Girnar 2, RG 559-3, HNG 69, RG 638) were evaluated in RBD with three replications for yield and its component traits during *kharif* 2022. In addition to that a total of 20 Spanish bunch advanced breeding lines with three checks (TG 37A, TAG 24, SG 99) were evaluated in RBD with three replications for yield and its component traits during *kharif* 2022.

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

I. Development of new advanced breeding lines

Five new high yielding advanced breeding lines (SB-1, VB-4) were developed from advanced generations during *kharif* 2022.

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

The breeding material of 12 different crosses from three segregating generations (F_4 to F_6 generation) were selected during *kharif* 2022 to supply AICRP-G centres for location specific selections for stem rot and collar rot.

Table 1.3: Details of different crosses from three segregating generations during *Kharif* 2022

SN	Cross	Generation	Objectives
1	Girnar 2 × OG52-1	F4	High yield with resistance to collar rot
2	OG52-1 × Girnar 2	F4	High yield with resistance to collar rot
3	OG52-1 × KDG 128	F4	High yield with resistance to collar rot
4	TG 37A × OG52-1	F4	High yield with resistance to collar rot
1	ICGV 00351× Kadiri Haritandhra	F5	High yield with resistance to collar rot
1	TG 37 A × PBS 18037	F6	High yield with resistance to stem rot
2	GG 20 × CS 19	F6	High yield with resistance to stem rot
3	TG 37 A × CS 19	F6	High yield with resistance to stem rot
4	KDG 128 × CS 19	F6	High yield with resistance to stem rot
5	KDG 128 × PBS 18037	F6	High yield with resistance to stem rot
6	GG 20 × PBS 18037	F6	High yield with resistance to stem rot

III. Multiplication and status of AICRP-G lines

During *kharif*-2022, seed of eight elite breeding lines (PBS 12200, PBS 12217, PBS 12218, PBS 12221, PBS 12223, PBS 12228, PBS 12231 and PBS 12232) were mass multiplied to get sufficient seed required for AICRP-G testing.

Screening of genotypes for resistance to collar rot

A total 203 groundnut breeding lines, cultivars and interspecific derivatives were screened in augmented trial under sick plot for resistance to collar rot at Bikaner during *kharif* 2022. Data were recorded on plant mortality up to 45 DAS. Collar rot incidenc ranged from 12 to 52%. Highest disease incidence was observed in breeding line PBS 12185. Results revealed that genotypes PBS 12175, PBS 12211, PBS 12214, Mallika and interspecific derivatives no 109,121,122,132 and 140 of cross (J 11 X A. duranensis) X TG 37A recorded less than 15% plant mortality while resistant genotypes *viz*., OG52-1 (26%), J 11 (28%) and PBS 22092 (24%) recorded average 28% plant mortality. These genotypes will be tested 2 more years to ascertain their resistance to collar rot.

Screened 400 groundnut germplasm 100 each of Valencia, Spanish bunch, Virginia bunch and Virginia runner for resistance to collar rot under natural condition during *kharif* 2022 at Bikaner. Collar rot mortality varied from 0 to 67% (NRCG 14074) in Valencia germplasm, 0 to 55% in Spanish germplasm (NRCG 10799), 0 to 56% (NRCG 12449) in Virginia bunch and 0 to 33% (NRCG 8972) in Virginia runner germplasm. These germplasms need to be screened for 3 more years to ascertain their resistance level.

Screening of genotypes for resistance to fusarium blight

A total 150 groundnut advanced breeding lines and cultivars were screened in augmented trial under disease affected identified area for resistance to fusarium leaf blight at Bikaner during *kharif* 2022. Data were recorded on plant mortality from 50 DAS to till harvesting. Maximum disease mortality was 44% in breeding line PBS 12200. These genotypes need to be tested three more years to ascertain the fusarium leaf blight resistance.

Seed production of groundnut varieties

During *kharif* 2022 at DGR- Regional Research Station, Bikaner TFL seed production of Girnar-2

Breeder seed production plot of Girnar 4 at RRS, Bikaner

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variety was taken up in 2.7 ha. and breeder seed production programme of variety Girnar 4 was undertaken in 5.8 ha area. Accordingly produced 30.9 q TFL seed of Girnar-2 and 97.9q breeder seed of variety Girnar 4. During 2022, supplied 1750kg quality seed of variety Girnar-2 through which generated revenue of Rs. 1,57,500/-. During *kharif* 2022, a revenue of Rs. 81,360/- was generated through sale of groundnut fodder while the sale of undersized pods generated a revenue of Rs. 20,210. RRS, Bikaner also handed over 151 q groundnut fodder to ICAR-CSWRI-ARC, Bikaner.

Sub-project: Enhancing resource use efficiency and crop productivity in groundnut-based cropping systems

(PI:-Raja Ram Choudhary)

Experiment 1: Studies on conservation tillage and residue management practices in groundnut-based cropping systems

A field experiment has been initiated at Bikaner from *kharif* 2022 to assess the impact of conservation tillage and residue management practices in groundnut-based cropping systems. The treatments were: five tillage and residue management practices viz. conventional tillage (*kharif*) - conventional tillage (*rabi*), conventional tillage + residue incorporation (*kharif*) - conventional tillage (*rabi*), conventional tillage + residue incorporation (*kharif*) - zero tillage (*rabi*), zero tillage + residue retention (*kharif*) - conventional tillage (*rabi*) and zero tillage + residue retention (*kharif*) - zero tillage (*rabi*) in vertical strip plots; and three cropping systems viz. groundnut-mustard, groundnut-chickpea and groundnut-wheat in horizontal strip plots. The experiment was laid out in strip plot design with three replications. All experimental plots were prepared performing one tillage operation each with MB plough followed by disc harrow and cultivator before start of experiment. Thus, in tillage treatments, zero tillage was equivalent to conventional tillage in *kharif* season. Sowing of groundnut was done on 11th July 2022 using Girnar-2 variety at 45X10 cm spacing. The recommended dose of fertilizers used was 20:40:00 kg N:P:K/ha. Harvesting was done on 16th November 2022. During *rabi* season 2022-23 mustard, chickpea and wheat crops were sown on 22nd, 24th and 25th November 2022, respectively.

Experimental Field View

Experiment: 2. Nutrient management options and tillage practices in groundnut-mustard cropping system

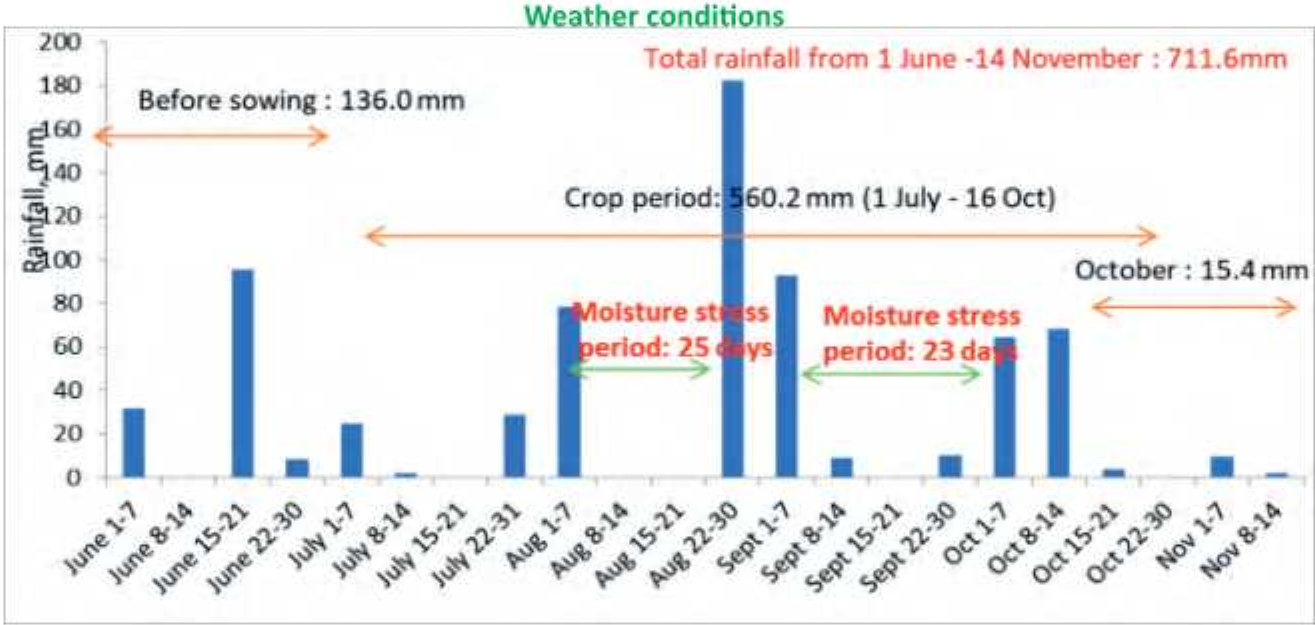
A field experiment has been initiated at Bikaner from *kharif* 2022 to assess the effect of nutrient management options and tillage practices in groundnut-mustard cropping system. The experiment consisted of seven treatments having farmers' practice, zero tillage + residue retention (*kharif* season) + 100% RDF to both the crops, zero tillage + residue retention (*kharif* season) + 75% RDF to both the crops + DGRC culture in groundnut, minimum tillage + residue incorporation (*kharif* season) + 100% RDF to both the crops, minimum tillage + residue incorporation (*kharif* season) + 75% RDF to both the crops + DGRC culture in groundnut, conventional tillage + residue incorporation (*kharif* season) + 100% RDF to both the crops, and conventional tillage + residue incorporation (*kharif* season) + 75% RDF to both the crops + DGRC culture in groundnut. The experiment was laid out in RBD design with three replications. All experimental plots were prepared performing one tillage operation each with MB plough followed by disc harrow and cultivator before start of experiment. Thus, conventional tillage was equivalent to minimum tillage and zero tillage in *kharif* season in the treatments. Sowing of groundnut was done on 13th July 2022 using Girnar-2 variety at 45 x 10 cm spacing. The 100% recommended dose of fertilizers was used as 20:40:00 kg N:P:K/ha. DGRC culture was used as seed treatment in groundnut. Harvesting of groundnut was done on 18th November 2022. During *rabi* season 2022-23, mustard crop was sown on 26th November 2022.

Project 2: Management of drought stress in groundnut at Anantapur and adjacent areas

PI: *Ajay BC*

Co-PI: *KK Pal, Praveen Kona, Rajanna GA, KK Reddy, Papa Rao V, Rinku Dey*

Weather conditions



Hybridization, selection and generation of advancement in segregating generations

Generation advancement during summer 2022

A set of 280 SPPs in F4 generation were advanced to next filial generation in a plant to row progeny method during Summer season (1st week of March 2022) at Anantapur for rapid generation advancement. At the time of harvest (3rd week of June 2022) selections were not imposed during this season, instead two representative pods from each plant in a row were bulked for further generation advancement

Kharif 2022

Five fresh crosses were attempted in *kharif* 2021 to enhance yield under drought stress and more than 140 hybrid pods were harvested with 20.2% crossing success. In summer 22 probable hybrid (F_1 generation) from four crosses attempted in *kharif* 2021 were raised and F_2 hybrid pods were harvested as single plants. These four crosses in F_2 generation were raised in Anantapur under rainfed conditions during *kharif* 2022 and advanced to next generation by single seed descent method. A set of 400 single plant progenies were advanced to F6, and 33 SPPs to F_4 generations. A set of 320 Narrow leaf segregants in F_5 generation were advanced to next filial generation.

Generation advancement during *Rabi* 22-23

A set of 293 SPPs in F6 and 16 SPPs in F_5 were advanced to next filial generation in a plant to row progeny method during post-rainy season (3rd week of October 2022) at Anantapur for rapid generation advancement. At the time of harvest (3rd week of Feb 2022) selections were not imposed during *Rabi* 22-23 instead two representative pods from each plant in a row were bulked for further generation advancement. Also, four crosses in F_2 generation were raised for advancing it to next generation by SSD bulk method.

Multiplication of promising breeding lines

A set of 36 advanced breeding lines were multiplied for further yield evaluation. Also, 10 advanced breeding lines (PBSA 11135, 11127, 11150, 11138, 11009, 11010, 11061, 21056, 21120 and 21111) were multiplied for further multi-locational testing.

Advanced yield evaluation of Early maturing genotypes under drought stress conditions

Twenty-two advanced breeding lines from cross TAG 24 x NRCG 6255 and 19 advanced breeding lines from cross TAG24 x Girnar 1 developed for early maturity were evaluated for yield performance under drought stress conditions of Anantapur along with parents and check (Dh 256, K 1812, and Dh 86). ABLs PBS 14098 (2728 Kg/ha) and 14116 (2873 Kg/ha) recorded high yields at par with Dh 256 (2712 kg/ha). Four ABLs PBS 14094, 14122, 14103 and 14117 recorded 50 percent flowering in 23 days after sowing which was very early compared to check varieties Dh 256 at 27 DAS.

Preliminary Yield Evaluation trial

A set of 86 Spanish advanced breeding lines were evaluated for yield related traits under natural drought prone conditions of Anantapur during rainy season of 2022 with K 1812 and Dh 256 as check varieties. Four advanced breeding lines PBSA 11006, 11017, 11054 and 11090 were identified for advanced yield evaluation trials. Similarly, a set of 60 Virginia advanced breeding lines were evaluated for their yield performance in comparison to KDG 128 as a check and identified 24 ABLs for further advanced yield evaluation trials.

A second set of 39 Spanish advanced breeding were evaluated for yield related traits under natural drought prone conditions of Anantapur during rainy season of 2022 with K 1812 and Dh 256 as check varieties. Nine advanced breeding lines (PBSA 11068, 11084, 11041-1, 11052-1, 11061-1, 11063-1, 11011, 11078 and 11030-1) were identified for further advanced yield evaluation trials. Similarly, A set of 50 Virginia advanced breeding lines were evaluated for their yield performance in comparison to KDG 128 as a check and identified 15 advanced breeding lines which were superior over the check for pod yield (PBSA 21018, 21019, 21019-1, 21025, 21029, 21034, 21050, 21046-1, 21068, 21073, 21035, 21075, 21079, 21045 and 21049) for further advanced yield evaluation trials.

Advanced yield evaluation of CAM transited genotypes

A set of 20 CAM transited genotypes were evaluated with three replications in row length of 5m having 5 rows with R 2001-2, DH 256, TG 37A and K1812 as checks during rainy seasons of 2020 to 2022. Pooled analysis of pod yield data indicated large genotypic variations for pod yield between seasons. Check genotypes K 1812 recorded high average yield and none of the CAM transited genotypes were superior to check.

Evaluation of *in situ* rainwater conservation practices and organic manure for mitigating the adverse effect of drought situations

The second-year study was conducted during *kharif* season of 2022 at ICAR-DGR, RRS, Ananthapur, Andhra Pradesh on a red sandy loam texture soil. The experiment consisted of 4 *in-situ* moisture conservation techniques [Farmers practice, deep tillage, deep tillage+ compartmental bunds and only compartmental bunds] assisted in main plots with three organic manures [control, FYM and vermicompost] assisted in sub plots using split plot design with three replications. Sowing was done on 07th July 2022 using Kadari Amaravathi variety of groundnut planted at a planting interval of 30×10 cm in a gross plot area of 6×3 m=18m^2. Harvesting was done on 17.10.2022. The recommended rate of fertilizer used was 20:40:50 kg NPK/ha along with gypsum application (500 kg/ha) at 25 days after sowing.

Results indicated that, *in-situ* moisture conservation techniques and organic manures influenced significantly on yield attributes, yield and crop water productivity of groundnut during 2022 crop season **(Table 2.1)**. Adoption of *in-situ* moisture conservation techniques like deep tillage + compartmental bunds (DTCB) recorded significantly higher pod yield (1532 kg/ha), haulm yield (3639 kg/ha), kernel yield (1132 kg/ha), shelling percentage (73.8%), 100 kernel weight (46.7g) and harvest index (45.5%) as compared to other *in-situ* moisture conservation techniques. Likewise, DTCB exhibited significantly higher crop water productivity of groundnut (4.03 kg/ha-mm) as compared to other techniques **(Fig. 2.1)**. Among organic manures, application of vermicompost @ 2 t/ha recorded significantly higher pod yield (1530 kg/ha), haulm yield (3634 kg/ha), kernel yield (1130 kg/ha), shelling percentage (73.8%), 100 kernel weight (46.3g), harvest index (45.5%) and crop water productivity (4.02 kg/ha-mm) as compared to control and FYM applied plots. Interaction effects are also found to be significant during the study season. Combination of deep tillage + compartmental bunds (DTCB) along with vermicompost applied plots exhibited significantly higher pod yield (1780 kg/ha), haulm yield (4066 kg/ha), kernel yield (1336 kg/ha), shelling percentage (75.1%), 100 kernel weight (46.9g) and crop water productivity (4.63 kg/ha-mm) as compared to other interaction effects. However, interaction effects did not show significant effect on harvest index in groundnut.

Soil moisture content: *In-situ* moisture conservation techniques and organic manures greatly influenced on soil moisture content in groundnut during 2022 crop season **(Figures 2.2-2.4)**. *In-situ* moisture conservation techniques like deep tillage + compartmental bunds (DTCB) retained significantly higher soil moisture during

Table 2.1. Effect of *in-situ* moisture conservation techniques and organic manures on yield attributes, yield and crop water productivity of groundnut

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Kernel yield (kg/ha)	Shelling %	100 Kernel weight (g)	Harvest index	Crop water productivity (kg/ha-mm)
In-situ moisture conservation technique							
Convention method/farmers practice (FP)	1372	3409	974	70.7	43.7	44.0	3.64
Deep tillage (DT)	1463	3540	1052	72.0	44.6	44.9	3.86
Deep tillage + Compartmental bunds (DTCB)	1532	3639	1132	73.8	46.7	45.5	4.03
Compartmental bunds (CB)	1477	3570	1071	72.5	45.2	44.9	3.89
Sem±	8	26	5	0.2	0.6	0.2	0.02
LSD (p<0.05)	**26**	**89**	**17**	**0.7**	**1.9**	**0.9**	**0.06**
Organic manure							
Control	1371	3375	966	70.3	43.4	44.3	3.63
FYM @ 5 t/ha	1482	3610	1076	72.6	45.4	44.6	3.90
Vermicompost @ 2 t/ha	1530	3634	1130	73.8	46.3	45.5	4.02
Sem±	14	37	12	0.4	0.5	0.3	0.03
LSD (p<0.05)	**41**	**110**	**36**	**1.3**	**1.4**	**NS**	**0.10**
Interaction effect : I x OM							
FP C	1206	2989	794	65.9	42.8	44.5	3.23
FP FYM	1480	3737	1079	72.9	45.7	43.0	3.90
FP VC	1430	3502	1049	73.4	42.5	44.4	3.78
DT C	1477	3717	1046	70.8	43.7	43.1	3.89
DT FYM	1509	3532	1079	71.5	43.8	46.3	3.97
DT VC	1402	3372	1031	73.5	46.2	45.3	3.71
DTCB C	1330	3252	986	74.1	46.2	44.7	3.53
DTCB FYM	1487	3599	1075	72.3	46.9	44.8	3.91

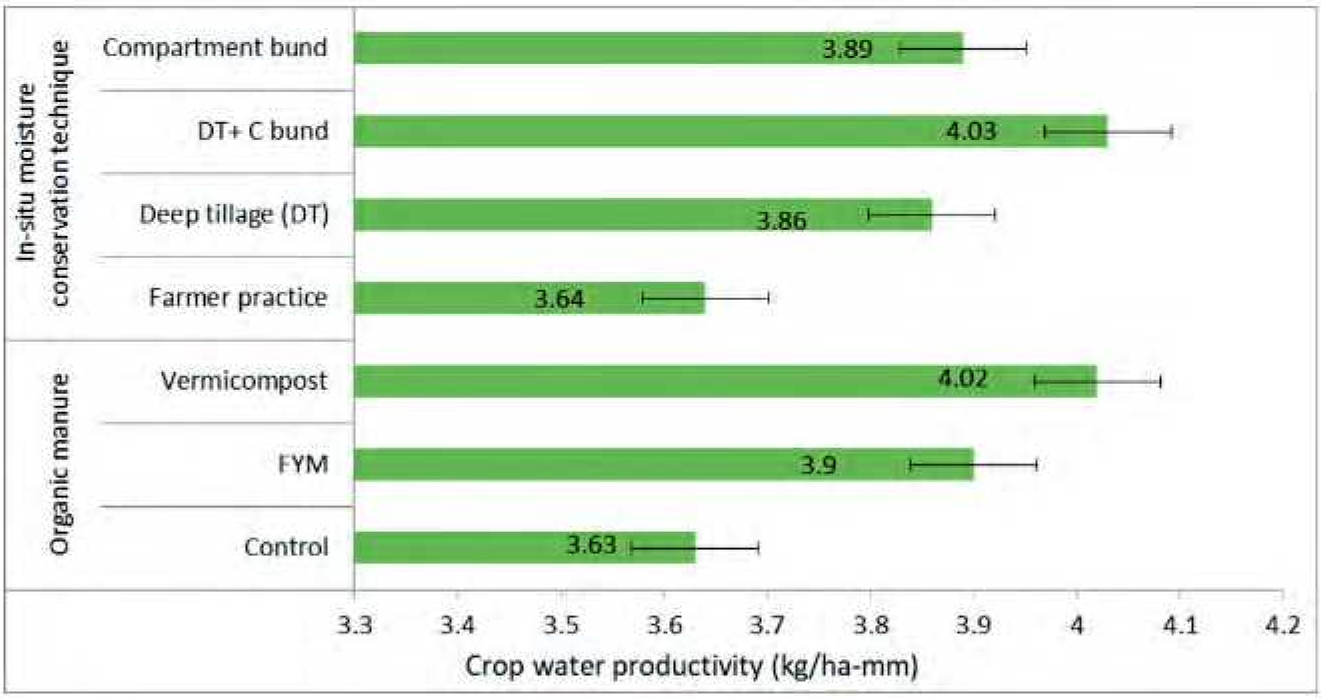


Figure 2.1. Effect of *in-situ* moisture conservation techniques and organic manures on crop water productivity of groundnut

all the groundnut crop growth stages due to *in-situ* harvesting and retention of rain water in the compartmental bunds as compared to deep tillage and farmers practice. Among organic manures, application of FYM @ 5 t/ha retained significantly higher soil moisture in the soil profile in all the crop growth stages as compared to control plots. Likewise, application of

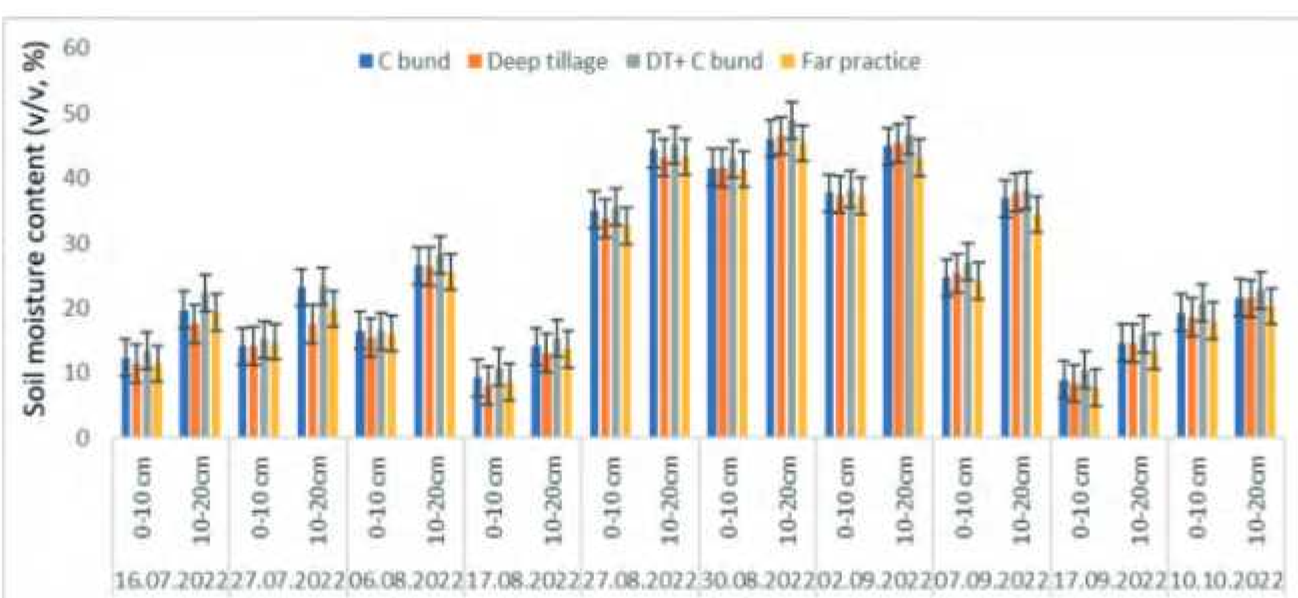


Figure 2.2: Effect of *in-situ* moisture conservation techniques on soil moisture content in groundnut

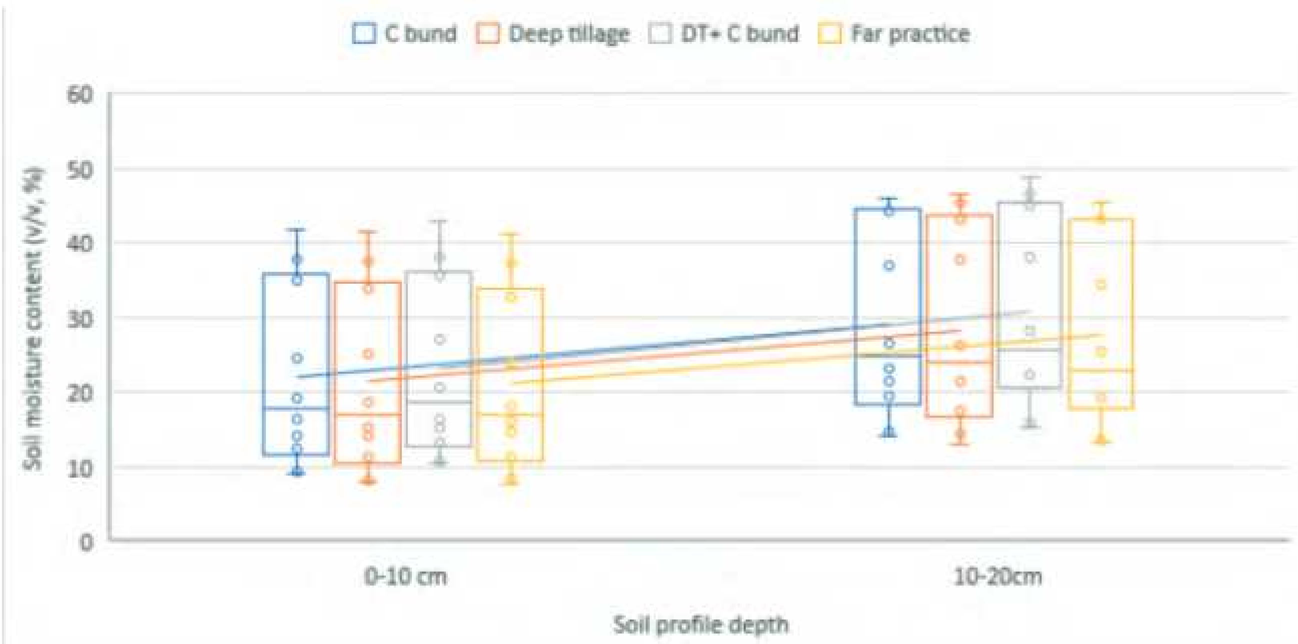


Figure 2.3. Variation in soil moisture content in different soil profile depths under *in-situ* moisture conservation techniques in groundnut

vermicompost also exhibited slightly higher soil moisture content over control plots (Figure 2.3). Among interaction effects, adoption of deep tillage with compartment bunds (DTCB) coupled with application of FYM @ 5 t/ha recorded significantly higher soil moisture content during the groundnut crop establishment to harvesting as compared to

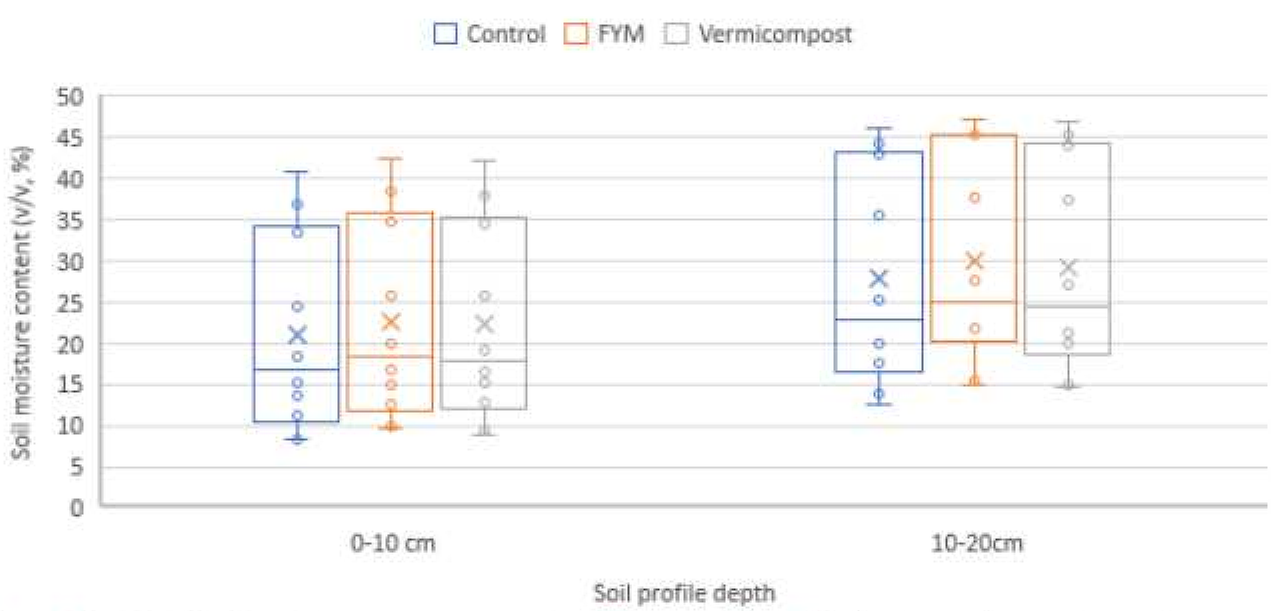


Figure 2.4. Variation in soil moisture content in different soil profile depths under *in-situ* moisture conservation techniques in groundnut

other combinations. Concurrently groundnut crop faced severe drought stress during early August and mid of September months, therefore soil moisture content has reached to permanent wilting point. During severe drought stress period also, adoption of compartmental bunding along with organic manures like FYM and vermicompost retained higher soil moisture content resulted in enhancing groundnut seed yield significantly. Significant variation in soil moisture content in different soil profile depths under *in-situ* moisture conservation techniques in groundnut was observed during the crop

Water harvesting through compartmental bunds

season. In all the crop growth stages, lower soil layer of 10-20 cm had significantly higher soil moisture content in DTCB (**Figure 2.3**) and application of FYM at 5 t/ha (**Figure 2.4**) over 0-10 cm soil profile depth. Thus, during stress, aforesaid treatments had lower soil moisture depletion over others.

Modified agronomic practices for enhancing efficiency of hydrogels in groundnut under arid-ecologies of Andhra Pradesh

The 2[nd] year experiment conducted during *kharif* season of 2022 at ICAR-DGR, RRS, Ananthapur, Andhra Pradesh and consisted of ten treatments having two types of hydrogels (SPG 1118 and Aaridhar) with three types of method of application (soil application, slurry application and seed treatment) along with FYM, no gypsum application and control plots using RBD with three replications. Sowing was done on 07[th] July 2022 using Kadiri Lepakshi (K1812) variety of groundnut planted at a planting interval of 30×10 cm in a gross plot area of 6 × 4.5 m=27m^2. Harvesting was done on 17.10.2022. The recommended rate of fertilizer used was 20:40:50 kg NPK/ha along with gypsum application (500 kg/ha) at 25 days after sowing.

Results of the study showed that, method of application of hydrogels along with FYM and no gypsum application influenced significantly on yield attributes, yield and crop water productivity of groundnut during 2022 crop season (Table 2.2). Adoption of seed treatment technique for SPG-1118 hydrogel exhibited significantly higher pod yield (1978 kg/ha), haulm yield (4566 kg/ha), kernel yield (1404 kg/ha), shelling percentage (71.0%), 100-seed weight (38.2g) and crop water productivity (4.80 kg/ha-mm) as compared to control plots and other aaridhar hydrogel applied plots. However, it was at par with soil application of SPG 1118 + FYM and only soil application of SPG-1118 plots. However, harvest index was found to be non-significant. Seed treated with hydrogels exhibited highest seed germination percentage as compared to soil and slurry application methods. Likewise, Seed treatment of SPG-1118 hydrogel produced significantly higher crop water productivity of groundnut (4.80 kg/ha-mm) as compared to other techniques (**Figure 2.5**) and it was at par with SPG-1118+ FYM applied plots.

Soil moisture content: application of novel hydrogel like SPG-1118 along with FYM @ 5 t/ha exhibited significantly higher soil moisture content at all the growth stages of groundnut as

Table 2.2. Effect of method of hydrogel application on yield attributes, yield and crop water productivity (CWP) of groundnut

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Kernel yield (kg/ha)	Shelling %	100 Seed weight	Harvest index
Aaridhar hydrogel (no gypsum)	1596	3990	1040	65.2	35.2	40.1
Control	1574	3750	1040	66.1	36.1	41.9
Slurry application of Aaridhar	1629	3872	1127	69.3	36.6	42.2
Slurry application of SPG-1118	1771	4061	1194	67.1	37.6	43.7
Soil application of Aaridhar	1604	3844	1104	68.9	36.7	41.7
Soil application of SPG-1118	1829	4356	1280	70.0	37.7	42.0
Soil application of SPG-1118+FYM @ 5t/ha	1889	4356	1335	70.6	38.6	43.4
Soil application of SPG-1118 (no gypsum)	1621	4002	1092	67.4	35.8	40.9
Seed treatment of Aaridhar	1681	4023	1106	65.8	37.0	41.8
Seed treatment of SPG-1118	1978	4566	1404	71.0	38.2	43.3
Sem±	67	137	51	1.3	0.7	1.5
LSD ($p<0.05$)	**199**	**406**	**150**	**3.7**	**2.2**	**NS**

compared to alone application of aaridhar hydrogel, SPG-1118 and control plots (**Figure 2.6**). Among hydrogels, application of novel hydrogel like SPG-1118 retained higher soil moisture content at all the growth stages of groundnut as compared to aaridhar hydrogel, and control plots. However, method of application of hydrogels like seed treatment, slurry application and soil

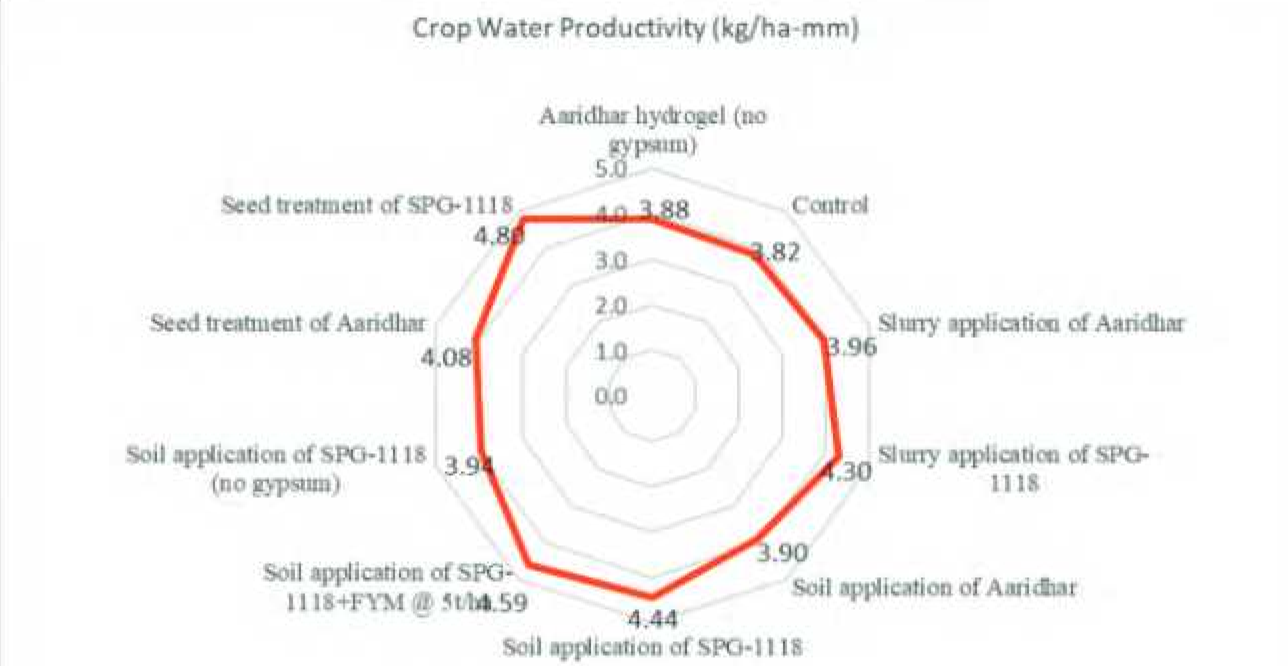


Figure 2.5. Effect of method of hydrogel application on crop water productivity of groundnut.

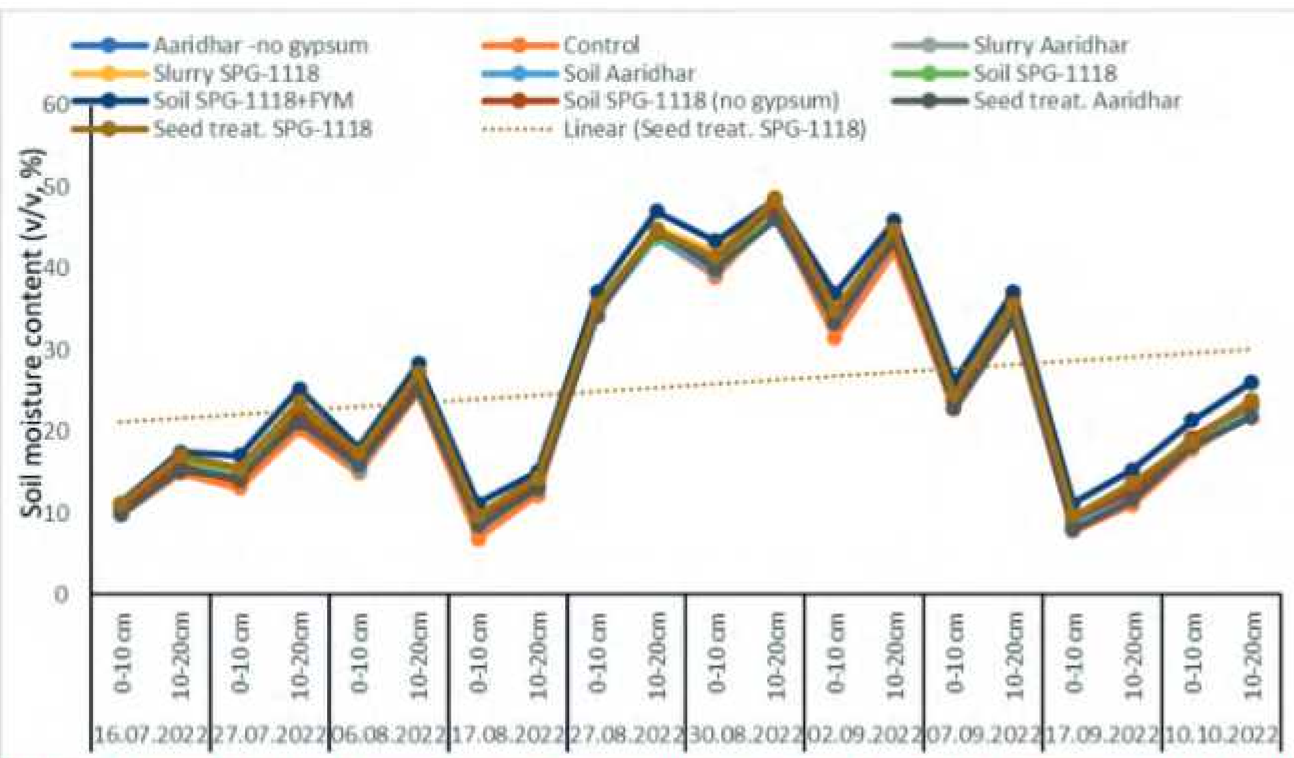


Figure: 2.6: Soil moisture content at different growth stages of groundnut as compared to alone application of aaridhar hydrogel, SPG-1118 and control plots

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Field view of hydrogel experiment

application had slight variation in soil moisture content and found to be non-significant. Contrastingly, at the time of physiological maturity and harvesting stages of groundnut, hydrogels did not show significant response on soil moisture content.

'Habitat adapted' endophytes:

The endophytic isolates obtained from Anantapur (379 new putative endophytes and 47 putative rhizobia) and rhizobia isolated from groundnut grown under extreme drought situation were purified to single colony types. One hundred ninety-three endophytes were evaluated for tolerance to moisture-deficit stress using PEG gradient. While 87 of these isolates could tolerate upto -4.0 MPa, rest 106 could tolerate upto -3.0 MPa.

Moisture-deficit stress tolerant rhizobia

In summer 2022, 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

Table 2.3. Evaluation of moisture-deficit stress tolerant groundnut rhizobia for enhancing yield of groundnut (cv. TG37A) during Summer 2022

Treatment	HY (kg/ha)	PY (kg/ha)	SOT (%)	HKM (g)	NN/p
Control	4183	1947	60.96	38.19	32.3
K508	4433	2050	62.18	39.34	38.7
K515	4663	2313	64.25	41.17	49.0
K521	4537	2253	65.16	41.40	50.3
K557	4647	2320	65.13	41.77	53.7
NC92	4277	2040	62.31	39.23	40.7
CD (0.05)	**266**	**271**	**0.85**	**1.79**	**6.1**

potential of -2.5 MPa to -3.5 MPa. Application of K515, K521 and K 557 significantly enhanced the pod and haulm yield, HKW, and shelling out-turn of groundnut (cv TG37A). The nodulation by the inoculant strains also improved significantly by inoculation of K515, K521, and K557 (**Table 2.3**). The effective isolates will be further evaluated in AICRP-G system.

Determination of temperature and soil moisture threshold for CAM transition in groundnut

A total of seven variants of TG37A (DGRMB3, DGRMB5, DGRMB17, DGRMB19, DGRMB24, DGRMB31 and DGRMB32) were evaluated alongside TG37A with two levels of irrigations, two and ten, after emergence. It was found that whereas reduction of biomass was around 49.3% in TG37A with two supplementary irrigations against normal condition, C3-CAM transited variants showed biomass reduction from 29.5-37% in similar conditions. Least reduction in biomass was obtained with DGRMB32 (**Table 2.4**).

Regarding expression of CAM modules, analysis of samples of previous years indicated 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. Variation among CAM variants have been found in terms of expression of genes involved in different modules of CAM. Monitoring of the soil moisture at 5 days interval indicated that soil moisture at 15 cm zone ranged, on an average, from 11.85 to 11.08% during 25-30 days of withholding of water, in groundnut when C3 groundnut start expressing CAM modules. The maximum air temperature during 25-30 days of moisture-deficit stress was between 39-41.5°C with max. RH of 55-75% at 14:30 h. The soil temperature during the same period at 14:30 h at 15 cm zone was 36.8-40.2°C.

Table 2.4. Evaluation of CAM transited variants at different level of supplementary irrigation

	Haulm Yield (kg/ha)			**Pod yield (kg/ha)**			**Biomass reduction**		
Treatments	2	10	**Mean**	2	10	**Mean**	Drought	Irrigated	Reduc. (%)
TG37A	1957	3710	**2833**	1055	2227	**1641**	3012	5937	49.27
DGRMB17	2700	3813	**3257**	1653	2663	**2158**	4353	6477	32.78
DGRMB19	2833	3917	**3375**	1743	2673	**2208**	4577	6590	30.55
DGRMB24	2773	3833	**3303**	1790	2747	**2268**	4563	6580	30.65
DGRMB3	2387	3840	**3113**	1613	2507	**2060**	4000	6347	36.97
DGRMB31	2767	3793	**3280**	1557	2643	**2100**	4323	6437	32.83
DGRMB32	2770	3727	**3248**	1780	2723	**2252**	4550	6450	29.46
DGRMB5	2733	3777	**3255**	1743	2710	**2227**	4477	6487	30.99
Mean	**2615**	**3801**	**3208**	**1617**	**2612**	**2114**			
LSD (0.05)									
Treatments	**226**			**118**					
Level of Irrigation	**89**			**60**					
TXL	**250**			**169**					

Endophytes for alleviation of drought stress and saving of irrigation water

To ascertain whether irrigation water can be saved by application of endophytic bacteria in groundnut at all level of irrigations. The maximum benefit was accrued due to inoculation of *Bacillus firmus* J22N followed by *Bacillus subtilis* REN51N for pod yield **(Table 2.5)**.

Table 2.5. Interactive effects of irrigation and endophytes on pod yield of groundnut, TG37A during summer 2022 and saving of water

Haulm yield (kg/ha)						**Pod yield (kg/ha)**				
Treatments	**No of supplementary Irrigations**					**No of supplementary Irrigations**				
	3	4	5	10	**Mean**	3	4	5	10	**Mean**
Control	3083	3543	3857	4330	**3703**	1543	1768	2040	2302	**1913**
REN47N	3493	3743	3970	4480	**3922**	1823	2017	2370	2490	**2175**
SEN29N	3680	3830	4437	4652	**4150**	1833	1987	2360	2540	**2180**
J20N	3525	3923	4507	4700	**4164**	1883	1932	2433	2487	**2184**
REN51N	3603	3920	4527	4723	**4193**	1858	2048	2450	2595	**2238**
J22N	3630	4020	4567	4730	**4237**	1965	2053	2477	2602	**2274**
Mean	**3503**	**3830**	**4311**	**4603**	**4061**	1818	1968	2355	2503	**2161**
LSD (0.05)										
Treatments	**127**					**116**				
Level of irrigation	**75**					**73**				
TXL	**184**					**178**				

summer groundnut, experiment was conducted with five endophytes (*Bacillus firmus* J22, *Bacillus subtilis* R51, *Pseudomonas pseudoalcaligenes* SEN29, *Acinetobacter junii* J20 and *Pseudoxanthomonas mexicana* REN47) during summer 2021 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 five 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

Evaluation of germplasm accessions for drought tolerance and CAM expression

From mini-core germplasm accessions, nineteen accessions were identified during summer 2022 by imposing drought stress of 105 days for further studies on the basis of superior pod yield (>5.0 g/plant). These 19 accessions along with GG7, TG37A, JL501, DGRMB24 and DGRMB32 as checks were evaluated in a replicated trial during summer 2022 by imposing 60 days of moisture deficit stress after emergence. The stress was withdrawn by providing irrigations at 60th and 80th days of emergence. Germplasm accessions

NRCG14324, NRCG14351, NRCG14365, NRCG14425, NRCG14461, NRCG14430, and NRCG14501 gave pod yield (1245-1333 kg/ha) have at par yield with DGRMB24 (1384 kg/ha) and DGRMB32 (1418 kg/ha) **(Table 2.6)**. Night-time carboxylation in these genotypes ranged from 3.24 µmole/m^2/s to 7.53 µmole/m^2/s.

Table 2.6. Evaluation of germplasm accessions for drought tolerance and CAM expression (irrigation only at 60 days after emergence)

Treatments	PY (kg/ha)	Treatments	PY (kg/ha)
GG7	423	NRCG14419	683
JL501	892	NRCG14425	1287
DGRMB24	1384	NRCG14430	1328
DGRMB32	1418	NRCG14447	602
NRCG14324	1275	NRCG14448	846
NRCG14344	999	NRCG14456	658
NRCG14348	697	NRCG14461	1245
NRCG14351	1314	NRCG14470	632
NRCG14355	282	NRCG14472	766
NRCG14362	530	NRCG14501	1285
NRCG14365	1334	TG37A	730
NRCG14369	775	CD (0.05)	218
NRCG14398	888	**CV (%)**	**14.3**

Isolation of new endophytes from germplasm accessions imposing moisture-deficit stress

A total of 68 putative endophytes (56 root endophytes and 12 stem endophytes) were isolated from nine germplasm accessions (NRCG 14325, NRCG 14351, NRCG 14362, NRCG 14369, NRCG 14398, NRCG 14419, NRCG 14456, NRCG 14461, and NRCG 14501) by imposing drought of 55 days. All the isolates were purified and will be evaluated *in vitro* for extent of tolerance to moisture-deficit stress in PEG gradients and will be characterised for plant growth promoting traits.

Cross-talk between endophytes and groundnut genotypes while alleviation of drought stress and modulation of enzymes of CAM pathways

An experiment was set up using with *Bacillus firmus* J22N and two CAM variants, DGRMB5 and DGRMB19, imposing two levels of irrigations, two (55 and 80 DAE) and ten after emergence. However, samples were collected in diel cycle (24 h) at 3 h interval at 30, 45, 55, and 60 after emergence for biochemical traits and expression of CAM modules. Night-time carboxylation was recorded at 45 DAE. P_N varies from 2.8 µmole/m^2/s to 6.87 µmole/m^2/s in different treatment in drought stress. Application of endophytes improved in carboxylation during night in drought stress. Yield parameters were also recorded at harvest. There was no significant difference among the treatments in both drought and irrigated condition in improving pod and haulm yield. The interaction was non-significant **(Table 2.7)**. The cDNAs of the samples collected at 30, 45, and 55 DAE were prepared and expression of genes in carboxylation and decarboxylation modules are underway besides genes involved in circadian rhythm.

Table 2.7. Effect of endophyte on alleviation of drought stress and yield in CAM variants (supplementary irrigations at 55 and 80 days of emergence)

Haulm Yield (kg/ha)				**Pod Yield (kg/ha)**		
	Level of irrigation			**Level of irrigation**		
Treatment	2	10	**Mean**	2	10	**Mean**
DGRMB19	3200	4300	**3750**	1650	2493	**2072**
DGRMB5	3333	4467	**3900**	1680	2517	**2098**
J22N + DGRMB19	3507	4500	**4003**	1847	2597	**2222**
J22N + DGRMB5	3490	4453	**3972**	1923	2630	**2277**
Mean	**3383**	**4430**	**3906**	**1775**	**2559**	**2167**
LSD (0.05)						
Treatment	**NS**			**NS**		
Level of irrigation	**70**			**76**		
TXL	**NS**			**NS**		

Effect of mulching, anti-transparent, endophytic bacteria & no. of irrigations on groundnut yield and growth parameters

The experiment was conducted in summer 2022, at DGR Junagadh experimental plot N6 with twelve treatments [T1:5 irrigations; T2:Kaolin+mulch+ 5 irrigations; T3:Mulch + Endophyte + 5 irrigations; T4-Kaolin + endophyte + 5 irrigations; T5:Kaolin+mulch+endophyte + 5 irrigations; T6:7 irrigations; T7:Kaolin + mulch + 7 irrigations; T8:Kaolin+Endophyte + 7 irrigations; T9:Mulch + endophyte + 7 irrigations; T10:Kaolin+ mulch + endophyte + 7 irrigations; T11:11 irrigations; T12:Kaolin + mulch + endophyte + 9 irrigations] and 3 replications in RBD. 25 kg N, 50 kg P_2O_5 and 30 kg K_2O/ha were supplied as basal dose. TG 37A, a Spanish bunch groundnut variety was used for sowing. Irrigations were chosen based on the critical stages of crop growth. Antitranspirant kaolin 6% spray was done at 30DAS, 50 DAS and 70 DAS. Endophyte is applied through seed treatment at the time of sowing and furrow application at 45 DAS. Wheat straw mulch @ 10 t/ha was applied 15-20 DAS. Significantly higher pod yield was obtained with T11 having 11 irrigations which was at par with T8 and T12. When 5 irrigations were applied along with kaolin & mulch, it increased pod yield by 34% (T2 vs T1) similarly, when kaolin, mulch & endophyte were applied along with 5 irrigations the pod yield increased by 49% (T5 vs T1). When 7 irrigations were applied compared to 5 irrigations alone, the pod yield increased by 18.8% (T6 vs T1). It was in general observed that proline content reduced in plants where the mulch is applied. Imposing the drought has affected the chlorophyll content and RWC severely, where the lowest values were observed in T1 (22.4 µg/cm^2 and 55.6%). Shoot height, root height, proline content, haulm yield and SLA were also significantly affected due treatment effects **(Table 2.8)**. Soil moisture content at 45 DAS (0 to 30 cm depth) ranged from 6.50 to 11.53% and the highest value was observed in T11 which was at par with T10 and T12, while at 90 DAS, it ranged from 10.63 to 15.66% and the highest value was observed in T11. There was a significant effect of mulch in increasing the soil organic carbon percent (%) by

Table 2.8: Effect of different treatments on growth, yield and physiological attributes

Treatments	Shoot ht. (cm)	Root ht. (cm)	Pod yield (kg/ha)	Haulm yield (kg/ha)	Proline content (ppm)	chlorophyll content (µg/cm2)	RWC (%)	SLA (cm^2/g)
T1	23.2	10.6	1195	2749	84	22.4	55.6	142
T2	28.8	11	1606	3694	41	37.5	61.4	215
T3	26.4	9.6	1710	3933	43	36.4	59.3	380
T4	26.3	10.5	1428	3284	89	35.5	64.3	317
T5	30.6	8.9	1780	4094	43	34.2	59.6	251
T6	32.0	7.6	1420	3266	196	31.8	64.6	161
T7	33.8	8.2	1859	4276	81	28.9	59.9	229
T8	34.2	8.9	2008	4618	185	42.8	65.5	231
T9	36.4	7.6	1605	3692	89	38.5	67.3	266
T10	34.8	8.4	1833	4216	113	38.9	69.8	272
T11	30.3	8.6	2142	4927	45	37.1	75.3	315
T12	30.8	8.1	2103	4837	47	37.7	71.2	238
LSD(P=0.05)	**4.1**	**1.23**	**231**	**516**	**21.2**	**7.4**	**4.3**	**38.6**

Table 2.9: Effect of different treatments on soil physicochemical properties (0-30 cm soil depth)

Treatments	Av. N (kg/ha)	Av. P (kg/ha)	Av. K (kg/ha)	OC (%)	% Macro aggregates	% Micro aggregates	Soil Moisture (%) at 45 DAS	Soil Moisture (%) at 90 DAS
T1	364	7.4	269	0.42	50.4	49.6	6.50	10.63
T2	351	7.6	265	0.62	39.8	60.2	8.25	12.36
T3	389	8.5	282	0.68	29.7	70.3	8.61	13.99
T4	426	8.5	262	0.54	35.2	64.8	8.93	13.06
T5	389	10.7	273	0.60	57.3	42.7	9.67	14.74
T6	339	7.6	244	0.46	40.2	59.8	7.99	12.12
T7	426	11.6	260	0.63	38.0	62.0	9.17	14.30
T8	376	8.9	232	0.58	34.2	65.8	8.56	14.69
T9	414	8.5	417	0.67	34.6	65.4	10.53	14.66
T10	314	10.2	305	0.75	39.2	60.8	10.87	15.03
T11	514	7.8	269	0.56	29.7	70.3	11.53	15.66
T12	477	8.5	271	0.68	33.7	66.3	10.50	14.63
LSD(P=0.05)	**64**	**1.9**	**57**	**0.11**	**4.6**	**6.7**	**2.40**	**2.84**

T1:5 irrigations; T2:Kaolin+mulch+ 5 irrigations; T3:Mulch+Endophyte + 5 irrigations; T4-Kaolin +endophyte + 5 irrigations; T5:Kaolin+mulch+endophyte + 5 irrigations; T6:7 irrigations; T7:Kaolin+ mulch+ 7 irrigations; T8:Kaolin+Endophyte+7 irrigations; T9:Mulch+endophyte + 7 irrigations; T10:Kaolin+ mulch + endophyte + 7 irrigations; T11:11 irrigations;T12:Kaolin+mulch+endophyte + 9 irrigations; RWC: Relative water content; SLA: Specific leaf area; OC: Organic carbon

0.15 to 0.2%. Percent macro-aggregates were found to be significantly high (57.3%) when kaolin + mulch + endophyte + 5 irrigations were applied. Similarly, percent micro-aggregates were found to be significantly high (70.3%) when mulch + endophyte + 5 irrigations were applied. Available NPK in soil was also significantly influenced by the treatment effects **(Table 2.9)**

Project 3: Optimization of mineral nutrition in Groundnut for better human and soil health

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Micronutrient nutrition and their biofortification in groundnut

Identification of Fe chlorosis efficient cultivars and validation of already identified Fe chlorosis tolerant ABLs

A field experiment comprising of 15 released cultivars of groundnut and 15 advanced breeding lines was undertaken for evaluation of iron deficiency tolerance in them (Figure 3.1). PBS 22040 and 29192 were the best performing advanced breeding lines in terms of their physiological, biochemical and molecular attributes under Fe deficiency in the soil. Among the released cultivars, Kadiri Lepakshi, Girnar 2, GJG 32, KDG 123, KDG 128, SG 99 and GJGHPS 2 recorded their VCR score as 1 and SPAD values ranging 40-44. Girnar 2 accumulated maximum chlorophyll (Chl a: 7.34 μg ml^{-1} and Chl b: 0.95 μg ml^{-1}) and GJGHPS 2 recorded maximum carotenoid content (2.09 μg ml^{-1}).

Resveratrol content recorded a significant increase in GJG 32 (8.6 ppm), GJGHPS2 (9.2 ppm), KDG 128 (11.5 ppm) and GJG 9 (7.3 ppm) over the susceptible check NRCG 7472 (3.6 ppm), during Fe deficit edaphic conditions.

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Figure 3.1: Field experiment showing varietal response to iron (Fe) deficiency

Transporters for Fe uptake at root plasma membrane (PM)

The qRT-PCR for the gene expression of Fe transporters namely *NRAMP*3, *ZIP* 5 and *YSL* 3 revealed 2-3-fold over-expression of *YSL 3* in PBS 22040 and 29192, over the susceptible check NRCG 7472 while *NRAMP3* recorded 1.5-fold over-expression in the periplasmic membrane of roots of PBS 22040 and PBS 29192 over the susceptible check NRCG 7472 **(Figure 3.2)**. However, expression of ZIP 5 was not significant.

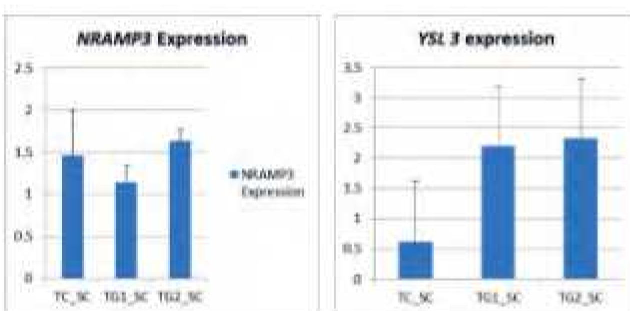

Figure 3.2: Expression of Fe transporters under Fe deficit edaphic conditions
TC: Tolerant check (ICGV 86031); TG1: PBS 29192; TG2: PBS 22040; SC: Susceptible check NRCG 7472

Evaluation of the effect of combined application of $ZnSO_4$ and microbial sources on Zn uptake and availability

A field experiment was envisaged during *Rabi-summer* 2022, to examine the effect of application of different zinc (Zn) on kernel and leaf Zn enrichment and availability, either individually

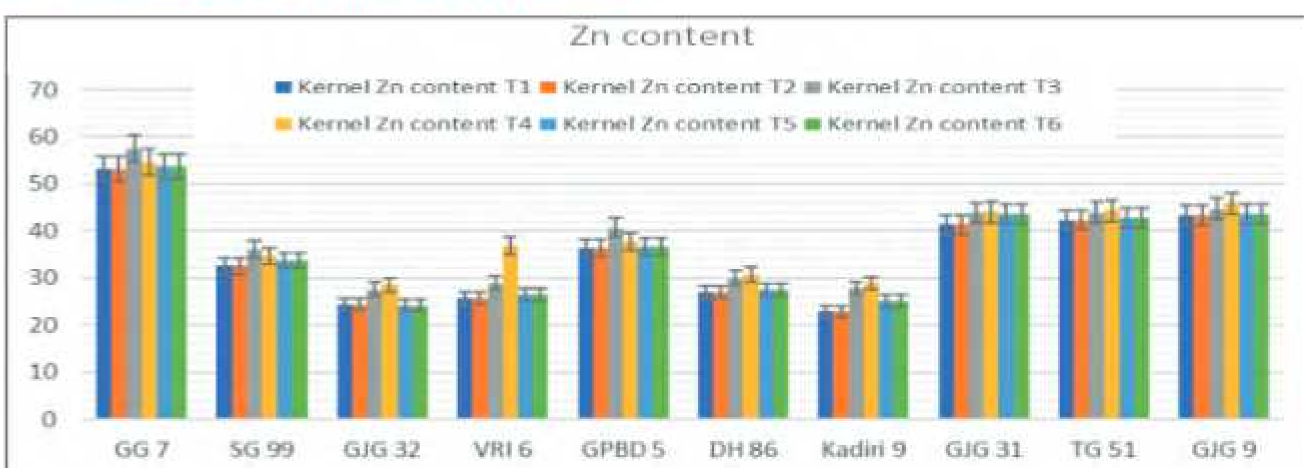

Figure 3.3: Zn enrichment in kernels upon treatment with different Zn sources

or in combination. The treatments comprised of T1: control; T2: $ZnSO_4$; T3: $ZnSO_4$ + BM 6; T4: $ZnSO_4$ + FP 82; T5: BM 6; T6: FP 82. The application of $ZnSO_4$+ BM 6 and $ZnSO_4$+ FP 82 recorded a significant increase in kernel Zn content (Figure 3.3) but the leaves did not show any significant increase or decrease in Zn content when compared to the control. Furthermore, the phytate reduction with combined application was at par with that of individual Zn solubilizing microbes with slight variations.

Nutrient management in groundnut through microbial solubilization and mobilization

Improving Zn, Mn and K availability and yield of groundnut

Performance of Zinc solubilizing bacteria (ZSB) in field

Five efficient Zn-solubilising microbial cultures were evaluated in a field trial during summer 2022 to study the effects of inoculation of groundnut with Zn-mobilising bacterial cultures on growth, yield and Zn uptake.

Seed inoculation with four of the isolates *Enterobacter cloacae* ZM3, *Enterobacter cloacae* subsp. *dissolvens* strain ZM-7, *Enterobacter cloacae* subsp. *dissolvens* strain ZM-9 and *Acinetobacter oleivorans* strain ZM-12 resulted in significant increase **(Table 3.1)** in pod yield (17.5% with ZM-12, at par with ZM-3, ZM-7 and ZM-9). These three isolates also resulted in enhancement of haulm yield, shelling outturn and hundred kernel mass. Inoculation with rest of the isolate resulted in pod yield at par with that of control.

In a similar field trial conducted during *kharif* 2022, seed inoculation three isolates resulted in significant increase **(Table 3.2)** in pod yield (16% with ZM-9, at par with ZM-12 and ZM-7).

Thus, these zinc-solubilising bacterial cultures can be used for enhancing yield of groundnut, along with increasing the uptake of Zn.

Performance of Potash solubilizing bacteria (KSB) in field

Five efficient K-solubilising bacterial cultures were evaluated in a field trial during summer 2022 to study the effects of inoculation of groundnut with K-mobilising bacterial cultures on growth, yield and K uptake. Seed inoculation with three of the isolates, *Acinetobacter lactucae* strain KM5-2, *Acinetobacter lactucae* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9 resulted in

Table 3.1. Effect of inoculation of Zn- solubilizing bacteria on the growth and yield of groundnut in field condition during summer 2022 (cv TG37A)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
Control	2127	3387	63.22	40.77
Enterobacter cloacae ZM3	2423	3727	64.68	42.80
Enterobacter cloacae subsp. *dissolvens* ZM6	2330	3403	63.32	40.55
Enterobacter cloacae subsp. *dissolvens* ZM7	2463	3873	65.11	41.90
Enterobacter cloacae ZM9	2473	3860	64.92	42.20
Acinetobacter oleivorans ZM12	2500	3897	65.08	43.05
CD(0.05)	**233**	**269**	**0.83**	**0.92**

Table 3.2. Effect of inoculation of Zn- solubilizing bacteria on the growth and yield of groundnut in field condition during *kharif* 2022 (cv TG37A)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
Control	1870	3387	61.98	33.59
Enterobacter cloacae ZM3	1893	3340	62.50	33.50
Enterobacter cloacae subsp. *dissolvens* ZM6	1848	3267	62.22	33.75
Enterobacter cloacae subsp. *dissolvens* ZM7	2110	3627	64.80	36.00
Enterobacter cloacae ZM9	2170	3713	65.67	36.63
Acinetobacter oleivorans ZM12	2103	3597	63.10	36.34
CD (0.05)	**182**	**310**	**2.55**	**1.27**

Table 3.3. Evaluation of K- solubilizing bacteria on growth and yield of groundnut (cv TG37A) during summer 2022 (field trial)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
CONTROL	2203	4093	63.35	39.43
Acinetobacter lactucae strain KM5-2	2540	4427	65.92	42.24
Acinetobacter oleivorans strain KM6-1	2390	4170	63.99	40.27
Acinetobacter lactucae strain KM8-1	2267	4267	63.42	40.20
Acinetobacter lactucae strain KM8-2	2500	4747	66.09	42.28
Pseudomonas taiwanensis strain KM-9	2557	4437	65.81	41.73
CD (0.05)	**208**	**354**	**0.85**	**1.97**

Table 3.4. Evaluation of K- solubilizing bacteria on growth and yield of groundnut (cv TG37A) during *kharif* 2022 (field trial)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
CONTROL	1810	3033	61.90	34.60
Acinetobacter lactucae strain KM5-2	2216	3647	67.03	36.90
Acinetobacter oleivorans strain KM6-1	1942	3067	61.93	35.30
Acinetobacter lactucae strain KM8-1	1976	3117	62.60	34.67
Acinetobacter lactucae strain KM8-2	2099	3427	64.70	36.85
Pseudomonas taiwanensis strain KM-9	2081	3547	64.93	37.40
CD (0.05)	**234**	**380**	**2.16**	**2.84**

significant increase in pod yield (Table 3.3), the maximum with KM-9 (16%). The isolates KM8-2 and KM-9 also resulted in enhancement of shelling outturn and hundred kernel mass.

During *kharif* 2022, seed inoculation with *Acinetobacter lactucae* strain KM5-2, *Acinetobacter lactucae* strain KM8-2 and *Pseudomonas taiwanensis* strain KM-9 resulted in significant increase **(Table 3.4)** in pod yield of groundnut (22% with KM5-2).

These K-solubilising bacterial isolates can be used for seed inoculation for improving mobilization of potash, along with yield enhancement.

Performance of Mn solubilizing bacteria in potted condition

A pot trial was conducted during summer 2022 to evaluate the inoculation effects of manganese-solubilizing bacterial isolates on growth, yield and Mn-mobilization in groundnut. Out of 19 Mn-mobilizing bacterial isolates tested, inoculation with 9 isolates resulted in significant increase in pod yield (g/p), ranging from 9.8 to 10.6%. The maximum increase was obtained with isolate ZM-4, followed by Mn12-1 and KM8-1. Inoculation with these isolates also resulted in significant increase in haulm yield of groundnut.

Performance of Manganese solubilizing bacteria in field

Five efficient Mn-solubilising bacterial cultures were evaluated in a field trial during *kharif 2022* to study the effects of inoculation of groundnut with Mn-mobilising bacterial cultures on growth and yield. Seed inoculation with three of the isolates, *Brevibacillus parabrevis* Mn-1, *Brevibacterium* sp. Mn12-1, and *Alcaligenes* sp. Mn12-2 resulted in significant increase in pod yield **(Table 3.6)**, the maximum with Mn12-2 (22%), at par with Mn-1 and Mn12-1.

Table 3.5. Evaluation of Mn-solubilizing bacteria in enhancing growth and yield of groundnut during summer 2022 (cv. TG37A)

Treatment	PY (g/p)	HY (g/p)
Control	8.35	4.60
Mn Control	8.70	5.13
Bacillus putida DAPG-5	8.86	5.43
Bacillus polymyxa H-5	8.66	5.38
Pseudomonas boreopolis strain KM5-1	8.78	5.49
Acinetobacter oleivorans strain KM6-1	9.48	6.05
Acinetobacter oleivorans strain KM6-2	9.08	5.37
Acinetobacter lactucae strain KM8-1	9.55	6.07
Acinetobacter lactucae strain KM8-2	8.55	5.35
Brevibacillus parabrevis Mn-1	9.53	6.07
Brevundimonas diminuta Mn11-2	8.81	5.04
Brevibacterium sp. Mn12-1	9.55	5.82
Alcaligenes sp. Mn12-2	9.48	6.10
Brevibacillus formosus Mn2-1	9.51	5.73
Bacillus sp. Mn9	9.42	5.79
Bacillus subtilis R51	8.71	5.31
Pseudomonas putida S16	8.54	5.07
Enterobacter cloacae subsp. *dissolvens* strain ZM-11	9.41	6.10
Acinetobacter oleivorans strain ZM-12	8.90	5.38
Acinetobacter calcoaceticus strain ZM-35	8.58	5.46
Acinetobacter pittii strain ZM-4	9.62	6.02
CD (0.05)	**0.63**	**0.59**

Groundnut rhizobia for enhancing BNF and yield in groundnut

Twenty-one new isolates of groundnut rhizobia were evaluated in a pot trial during summer 2022 for their efficiency in increasing yield in groundnut. Seed inoculation with 11 isolates (K503, K507, K508, K510, K515, K521, K533, K534, K557, K564, and K565) resulted in significant enhancement of

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Table 3.6. Evaluation of Mn- solubilizing bacteria on growth and yield of groundnut (cv TG37A) during *kharif* 2022 (field trial)

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)
CONTROL	1861	3230	63.90	34.37
Brevibacillus parabrevis Mn-1	2215	3687	65.27	36.33
Brevibacillus formosus Mn2-1	1950	3553	63.03	34.47
Brevundimonas diminuta Mn11-2	1881	3577	63.20	35.20
Brevibacterium sp. Mn12-1	2112	3810	65.60	37.27
Alcaligenes sp. Mn12-2	2280	3840	65.20	36.97
CD (0.05)	208	371	1.02	1.81

Table 3.7. Effect of inoculation of efficiently nodulating and nitrogen fixing strains of groundnut rhizobia on yield of groundnut (cv. TG37A) in potted conditions, summer 2022

Treatments	PY (g/p)	PB (g/p)
Control	4.67	8.17
K503	5.86	9.10
K507	5.27	8.20
K508	5.73	9.23
K509	4.91	8.25
K510	5.97	9.34
K511	4.75	8.60
K514	4.77	8.47
K515	5.78	9.47
K517	4.92	8.15
K520	4.53	8.52
K521	5.85	9.09
K530	4.92	8.60
K532	4.66	8.26
K533	5.92	9.38
K534	5.75	9.17
K554	4.72	8.45
K556	5.22	8.47
K557	5.84	9.66
K564	5.91	9.19
K565	5.57	8.67
K567	5.02	8.55
CD (0.05)	**0.57**	**0.84**

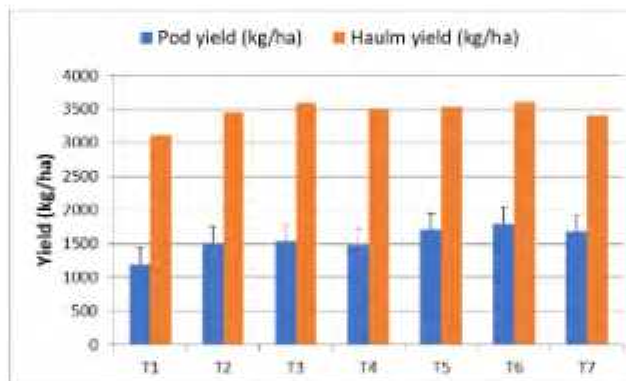
yield, the maximum with K510 (27.8%).

Improving nutrient use efficiency in groundnut and its cropping systems

Summer 2022

Experiment : Effect of PSB and different levels of P on groundnut yield and soil P fractions

The experiment was conducted in summer 2022, with seven treatments [T1:0 kg P_2O_5/ha; T2:25 kg P_2O_5/ha; T3:50 kg P_2O_5/ha; T4:0 kg P_2O_5/ha + DGRC 1; T5:25 kg P_2O_5/ha + DGRC 1; T6:50 kg P_2O_5/ha + DGRC 1; T7:25 kg P_2O_5/ha +DGRC 1+Mulch] and



T1:0 kg P_2O_5/ha; T2:25 kg P_2O_5/ha; T3:50 kg P_2O_5/ha; T4:0 kg P_2O_5/ha + DGRC 1; T5:25 kg P_2O_5/ha + DGRC 1; T6:50 kg P_2O_5/ha + DGRC 1; T7:25 kg P_2O_5/ha + DGRC 1+Mulch

Fig 3.4: Effect of different treatments on pod and haulm yield

three replications in RBD. Twenty five kg N, P_2O_5 as per treatment and 30 kg K_2O/ha was supplied. TG 37A, a Spanish bunch groundnut variety was used for sowing. Wheat mulch @10 t/ha was used. DGRC 1, a phosphate solubilizing bacterial culture was used for seed treatment. Significantly higher pod yield was obtained with T6 (50 kg P_2O_5/ha + DGRC Culture) which was at par with T5 and T7. Haulm yield was observed to be non-significant. Different fractions analyzed were labile P-pool (Resin-Pi, $NaHCO_3$-Pi, and $NaHCO_3$-Po), moderately labile P-pool (NaOH-Pi and NaOH-Po), and non-labile P-pool (HCl-Pi and Residual P).

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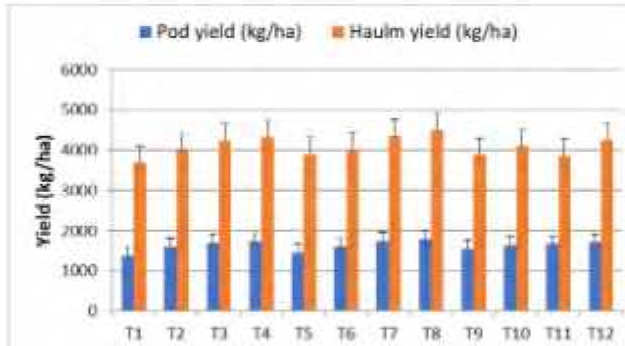
Labile-P consists of P in soil solution and easily exchangeable P from soil lattices. Moderately labile P-pool consists of Fe and Al bound P. Non-labile-P pool consist of Ca and Mg bound P. Before sowing, average total-P pool in soil is 3218 mg P_2O_5/kg soil, labile-P pool is 188 mg P_2O_5/kg soil, moderately labile P pool is 374 mg P_2O_5/kg soil and non-labile-P pool is 2656 mg P_2O_5/kg soil. At harvest, in different treatments total-P pool in soil ranged from 3010-3694 mg P_2O_5/kg, labile-P pool ranged from 174-312 mg P_2O_5/kg soil, moderately labile P pool ranged from 382-568 mg P_2O_5/kg soil and non-labile P-pool ranged from 2454-2978 mg P_2O_5/kg soil. A 29% increase in labile-P pool is noted when DGRC culture is applied over control (T1 vs T5), and 47% increase in labile-P pool is noted when DGRC culture is applied along with 25 kg P_2O_5/ha over T2 (T5 vs T2)



T1:12-32-16 (25 kg P_2O_5/ha); T2:12-32-16 (50 kg P_2O_5/ha); T3:18-46-0 (25 kg P_2O_5/ha); T4:18:46:0 (50 kg P_2O_5/ha); T5:12-32-16 (25 kg P_2O_5/ha) +DGRC 1; T6:12-32-16 (25 kg P_2O_5/ha) + Biostimulant; T7:18-46-0 (25 kg P_2O_5/ha)+ DGRC1; T8:18-46-0 (25 kg P_2O_5/ha)+ Biostimulant; T9:12-32-16 (50 kg P_2O_5/ha) +DGRC 1; T10:12-32-16 (50 kg P_2O_5/ha) + Biostimulant; T11:18-46-0 (50 kg P_2O_5/ha) +DGRC1; T12:18-46-0 (50 kg P_2O_5/ha)+ Biostimulant

Fig 3.5: Effect of different treatments on pod and haulm yield

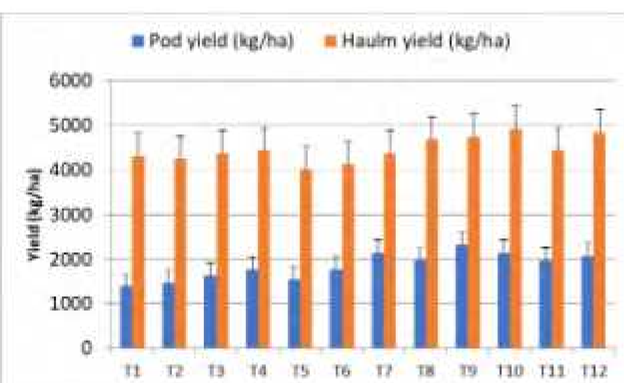
Kharif 2022

Effect of different source of P, P doses, DGRC and biostimulants on soil P fractions and groundnut yield

The experiment was conducted in *kharif* 2022, with twelve treatments [T1:12-32-16 (25 kg P_2O_5/ha); T2:12-32-16 (50 kg P_2O_5/ha); T3:18-46-0 (25 kg P_2O_5/ha); T4:18:46:0 (50 kg P_2O_5/ha); T5:12-32-16 (25 kg P_2O_5/ha) + DGRC 1; T6:12-32-16 (25 kg P_2O_5/ha) + Biostimulant; T7:18-46-0 (25 kg P_2O_5/ha) + DGRC1; T8:18-46-0 (25 kg P_2O_5/ha) + Biostimulant; T9:12-32-16 (50 kg P_2O_5/ha) + DGRC 1; T10:12-32-16 (50 kg P_2O_5/ha) + Biostimulant; T11:18-46-0 (50 kg P_2O_5/ha) + DGRC1; T12:18-46-0 (50 kg P_2O_5/ha) + Biostimulant] and 3 replications in RBD design. 25 kg N, P_2O_5 as per treatment and 30 kg K_2O/ha was supplied. Two P sources were used in the trial is 12-32-16 and 18-46-0, expressed in N: P_2O_5: K_2O terms. Balance N, K_2O which could not be supplied through selected P sources was applied through urea and muriate of potash. Biostimulant used was Dhanzyme gold (Dhanuka) having sea weed extract and humic acid. KDG 128, a Virginia bunch groundnut variety was used for sowing. Biostimulant and DGRC culture were used for seed treatment. Significantly higher pod yield (1805 kg/ha) was obtained with T8 [18-46-0 (25 kg P_2O_5/ha) + Biostimulant] which was at par with T3, T4, T10, T11 and T12. Haulm yield was found to be significantly high (4508 kg/ha) in T8, which was at par with T7. There is 6.5%, 13.3% pod yield increase when biostimulants were applied in T6 vs T1 and T8 vs T3, respectively. Different fractions analyzed were labile P-pool (Resin-Pi, $NaHCO_3$-Pi, and $NaHCO_3$-Po), moderately labile P-pool (NaOH-Pi and NaOH-Po), and non-labile P-pool (HCl-Pi and Residual P). Labile-P consists of P in soil solution and easily exchangeable P from soil lattices. Moderately labile P-pool consists of Fe and Al bound P. Non-labile-P pool consist of Ca and Mg bound P. Before sowing, average total-P pool in soil is 3316 mg P_2O_5/kg, labile-P pool is 163 mg P_2O_5/kg soil, moderately labile P pool is 319 mg P_2O_5/kg soil and non-labile-P pool is 2834 mg P_2O_5/kg soil. At harvest, in different treatments total-P pool in soil ranged from 3297-3412 mg P_2O_5/kg, labile-P pool ranged from 174-318 mg P_2O_5/kg soil, moderately labile P pool ranged from 254-416 mg P_2O_5/kg soil and non-labile P-pool ranged from 2678-2869 mg P_2O_5/kg soil. A 38% increase in labile-P pool is noted when biostimulants is applied (T6 vs T1) and 42% increase in labile-P pool is noticed when DGRC 1 is applied (T5 vs T1)

Effect of varying doses of P, S, DGRC and biostimulant on soil P fractions on groundnut yield

The experiment was conducted in *kharif* 2022, with twelve treatments [T1: 25 kg P_2O_5 + 20 kg S; T2:25 kg P_2O_5 + 40 Kg S; T3:25 kg P_2O_5 + 20 kg S + DGRC1; T4:25 kg P_2O_5 + 20 Kg S + Biostimulant; T5:25 kg P_2O_5 + 40 kg S + DGRC1; T6:25 kg P_2O_5 + 40 Kg S + Biostimulant; T7:50 kg P_2O_5 + 20 kg S; T8:50 kg P_2O_5 + 40 Kg S: T9:50 kg P_2O_5 + 20 kg S + DGRC1; T10:50 kg P_2O_5 + 20 Kg S + Biostimulant; T11:50 kg P_2O_5+ 40 kg S + DGRC1; T12-50 kg P_2O_5 + 40 Kg S + Biostimulant] and 3 replications in RBD design. 25 kg N, P_2O_5, S as per treatment and 30 kg K_2O/ha was supplied. N, P_2O_5, K_2O were supplied through urea, DAP and muriate of potash. KDG 128, a Virginia bunch groundnut variety was used for sowing. Biostimulant used was Dhanzyme gold (Dhanuka) having sea weed extract and humic acid. Biostimulant and DGRC culture were used for seed treatment. Bentonite S having 90% water soluble S is used as S source. Significantly higher pod yield (1805 kg/ha) was obtained with T9 [50 kg P_2O_5+20 kg S+ DGRC1] which was at par with T7, T9 and T12. Haulm yield was found to be significantly high (4926 kg/ha) in T10, which was at par with T8, T9, T11 and T12. Before sowing, average total-P pool in soil is 3284 mg P_2O_5/kg, labile-P pool is 182 mg P_2O_5/kg soil, moderately labile P pool is 308 mg P_2O_5/kg soil and non-labile-P pool is 2794 mg P_2O_5/kg soil. At harvest, in different treatments total-P pool in soil ranged from 3168-3316 mg P_2O_5/kg, labile-P pool ranged from 184-328 mg P_2O_5/kg soil, moderately labile P pool ranged from 266-432 mg P_2O_5/kg soil and non-labile P-pool ranged from 2556-2718 mg P_2O_5/kg soil. A 24% increase in labile-P pool is noted when S dose is increased from 20 kg/ha to 40 kg/ha (T2 vs T1) and 36% increase in labile-P pool is noticed when DGRC 1 is applied with higher S dose i.e., 40 kg/ha (T5 vs T1)



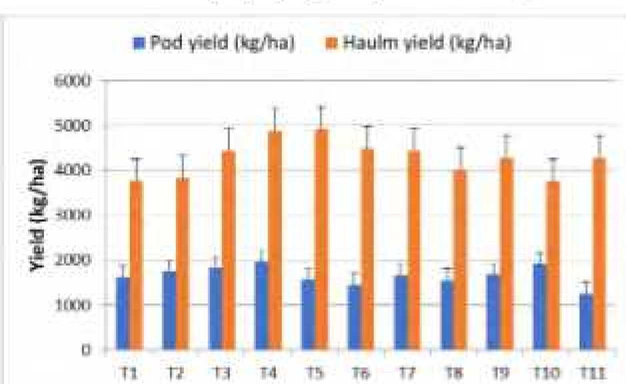
T1: 25 kg P_2O_5+20 kg S; T2:25 kg P_2O_5+40 Kg S; T3:25 kg P_2O_5+20 kg S+ DGRC1; T4:25 kg P_2O_5+20 Kg S+ Biostimulant; T5:25 kg P_2O_5+40 kg S+ DGRC1; T6:25 kg P_2O_5+40 Kg S+ Biostimulant; T7:50 kg P_2O_5+20 kg S; T8:50 kg P_2O_5+40 Kg S: T9:50 kg P_2O_5+20 kg S+ DGRC1; T10:50 kg P_2O_5+20 Kg S +Biostimulant; T11:50 kg P_2O_5+40 kg S+ DGRC1; T12-50 kg P_2O_5+40 Kg S+Biostimulant

Fig 3.6: Effect of different treatments on pod and haulm yield

Soil and foliar application of P with varying doses affecting the soil P fractions and groundnut yield

The experiment was conducted in *kharif* 2022, with eleven treatments [T1:17:44:0 (foliar spray) @ 0.5 % at 30, 45 and 60 DAS; T2:0:52:34 (foliar spray) @ 0.5 % at 30, 45 and 60 DAS; T3:25 kg P_2O_5 + 17:44:0 (foliar spray) @ 0.5% at 30, 45 and 60 DAS; T4:25 kg P_2O_5 + 0:52:34 (foliar spray) @ 0.5 % at 30, 45 and 60 DAS; T5:17:44:0 (foliar spray) @ 1% at 30, 45 and 60 DAS; T6:0:52:34(foliar spray) @1% at 30, 45 and 60 DAS; T7:25 kg P_2O_5 + 17:44:0 (foliar spray) @1% at 30, 45 and 60 DAS; T8:25 kg P_2O_5 + 0:52:34 (foliar spray) @ 1% at 30, 45 and 60 DAS; T9:25 kg P_2O_5; T10:50 kg P_2O_5; T11: 0 kg P_2O_5]

and three replications in RBD. Two water soluble fertilizers (17:44:0 and 0:52:34 expressed in N: P_2O_5: K_2O terms) at two spray rates 0.5 and 1 percent were used. KDG 128, a Virginia bunch groundnut variety was used for sowing. 25 kg N, P_2O_5 as per treatment and 30 kg K_2O/ha was supplied. Significantly higher pod yield (1977 kg/ha) was obtained with T4 [25 kg P_2O_5 + 0:52:34 (foliar spray) @ 0.5 % at 30, 45 and 60 DAS] which was at par with T1, T2, T3, T7, T9 and T10. Foliar spray at 0.5 % was observed to be beneficial and to improve yields, while at 1% it was observed to negatively affect pod yield. Haulm yield was found to be significantly high (4912 kg/ha) in T5, which was at par with T3, T4, T6 and T7. Before sowing, average total-P pool in soil is 3495 mg P_2O_5/kg, labile-P pool is 212 mg P_2O_5/kg soil, moderately labile P pool is 346 mg P_2O_5/kg soil and non-labile-P pool is 2937 mg P_2O_5/kg soil. At harvest, in different treatments, total-P pool in soil ranged from 3268-3545 mg P_2O_5/kg, labile-P pool ranged from 218-372 mg P_2O_5/kg soil, moderately labile P



T1:17:44:0 (foliar spray) @ 0.5 % at 30, 45 and 60 DAS; T2:0:52:34 (foliar spray) @ 0.5 % at 30, 45 and 60 DAS; T3:25 kg P_2O_5 + 17:44:0 (foliar spray) @ 0.5% at 30, 45 and 60 DAS; T4:25 kg P_2O_5 + 0:52:34 (foliar spray) @ 0.5 % at 30, 45 and 60 DAS; T5:17:44:0 (foliar spray) @ 1% at 30, 45 and 60 DAS; T6:0:52:34(foliar spray) @1% at 30, 45 and 60 DAS; T7:25 kg P_2O_5 + 17:44:0 (foliar spray) @1% at 30, 45 and 60 DAS; T8:25 kg P_2O_5 + 0:52:34 (foliar spray) @ 1% at 30, 45 and 60 DAS; T9:25 kg P_2O_5; T10:50 kg P_2O_5; T11: 0 kg P_2O_5

Fig 3.7: Effect of different treatments on pod and haulm yield

pool ranged from 298-495 mg P_2O_5/kg soil and non-labile P-pool ranged from 2678-2752 mg P_2O_5/kg soil. A 29% increase in labile-P pool is noted when foliar spray is applied (T1 vs T11) and 36 % increase in labile-P pool is noticed when 25 kg P_2O_5 is applied along with foliar spray (T4 vs T11)

Project 4: Breeding groundnut for earliness, fresh seed dormancy and confectionary types

PI: *Praveen Kona*

Co-PI: *Kirti Rani*, Narendra Kumar, Chandramohan S.*

Associated up to 28th October, 2022

Subproject: Breeding for confectionary quality traits improvement in groundnut

Summer 2022

New Advanced Breeding Lines seed multiplication

Total 17 newly selected advanced breeding lines of large seed were multiplied to get sufficient seed to conduct their evaluation trial. In addition to this total 17 early maturing lines *viz*., PBS 12431, PBS 11092, PBS 14060, PBS 14064, PBS 14068, PBS 16022, PBS 15014, PBS 15022, PBS 16023, PBS 15028, PBS 15056, PBS 15027, PBS 16033, PBS 16044, PBS 14085, PBS 14086, PBS 14088 seed were multiplied.

New genotype supplied to AICRP-G Trials:

One genotype *viz*., PBS 14088 was supplied to AICRP-G testing for evaluation in rabi-summer 2022-23.

Generation advancement

About 300 probable hybrid pods from 10 crosses were sown in summer 2022 for true F_1 plants identification and generation advancement targeting early maturity. Total 92 single plants were selected from 10 crosses. Total 300 crossed pods were harvested from nine crosses during *Kharif*, 2021 were sown in summer, 2022 targeting quality traits improvement. Total 48 probable F_1s were identified from nine crosses based on male parent characters **(Table 4.1.)**

Table 4.1. Identified individual hybrid plants in F_1 generation during summer 2022.

S. No.	Cross	Characters	No. F_1 pods	Probable F_1s
1	TG37 A x PBS 29079 B	Large seed size	25	5
2	K1812 X GJGHPS 2	Large seed size	21	2
3	J95 X ICGV 86564	Large seed size	46	10
4	KDG 123 X K7 Bold	Large seed size	24	2
5	J11 X PBS 29146	Large seed, high protein and low oil	23	3
6	K1812 X PBS29146	Large seed, high protein and low oil	23	4
7	Dh 257 X PBS 29213	Large seed, high protein and low oil	72	9
8	GJG HPS 2 X TG 37A	Large seed size	27	8
9	Girnar 2 X K 1812	Large seed size with high yield	39	5
10	TAG 24 x Gangapuri	Early maturity	300	8
11	TG 37A x Gangapuri	Early maturity		14
12	GJG 32 x Gangapuri	Early maturity		5
13	GJG 32 x VRI 3	Early maturity		5
14	TAG 24 x VRI 3	Early maturity		8
15	TG 37A x VRI 3	Early maturity		9
16	TAG 24 x ICGV 92206	Early maturity		15
17	TG 37A x ICGV 92206	Early maturity		12
18	TAG 24 x K 1812	Early maturity with high yield		8
19	TG 37A x K 1812	Early maturity with high yield		8

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Evaluation of advanced breeding lines for quality and yield related traits.

In Spanish trial, 14 ABLs were evaluated with two checks, TPG41, TKG 19A in three replications under RBD design during *summer*, 2022. All the traits *viz*., HKW, HPW, SP, KL, pod yield per plant, oil (%) and protein (%) showed significant variation when compared to checks. Genotypes,PBS 19035, PBS 19036, PBS19040, PBs 19041, PBS 19050 and PBS 19052 recorded >60g of hundred kernel weight and found superior over best check TKG 19A (59.1 g). Genotype, PBS 19042 recorded highest SP as 70.2 % and found superior over best check TKG 19A (67.3 %). The kernel length was varied from 1.57 cm (PBS 19036) – 1.75 cm (PBS 19038, 19040, 19041). Total 06 genotypes recorded >30 % of protein of which PBS 19038 and 19040 recorded highest protein content (31.8 %). PBS 19040, PBS 19041, PBS 19050, and PBS 19052 lines found superior over best check TKG 19A (8.7g) in terms of pod yield/plant recording >11g/plant and having good combination of quality characters.

In Virginia trial, 17 ABLs along with five checks Mallika, Girnar 2, Raj Mungphali 3, GJG HPS2 and BAU13 were evaluated under RBD design with three replications. All the traits *viz*., HKW, HPW, SP, KL, pod yield per plant, oil and protein content showed significant variation when compared to checks. Genotype, PBS 29238 is recorded highest shelling percentage (73 %) followed by PBS 29236 (72.9%). PBS 29236 and PBS 29239 lines recorded >60 g of HKW. PBS 29243, PBS 29239, PBS 29247, PBS 29248 and PBS 29250 lines found superior over best check GJG HPS 2 (10.25 g) in terms of pod yield/plant recording >12 g/plant with good combination of quality traits.

In PYT trial 17 ABLs were evaluated with three checks for yield traits under RBD design with three replications. All the traits *viz*., HKW, HPW, SP, KL, pod yield per plant showed significant variation when compared to checks. Genotypes PBS 29254 (10a), PBS 29256 (10c), PBS 29258 (10e) recorded >80 g HKW and found superior over best check GJG HPS 2 (67.7 g). Genotypes PBS 29254, PBS 29255, PBS 29256, PBS 29257, PBS 29258, and PBS 29266 showed good combination of confectionery traits.

Evaluation of 102 released Spanish groundnut cultivars for sucrose and blanching traits.

Total 102 released Spanish bunch varieties of groundnut were raised during summer 2021 under alpha lattice design. The total soluble sugars were estimated using Anthrone reagent method in all the varieties. Total 35 varieties recorded > 7% of total soluble sugars. These 35 varieties will be used for estimation of sucrose percent using Ion chromatography. Among the 35 varieties, VRI 4 recorded highest total soluble sugars as 9.14 g/100 g.

Blanchability was estimated in 102 Spanish bunch varieties of summer 2021 trial with standard procedure using hot air oven. Eleven genotypes viz., Dharani, GJG-9, SB Improved 1, GJG 33, GPBD-4, G2-52, Pratap Mungphali-2, Kadiri Haritandra, Tirupati-2, GPBD-5 and Dh-86 recorded >90% blanching.

***Kharif* 2022**

Hybridization Programme:

Total 16 crosses targeting to improve the quality traits in groundnut related to seed size, oil, and protein content, early maturity (90 days) and fresh seed dormancy (>3weeks) and blanchability and sucrose content were effected during *Kharif*, 2022. Total 751 mature crossed pods were harvested from 16 crosses **(Table 4.2)** with a range of 3 (PBS 29079B × KDG 128) to 96 (RG 638 × GJG HPS 2).

Advancement of segregating generations

Total 48 probable F_1s selected from nine crosses during summer, 2022 were sown to generate F_2

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Table 4.2. List of crosses undertaken for quality traits improvement in groundnut

S. No.	Name of Cross	Purpose	Bud pollinated	No. F_1 pods
1	K 1812 × PBS 29079B	Large seed size with high yield	403	55
2	J 95 × GJG HPS 2	Large seed size with high yield	378	47
3	K 1812 × RG 638	Large seed size with high yield	181	25
4	PBS 29079B × KDG 128	Large seed size with high yield	265	3
5	Dh 256 × PBS 29146	Large seed, high protein and low oil	252	27
6	K 1812 × PBS 29146	Large seed, high protein and low oil	162	41
7	Dh 257 × PBS 29213	Large seed, high protein and low oil	595	95
8	RG 638 × GJG HPS 2	Large seed size with high yield	509	96
9	KDG 128 × PBS 29079B	Large seed size with high yield	212	57
10	PBS 29146 × K 1812	Large seed, high protein and low oil	382	49
11	K 1812 × VRI 4	High yield, High sucrose	343	48
12	KDG 128 × R 2001-2	Mapping population for Blanchability	323	42
13	TAG 24 × SG 99	Early maturity, High yield	242	43
14	VRI 3 x K 1812	Early maturity, High yield	317	53
15	ICGV 92206 x GJG 32	Early maturity, High yield	120	12
16	PBS 15044 x K 1812	High yield with fresh seed dormancy	578	58

generation during *Kharif*, 2022. Total 345 single plants from nine crosses in F_2 generation, 582 single plants from nine crosses in F_3, 547 single plants from 10 crosses in F_4, 519 single plants and 2-line bulks from eight crosses in F_5 generations and 22 single plants/line bulks from six crosses in F_7 were selected and advanced to next generation based on male parent characters for quality traits improvement. By using single pod descent method, the cross ICGV 15090 x PBS29148 is advanced from F_5 generation (198 lines) to next generation to develop RIL population. Total 26 crosses targeting early maturity and fresh seed dormancy are advanced by selecting 430 single plants from F_2 to F_3 generation, two crosses by selecting 100 single plants from F_3 to F_4 generation and 446 single plants from 14 crosses in F_4 to F_5 generation.

Evaluation of advanced breeding lines for quality and yield related traits

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Table 4.3. Mean data of HKW of ABLs evaluated in four seasons

Mean Hundred Kernel weight (g)							
Sr no.	**Code**	**GENOTYPE**	**Summer 2021**	***Kharif* 2021**	**Summer 2022**	***Kharif* 2022**	**Pooled Mean**
1	10a	PBS 29254	62.6	61.8	82.6	75.37	70.6
2	10b	PBS 29255	68.1	62.4	78.1	70.70	69.8
3	10c	PBS 29256	87.1	88.6	81.1	88.53	86.3
4	10d	PBS 29257	72.5	82.8	79.5	84.10	79.7
5	10e	PBS 29258	71.9	62.2	81.9	77.20	73.3
6	11a	PBS 29259	64.2	68.0	72.2	73.33	69.4
7	11b	PBS 29260	60.5	64.0	64.5	72.87	65.5
8	11c	PBS 29261	64.4	65.8	64.4	72.73	66.8
9	11d	PBS 29262	60.6	67.6	63.6	73.20	66.3
10	11e	PBS 29263	63.7	69.6	73.7	75.53	70.6
11	12a	PBS 29264	60.0	66.8	67.0	84.23	69.5
12	13a	PBS 29265	66.7	63.0	56.7	84.63	67.8
13	13b	PBS 29266	72.0	67.6	77.0	85.73	75.6
14	13c	PBS 29267	87.1	85.0	81.1	89.27	85.6
15	13d	PBS 29268	57.9	66.4	57.9	83.03	66.3
16	13e	PBS 29269	88.2	85.0	80.2	92.10	86.4
17	14a	PBS 29270	65.1	62.8	65.1	64.10	64.3
C1	**Mallika**		51.7	63.8	67.7	75.13	64.6
C2	**GJG HPS 2**		52.3	68.5	49.8	74.20	61.2
C3	**Raj Mungphali 3**		58.3	65.4	66.9	75.47	66.5

At Junagadh and Bikaner, a Spanish trial with 14 ABLs along with two checks, TPG41, TKG 19A in three replications under RBD was evaluated during *Kharif*, 2022. All the traits *viz*., HKW, HPW, SP, KL, pod yield per plant, oil (%) and protein (%) showed significant variation when compared to checks in both locations. At Junagadh, genotypes, PBS19040 and PBS19041 recorded 68.3 g and 65.27 g of hundred kernel weight, respectively and found superior over best check TKG 19A (62.63 g). PBS 19040, PBS 19041, PBS 19042, PBS 19050, and PBS 19052 lines found superior over best check TKG 19A (7.32 g) in terms of pod yield/plant recording > 9 g/plant at Junagadh whereas at Bikaner, PBS 19040, PBS 19050, and PBS 19052 genotypes found superior over best check TPG 41 (30.34 g) in terms of pod yield/plant recording >37 g/plant.

In Virginia trial, 17 ABLs along with five checks Mallika, Girnar 2, Raj Mungphali 3, GJG HPS2 and BAU13 were evaluated under RBD design with three replications at Junagadh and Bikaner. All the traits *viz*., HKW, HPW, SP, KL, pod yield per plant, oil (%) and protein (%) showed significant variation when compared to checks. Genotypes PBS 29238, PBS 29241 found to have good combination of confectionery traits and yield (> 10 g/plant at Junagadh and > 30 g/plant at Bikaner) when compared to the best check Girnar 2 at Bikaner and GJGHPS 2 at Junagadh.

A yield trial with 17 ABLs along with three checks under RBD with three replications at Junagadh is undertaken. All the traits *viz*., HKW, HPW, SP, KL, pod yield per plant showed significant variation when compared to checks. In the pooled analysis of four seasons (summer 2021, *Kharif* 2021, summer 2022 and *Kharif* 2022) for the same trial, genotypes viz, PBS 29256, PBS 29267 and PBS 29269 recorded > 85% of Hundred Kernel Weight and found superior over the best checks **(Table 4.3)**.

In *Kharif* 2021 and 2022, a 5x5 m advanced groundnut trial was undertaken using 12 advanced breeding lines along with three checks (GJGHPS 2, Mallika and Rajmungphali 3). Pod yield, HKW and shelling percent showed significant variation in pooled analysis. In pooled analysis, PBS 19041, PBS 19050 and PBS 19052 genotypes recorded > 15% higher pod yield compared to best check GJGHPS 2.

Genetic variability and association analysis for blanchability trait in groundnut: Genotyping of 96 Spanish bunch groundnut genotypes was completed using 98 SSR markers.

Subproject: Breeding groundnut for earliness and fresh seed dormancy

Evaluation of advanced breeding lines for fresh seed dormancy and yield

A study was conducted to identify sources of highly stable fresh seed dormancy with Spanish descent in groundnut. Intensity of dormancy is defined as the percentage of seeds not germinated even after specified period of time after the harvest.

Fourteen advanced breeding lines *viz.,* PBS 11092, PBS 14060, PBS 14064, PBS 14068, PBS 15014, PBS 15022, PBS 15027, PBS 11077, PBS 16023, PBS 16044, PBS 15028, PBS 15056, PBS 16022 and PBS 16033 were evaluated for fresh seed dormancy for five seasons *viz., Kharif* 2019, *Kharif* 2020, Summer 2020, Summer 2021 and *kharif*-2021 along with four released varieties *viz.*, TAG 24, Dh 86, Girnar 3 and TG 37A as checks. These genotypes were harvested at maturity as indicated by blackening of inner parenchyma of the pod (Miller and Burns, 1971). After germination test for first three seasons in petri plate *i.e., Kharif* 2019, *Kharif* 2020, Summer 2020, four genotypes namely, PBS 11077, PBS 14064, PBS 15014 and PBS 16023 were identified with 100 percent dormancy at about 21 days. Further,

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Table 4.4: Intensity of dormancy in advanced breeding lines 21 days after sowing

Genotypes	*Kharif*-2019	Summer-2020	*Kharif*-2020	Summer-2021			*Kharif*-2021		
	Laboratory test			Laboratory test	Field test	*In-situ test**	Laboratory test	Field test	*In-situ test**
Dh 86	0	12.5	33.35	0	12	Present	10	18	Present
Girnar 3	100	100	100	97	99	Absent	93	95	Absent
PBS 11077	100	100	100	100	100	Absent	87	91	Absent
PBS 11092	100	95	86.7	100	90	Absent	80	100	Absent
PBS 14060	100	100	86.65	100	100	Absent	0	11	Present
PBS 14064	**100**	**100**	**100**	**100**	**99**	**Absent**	**100**	**100**	**Absent**
PBS 14068	100	92.5	93.35	100	100	Absent	78	90	Absent
PBS 15014	**100**	**100**	**100**	**100**	**100**	**Absent**	**97**	**98**	**Absent**
PBS 15022	100	95	100	100	92	Present	85	91	Absent
PBS 15027	100	90	90	100	96	Absent	82	90	Present
PBS 15028	96.5	97.5	100	100	100	Absent	87	92	Present
PBS 15056	90.2	60	93.35	50	100	Present	99	96	Absent
PBS 16022	90	60	93.35	100	100	Present	83	87	Present
PBS 16023	**100**	**100**	**100**	**100**	**100**	**Absent**	**98**	**100**	**Absent**
PBS 16033	83.35	70	100	100	97	Absent	82	94	Present
PBS 16044	96.65	100	93.35	95	100	Absent	88	90	Absent
TAG 24	37.3	55	67	45	75	Present	36	78	Present
TG 37A	3	0	0	3.1	25	Present	12	18	Present

Note: Intensity of dormancy of individual seasons is presented after removing outliers; *present /absent: presence and absence of germination in uprooted plants recorded 21 days after attaining maturity.

as desired PBS 14068, PBS 15022, PBS 15028 and PBS 16044 were identified to have more than 90 percent dormancy in individual seasons. So, to further validate the results, in subsequent seasons germination test was carried out in the field by resowing fresh kernels from freshly harvested pods and germination behaviour of pods attached to the mother plant *i.e.*, in-situ germination behaviour was observed after 21 days of attaining maturity. The purpose was to find the relation among the germination behaviour of mature kernels in the laboratory, in the field and germination behaviour of pods when they are attached to the mother plant and to validate the standard operating procedure of germination test as carried out in the petriplate. The above observation was recorded to validate the intensity of dormancy in subsequent seasons

Fig 4.1. Germination test in petriplate (as per SOP for germination test)

viz., summer-2021 and *kharif*-2021. So, in total experiment was conducted in nine environments to find out the dormant lines with more than > 90 % dormancy at 3 weeks. From practical point of view, high intensity of dormancy (>90 %) for 2-3 weeks duration in Spanish types is very important (Kumar *et al.,* 2017). To assess fresh seed dormancy in laboratory, mature seeds (30 kernels/plate) from freshly harvested pods of test genotypes were placed on germination paper in petriplates and regularly watered. For field tests, seeds harvested from fresh pods were treated with carbendazim (3g/kg of seed) and sown in randomized complete block design with three replications. The data on number of seeds germinated were recorded at weekly interval for up to 25 days to calculate intensity of dormancy (IOD) equivalent to 21 days in petriplate. Further, in each replication 10-15 plants were left standing in the field for about more than 3 weeks after they attained maturity, moisture was maintained in the field at field capacity level. After 3 weeks plants were uprooted and presence/absence of in-situ germination was recorded for test genotypes. The calculated intensity of dormancy at 3 weeks of tested genotypes over the seasons under different environments is listed in **Table 4.4**. From the cumulative observation three genotypes namely, PBS 14064, PBS 15014 and PBS 16023 were identified to have constantly more than 90 percent dormancy in each individual environment. From *rabi*-2022 and *kharif*-2022 evaluation, PBS 11077 showed more than 10g pod yield /plant and found superior over best check Dh 86 (8.5g).

Screening of advanced breeding lines for fresh seed dormancy (field and laboratory tests) and evaluation for pod yield

A set of Spanish advanced breeding lines (PBSs 15044, 16004, 16013 , 16015 , 16016 , 16017 , 16020 , 16021 , 16022, 16024 , 16025, 16026, 16027, 16028, 16029, 16031, 16032, 16035, 16037, 16038, 16039, 16041, 16042, 16045, 16046, 16047, 16051, 16052, and 16053) were screened for fresh seed dormancy both *in-situ* germination on field and *ex situ* germination through perti plate method. From both the tests, superior ABLs (Table 4.5) were identified that recorded 100% dormancy up to 21 days for *rabi*-2022. Further, during *rabi*-2022, PBS 11092, PBS 15028, PBS 16022, PBS 16031, PBS 16032, PBS

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Table 4.5: Intensity of dormancy in advanced breeding lines 21 days after sowing

Genotypes	*Kharif*- 2021			Summer-2022			*Kharif*-2022	
	Laboratory test	Field test	*In-situ test*	Laboratory test	Field test	*In-situ test**	Laboratory test	*In-situ test**
Dh 86	51	60	present	47	71	present	63	present
Girnar 3	85	71	absent	90	35	absent	96	absent
PBS 16004	92	95	absent	100	100	absent	100	absent
PBS 16013	96	97	absent	100	100	absent	100	absent
PBS 16015	**100**	**100**	absent	**100**	**100**	absent	**100**	absent
PBS 16021	**100**	**100**	**absent**	**100**	**100**	**absent**	**100**	**absent**
PBS 16022	**91**	**80**	absent	**100**	95	absent	**94**	absent
PBS 16026	95	90	absent	100	99	absent	100	absent
PBS 16031	97	94	absent	100	100	absent	100	absent
PBS 16035	100	98	present	100	100	present	97	present
PBS 16037	94	93	present	100	100	present	100	present
PBS 16038	95	96	absent	100	100	absent	98	absent
PBS 16041	**100**	**100**	**absent**	**100**	**100**	**absent**	**100**	**absent**
PBS 16045	100	98	absent	97	100	absent	100	absent

Fig 4.2. Germination test in petriplate (as per SOP for germination test)

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16044, PBS 16046, PBS 16047, PBS 16051, PBS 16052 showed more than 10 g pod yield/plant and found superior over best check Girnar 3. Same set of genotypes were taken for *in-situ* germination test and laboratory screened for fresh seed dormancy in *kharif*-2022 and superior ABLs for FSD were identified (Table 4.5). So, from germination test for three consecutive seasons *viz.*, *Kharif*-2021, Summer-2022 and *Kharif*-2022, superior advanced breeding lines *viz.*, 16015, 16021 and PBS 16041 were identified with constantly 100 % IOD constantly for all environments, and other breeding lines as listed in table with high pod yield were identified with more than 90 percent dormancy in each individual environment for 3 weeks fresh seed dormancy (**Table 4.5**). From *rabi*-2022 and *kharif*-2022 evaluation, PBS 16022 showed more than 10 g pod yield/plant and found superior over best check Dh 86 (8.5g).

Evaluation of advanced breeding lines for maturity and pod yield

Twenty-two advanced breeding lines from the cross TAG 24 x NRCG 6255 along with five checks (JL 24, TG 26, GG 7, Dh 86 and JL 501) and 19 advanced breeding lines from cross TAG 24 x Girnar 1 along with five checks (JL 24, TG 26, GG 7, Dh 86 and JL 501) were evaluated for yield and maturity during summer-2021 (Junagadh and Deesa) and *kharif*- 2021 (Junagadh) in RCBD design in three replications (3 x 5). Based on two samplings at CTT= 1580 °Cd and 1850 °Cd, and yield data advanced breeding lines *viz.,* PBS 14085, PBS 14086, PBS 14100, PBS 14105, PBS 14106, PBS 14107, PBS 14093, PBS 14087, PBS 14101, PBS 14092, PBS 14094, PBS 14096, and PBS 14087 from cross TAG 24 X NRCG 6255 and advanced lines namely, PBS 14088, PBS 14113, PBS 14114, PBS 14115, PBS 14116, PBS 14119,

Table 4.6: Mean performance of advanced breeding lines over three environments

Genotypes	Mean values			
	Total pod weight/plant	Hundred pod weight	Hundred kernel weight	Shelling percentage
PBS 14088	21.31	90.29	35.18	57.28
PBS 14099	18.15	86.42	35.48	57.37
PBS 14120	13.50	59.73	25.50	58.72
PBS 14098	16.26	73.97	31.61	64.48
PBS 14085	22.47	99.01	34.87	54.49
PBS 14117	15.18	83.61	30.24	46.29
PBS 14136	16.89	60.33	23.38	57.54
PBS 14116	24.10	87.16	36.07	61.34
PBS 14125	13.50	64.02	29.55	62.08
PBS 14122	17.88	59.16	26.75	68.03
PBS 14118	17.29	77.77	29.20	57.14
PBS 14102	16.83	88.01	31.80	54.53
PBS 14086	21.87	102.79	40.23	55.76

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PBS 14094	20.27	86.98	33.26	58.12
PBS 14114	17.35	77.07	25.54	54.12
PBS 14105	12.93	78.96	29.05	56.85
PBS 14090	14.04	79.96	25.05	44.29
PBS 14121	17.67	67.54	26.45	58.10
PBS 14119	16.24	64.72	33.61	59.08
PBS 14113	15.51	65.28	24.53	59.87
PBS 14123	14.46	74.05	30.67	56.96
PBS 14115	16.14	77.76	29.29	54.90
PBS 14110	16.30	72.26	34.13	59.20
PBS 14092	18.37	85.64	28.87	56.78
PBS 14111	19.38	83.43	34.86	56.53
PBS 14093	19.96	80.12	32.50	60.15
PBS 14103	16.09	84.47	31.85	53.13
PBS 14108	20.94	81.32	35.13	61.78
PBS 14100	20.43	78.91	26.26	52.65
PBS 14089	20.39	77.23	28.67	60.98
PBS 14014	14.33	73.90	29.30	57.36
PBS 14095	19.43	86.77	34.12	58.46
PBS 14101	17.01	84.16	30.33	52.52
PBS 14109	18.93	80.43	29.82	55.49
PBS 14107	18.01	83.40	30.81	52.70
PBS 14106	20.76	82.15	33.41	59.77
PBS 14091	14.26	55.37	25.06	66.26
PBS 14124	16.48	77.05	32.35	64.03
PBS 14097	16.84	84.19	33.15	56.38
PBS 14087	21.14	89.04	32.84	57.32
PBS 14096	16.33	79.43	32.42	62.15
DH 86	7.20	94.74	48.45	58.70
GG 7	6.56	90.60	50.24	61.07
JL 24	5.35	92.81	54.53	65.34
TAG 24	13.38	103.47	49.00	66.21
TG 26	3.95	80.07	50.16	67.99

PBS 14121, PBS 14122,PBS 14124 and PBS 14089 from cross TAG 24 x Girnar 1, were identified to be early maturing. These lines were identified to mature at CTT 1580 °Cd which is equivalent to 85-87 calendar days. The mean values of PBS lines with yield and yield contributing traits from three consecutive sesaons (Deesa 2021, Junagadh *Kharif*-2021, and Junagadh *Summer*-2021 are listed in **(Table 4.6)**.

Project 5: Genetic Enhancement of Groundnut through Genome editing and Molecular approaches.

PI: *Sangh Chandramohan*

Co-PI: *S. K. Bera and Papa Rao Vaikuntapu*

Targeted Gene Editing Using CRISPR/Cas9 for high oleate trait

- Streaking and multiplication of Plasmid (47024 and 59177): We have used the bacterial stab to streak bacteria onto a plate containing LB media, grown overnight at 35 °C, and isolated the single colonies. Single colony was inoculated in liquid LB media and left overnight for culture growth. The obtained cultures were used for plasmid screening and verification.
- Isolation of Plasmid DNA: Plasmid isolation was carried out by alkali lysis method.
- Amplification of promoter and scaffold from vectors: The promoter and scaffold region were amplified using promoter specific and scaffold specific primers synthesized by IDT.
- Enzyme digestion of Vectors: Restriction digestion was performed using SpeI enzyme and linearized plasmid was observed indicating the cut.

Screening of Transgenic groundnut expressing defensin gene for Aflatoxin resistance.

- In the first set 310 transgenic T4 plants were used for screening using npt-II markers and tested positive in all samples including negative and positive control and water also.
- The same set was used for screening using gene specific marker (Tfgd2-F & RsAFP2-R) and tested negative in all samples (amplification was observed in positive control)
- In the second set 75 lines consisting of 497 plants were used for screening using npt-II markers and tested positive in all samples including negative and positive control and water also.
- The same set was used for screening using gene specific marker (Tfgd2-F & RsAFP2-R and Tfgd2-F & SynDEF-2 R) and none were found positive, amplification was observed in positive control only.
- Fifty-three transgenic defensin lines were sown in glass house. RNA isolation of five defensin lines was carried out using kit method (L-5 05-03-02-01, L-94 94-12-01-05, L-98 98-05-05-01, L-202 202-04-03-01 and L-98 98-05-05-01) and cDNA was prepared for three samples. PCR was carried out using cDNA as template with gene specific primer and actin primer. No amplification found with gene specific primer but found positive result with actin primer.

Breeding groundnut for earliness, fresh seed dormancy and confectionery types

Mining of SSR markers for fresh seed dormancy

- Mining of SSR markers for fresh seed dormancy was done using the genomic information from A09 and B05 chromosomes. A total of 110 SSR markers were identified from A09 and B05 chromosome. Genotyping for all the primers was completed in 96 Spanish varieties. 30 SSR markers (~27% polymorphism) out of 110 were found to be polymorphic. Some of the basic summary are given below

Out of the 110 primers, 82 primers were amplified

Marker	Major Allele Frequency	Allele No	Gene Diversity	PIC
DGR_D1	0.2169	10.00	0.8425	0.8232
DGR_D23	0.2184	9.00	0.8395	0.8195
DGR_D33	0.3059	9.00	0.7983	0.7706
DGR_D62	0.3404	7.00	0.7770	0.7445
DGR_D2	0.4045	7.00	0.7645	0.7373
DGR_D15	0.3167	6.00	0.7622	0.7239
DGR_D22	0.3253	8.00	0.7444	0.7024
DGR_D4	0.4945	7.00	0.6989	0.6691
DGR_D39	0.3407	4.00	0.7129	0.6574
DGR_D31	0.3696	5.00	0.7060	0.6553
DGR_D9	0.4198	5.00	0.6917	0.6401
DGR_D68	0.3514	4.00	0.6973	0.6382
DGR_D40	0.4839	6.00	0.6461	0.5843
DGR_D44	0.5604	5.00	0.6224	0.5802
DGR_D74	0.5349	4.00	0.6239	0.5681
DGR_D37	0.5106	4.00	0.6066	0.5335
DGR_D45	0.5380	3.00	0.5820	0.5040
Min	0.2169	2.00	0.1017	0.0966
Max	0.9462	10.00	0.8425	0.8232
Mean	0.4826	4.63	0.6047	0.5372

with 30 primers showing polymorphisms with an average frequency of 4.633 alleles per marker among 96 cultivated genotypes. Similarity matrix analysis for SSR data of 96 groundnut genotype was done by free tree software. Maximum similarity matrix value is 0.9211 between Spanish improved and JL 501. Minimum similarity matrix value is 0.1552 between TMV-12 and DH86. The dendrogram drawn based on similarity matrix using free tree based on data derived from all 110 SSRs grouped 96 groundnut genotypes into three major clusters. Cluster I, II and III. Cluster I consisted of 33 groundnut genotypes. Cluster II consisted of 27 genotypes. Cluster III consisted of 36 groundnut genotypes. Total 30 polymorphic primers amplified 136 alleles with of average 4.63. The number of alleles detected range from 2 to 10 with average of 4.63. Major allele frequency ranged from the 0.2169 to 0.9462 with the mean 0.4826. The maximum major allele frequency 0.9462 observed was in DGR_D73. The minimum major allele frequency 0.2169 observed was in DGR_D1. The genetic diversity ranged from 0.1017 to 0.8425. The maximum gene diversity 0.8425 was observed by DGR_D1. The minimum gene diversity 0.1017 was observed by DGR_D73. Many SSRs recorded heterozygosity among the populations. The heterozygosity varies from 0 to 1 with mean range 0.3115 for SSR marker. 12 primers were unable to detect any heterozygosity within population. Whereas, 18 primers were able to identify the heterozygotes. However maximum heterozygosity 1 was recorded by DGR_D46. The polymorphic information content (PIC) was calculated by software power maker for each primer. The maximum PIC value 0.8238 was recorded by DGR_D1, while minimum PIC value 0.0966 was recorded by DGR_D73. The population structure of population has been inferred to form two groups. The two cluster 1 and

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2 with different colour segments. In inferred population one (cluster 1), there were 50 genotypes mainly for different population. Whereas in inferred population two (cluster 2) there are 46 genotypes which were mainly from different population. The genic variation analysis was performed using Popgene. The highest Shannon information index was observed in DGR_D1 with a value of 1.983 mean observed number of alleles is 10 and mean effective number of alleles 6.280. The lowest Shannon information index was observed in DGR_D61 with a value of 0.551 mean observed number of alleles is 3 and mean effective number of alleles 1.458. The Nei's expected heterozygosity was highest in primer DGR_D1 with a value of 0.845 and mean observed heterozygosity was 0.000. The Nei's expected heterozygosity was lowest in primer DGR_D73 with a value 0.102 and mean observed heterozygosity was 0.021. The maximum genetic identity was 0.941 observed between Maharashtra and Tamil Nadu. The minimum

Markers	Major Allele frequency	Allele Number	Genetic Diversity	PIC
DGR_SR_30	0.2373	10	0.8482	0.8307
DGR_SR_33	0.275	9	0.8244	0.8021
DGR_SR_48	0.3214	6	0.7832	0.7516
DGR_SR_37	0.2879	5	0.7813	0.7462
DGR_SR_24	0.3676	5	0.7482	0.7082
DGR_SR_53	0.3545	5	0.7423	0.6976
DGR_SR_28	0.3676	5	0.7384	0.6956
DGR_SR_23	0.4559	7	0.6981	0.6554
DGR_SR_35	0.4182	6	0.7023	0.6537
DGR_SR_4	0.4485	4	0.6874	0.6354
DGR_SR_50	0.4846	7	0.6684	0.6203
DGR_SR_22	0.4338	8	0.6731	0.6186
DGR_SR_42	0.5299	5	0.6471	0.6032
DGR_SR_29	0.5074	6	0.6527	0.6028
DGR_SR_21	0.5645	7	0.6335	0.6015
DGR_SR_31	0.5077	6	0.651	0.6007
DGR_SR_34	0.4848	4	0.6561	0.599
DGR_SR_43	0.4254	3	0.6533	0.5798
DGR_SR_19	0.5692	5	0.6136	0.5709
DGR_SR_6	0.4355	4	0.641	0.568
DGR_SR_3	0.4485	4	0.6232	0.5468
DGR_SR_32	0.5735	4	0.5909	0.535
Mean	0.5608	4	0.5413	0.4228
Min	0.2373	2	0.0431	0
Max	0.9779	10	0.8482	1

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genetic identity was 0.315 observed between Punjab and Haryana. The maximum genetic distance was 1.154 observed between Haryana and Punjab. The minimum genetic distance was 0.089 observed between Maharashtra and Andhra Pradesh. The total genetic variation harboured within the population. It was consistent with the result of analyses of molecular variance (AMOVA), which detect genetic variation among the population and among the individuals were 2% and 55% respectively. Genetic variation within the population is 43%.

Genotyping of advanced Breeding lines for fresh seed dormancy

- Forty ABLs developed for dormancy and 9 non dormant genotypes were screened using 110 SSR markers developed using the genomic information from A09 and B05 chromosomes. Genotyping of all the primers is completed. Scoring is ongoing

Mining of SSR markers for stem rot resistance

- Mining of SSR markers for stem rot resistance was done using the genomic information from Dodia, *et al* 2019 and Lou *et al*, 2020. A total of 43 SSR markers were identified.
- Total of 50 varieties (34- spanish bunch, 14- Virginia bunch and 2- Virginia runner) were taken for genotyping using newly developed markers for stem rot resistance.
- Out of 43 primers, 22 primers showed PIC value of greater than 0.5 and remaining 21 primers have the PIC value of less than 0.5. The results indicate that the primer pair designed were efficient in differentiating the germplasm. Further these 22 pair of primer can be utilized to differentiate the stem rot resistance cultivar. Two primers (DGR_SR_30 and DGR_SR_33) have PIC of greater than 0.8 which showed high differentiating power to differentiate individuals and thereby help in identifying stem rot resistance cultivars. Some of the basic summary are given below

Hybridization

During *kharif* 2022 10 crosses (Dh 257 × ICGV 16690, K 1812 × ICGV 16690, GG 32 × ICGV 16690, Dh 257 × Girnar 4, K 1812 × Girnar 4, GG 32 × Girnar 4, Dh 257 × ICGV 15080, SG 99 × Girnar 4, JL 501 × ICGV 15080, KDG 128 × Girnar 4, Girnar 2 × Girnar 4, TG 51 × ICGV 15080, K 6 × Girnar 4, K 1812 × HFS 62, and J 87 × HFS 24) were done to transfer high oleic traits to high yielding varieties. Numbers of flowers ranging 21-249 were pollinated in 15 crosses. Probable cross pods ranging from 5-86 were harvested and will be planted for genotyping in early generation and generation advancement during summer 2023.

Yield evaluation of high oleic Spanish bunch breeding lines

Initial yield evaluation of 108 SB lines along with 5 checks (DH-257, GG-32, GG-7, JL-501 and TG37A) were done in RBD with three replications during summer 2022. Each line was planted in single line on five-meter bed. Out of which line numbers 769, 88, 926 and 16 were found promising and have significantly higher pod yield over best check. In case of kernel weight 54 lines were promising compared to check. Lines 769, 88, 926, 16, 549, 609 and 950 were found promising.

Spanish bunch high oleic breeding lines (F_{6-7}) were further evaluated for yield performance during *kharif* 2022. Experiment was planted in RBD with three replications. Hundred and eleven Spanish bunch breeding lines and five checks (DH 257, GG 7, GJG 32, JL 501 and TG 37A) were sown in single line on three-meter beds. Pod yield of check varieties ranged from 160 g/20 plants to 272 g/20 plants. Pod yield of GJG 32 (272 g/20 plants) was maximum than other check varieties. While, 10 breeding lines (Line nos. 219, 3089, 3704, 369, 309, 1604, 678, 643, 720 and 223 had 9-35 per cent higher pod yield than GJG 32. These 10 breeding lines also had 61-82 per cent shelling. Upon confirmation of their superiority over check variety for one more season selected breeding lines will be tested in larger plot area.

Yield evaluation of high oleic Virginia bunch breeding lines

Initial yield evaluation of 33 VB lines along with three checks (KDG-123, GG-22 and KDG-128) were done in RBD with three replications during summer 2022. Each line was planted in one row on five-meter bed. In terms of pod yield none of the lines found significantly superior over best check. Out of which lines 693 and 527 were having pod yield at par with check, and significantly higher kernel weight and shelling per cent.

Virginia bunch high oleic breeding lines (F_{6-7}) were further evaluated for yield performance during *kharif* 2022. Experiment was planted in RBD with three replications. Thirty-three Virginia bunch breeding lines and three checks (GG22, KDG 123 and KDG 128) were sown in single line on three-meter beds. Pod yield of check varieties ranged from 138 g/20 plants to 246 g/20 plants. Pod yield of GJG 32 (246 g/20 plants) was maximum than other check varieties. While, single breeding line (Line no. 758 with 323 g/20 plants) had more than 10 per cent higher pod yield than GJG 32. Upon confirmation of their superiority over check variety for one more season selected breeding line will be tested in larger plot area.

Genotyping of segregating lines for *ahFAD2* mutant alleles conferring high oleic trait in groundnut.

Plants were genotyped for presence of *ahFAD2a* and *ahFAD2b* mutant alleles in different generation and plants positive with both the alleles were selected for further advancement. Single plants (F_{1-2}) from 18 crosses (GJG 32 X HFS 22, K 1812 X HFS 22, JL 1085 X HFS 22, J 87 X HFS 22, SG 99 X HFS 22, GIRNAR 2 X HFS 121, HOS 724 X HFS 121, RAJ MUNGFALI 3 X HFS 121, J 100 X HFS 22, HNG 69 X HFS 22, TG 81 X HFS 22, TG 84 X HFS 22, HFS 22 X HFS 91, HFS 62 X HFS 115, HFS 62 X HFS 22, HFS 91 X HFS 121, CS 644 X HFS 22 and JL 776 X HFS 22 were genotyped during summer 2022. F_1 plants from 18 crosses were planted in the field and genotyped for presence of *ahfad2a* and *ahfad2b* alleles. Hundred twenty-four plants out of 324 plants were found positive for both the alleles and selected for advancement.

Besides, F_{3-4} single plant progenies from four crosses (GJG-32 × Girnar-4, J-87 × HFS-24, K-1812 × HFS-62 and TG-81× HFS -24) were advanced during summer 2022. A total of 264 single plant progenies were planted in single line of five-meter bed and forwarded to next generation.

Three thousand five hundred and fifty-six single plants of F_{5-6} generation from seven crosses were genotyped and 316 plants positive for both alleles were selected during *kharif* 2022. Besides, 2679 single plants of F_{2-3} generation from 17 crosses were genotyped for presence of *ahFAD2a* and *ahFAD2b* mutant alleles and 89 plants positive for both ahFAD2 alleles and higher pod yield were selected. Pod yield per plant in 89 single plant progenies ranged from 3 g to 67 g.

Seed multiplication of high oleic advanced breeding lines

High yielding advanced breeding lines with high oil content (two lines with 53% oil) as well as high oleic acid content (13 lines with more than 78% oleic acid) were multiplied during *kharif* 2022. Seed multiplication ranged from 2 to 68 kg based on availability of seeds.

Advanced breeding lines submitted for AICRPG testing

High yielding advanced breeding lines, three in number with more than 78% oleic acid content are submitted for AICRPG testing during *kharif* 2022.

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Fig 5.1: Agarose Gel Image for Confirmation of FAD2 mutant alleles in segregating populations.

Project No. 6: Development of groundnut pre-breeding materials for biotic and abiotic stresses and quality traits

PI: *SK Bera*

Co-PI: *Narendra Kumar, Ajay BC, Chandramohan Sangh, Ananth Kurella*

Hybridization

Hybridization was done between cultivated groundnut and wild *Arachis* species to develop pre-breeding lines and gene/allele introgression from wild species. Cultivated groundnut (high yielding variety, DH 257) was hybridized with four different wild *Arachis* species NRCG 14863, *A. kreschmani*, *A. diogoi* and *A. correntina.* Number of flowers 240, 155, 320, and 184 were pollinated in four crosses, respectively. Probable cross pods were harvested and will be planted during *kharif* 2023.

Interspecific cross derivatives

Two diploids wild *Arachis* species and two diploid synthetics were hybridized with cultivated groundnut to introgress desirable traits from wild background to cultivated background during *kharif* 2022. A total of 449 single plants progenies (F_{2-3} and F_{5-6}) were further advanced to next generations and harvested single plant wise. Plants are mostly wild type with single seeded pods. These wild segregating populations will be advanced till F_{10} and characterized/screened for biotic and abiotic stresses.

Screening of interspecific breeding lines for resistance to collar rot disease

Interspecific breeding lines from three interspecific crosses (J11 × *A. duranensis*, J11 × *A*

Figures showing 449 single plants progenies (F_{2-3} and F_{5-6}) from interspecific crosses planted in the field

Figures showing pods (F_{2-3} and F_{5-6}) from interspecific crosses.

diogoi and J 11 × *A. pusilla*) were screened for resistance to collar rot at Regional Research Station, Bikaner during *kharif* 2022. Screening of 40 pre-breeding lines was done in single lines of three-meter bed under natural hot spot conditions. Mortality was recorded at harvest which ranged from 12 to 43%. Fourteen lines had less than 20 per cent mortality and require further confirmation.

Screening of RIL populations for resistance to stem rot disease

RILs, 149 in number were screened for resistance to stem rot disease under artificially inoculated conditions during *kharif* 2022. Screening was done in two replications and each RIL was planted in one line on two-meter bed. Screening was done following the protocols developed at DGR. Mortality per cent ranged from 23 to 100. Forty-five lines had less than 20 per cent mortality and could be resistant to the stem rot disease which needs further confirmation.

Screening of germplasm for three seeded pods

Groundnut germplasm of Valencia habit group were sown for screening based on presence of three kernels per pod during summer 2022. A total of 77 germplasm lines were planted in single line on five-meter bed. Observation was recorded at harvest and germplasm short listed based on presence of more than 40% pods with three seeds. A total of 35 germplasm was found having more than 40% pods with three seeds. Further, 35 germplasm were planted in *kharif* 2022 and more than 41-67% three seed pods per plant was observed in 23 Valencia germplasm lines during *kharif* 2022. However, average number pods per plant remain very low (2-4) in these germplasms. However, 11 genotypes (11863, 6517, 14107, 16420, 11088, 14366, 13118, 10372, 12668, 8240 and 2258) had more than 50% three seeded pods in both summer 2022 and *kharif* 2022.

Yield evaluation of Virginia bunch advanced breeding lines

Advanced breeding lines were evaluated for yield performance during *kharif* 2022. Experiment was planted in RBD with three replications. Fourteen Virginia bunch advanced breeding lines and two checks (KDG 123 and KDG 128) were sown in five lines on five-meter beds. Pod yield of KDG 123 (847g/250 plants) was higher than KDG 128 (764g/250 plants). While, four advanced breeding lines (NRCGCS 658, NRCGCS 663, NRCGCS 656 and NRCGCS 657 had 10 per cent higher pod yield ranging from 10% to 24% than KDG 123. Four advanced breeding lines also had 69-70 per cent shelling and 30-35g 100 kernels weight. Upon confirmation of their superiority over check variety for one more season selected advanced breeding lines will be tested in AICRPG.

Advancement of Recombinant Inbred Line (RIL) population

Hybridization was effected between JL 24, a variety susceptible to Peanut bud necrosis disease (PBND) with ICGV 86031, a resistant variety to PBND for mapping the resistance gene for PBND in ICGV 86031. Segregating population was forwarded to develop RIL population and vis-à-vis mapping of gene. A total of 109 single plant progenies (F_4) from a cross JL24 32 × ICGV 86031 were planted for advancement from F_{4-5} generation during summer 2022. Each progeny was planted in single line on five-meter bed. A few progenies with very high numbers of pods/plant were observed at harvest. Further these 109 lines (F_5) were planted in single line on three-meter bed and advanced to next generation during *kharif* 2022. Seeds of the RILs will be multiplied further for phenotyping at natural hot spots for PBND over two seasons for further studies.

Similarly, hybridization was effected between GJG 32, a very high yielding variety having 53% oil content with an elite breeding line, HOS 89 with 57% oil content to transfer the high oil trait to GJG 32 as well as map the gene responsible for high oil content in HOS 89. Segregating population was forwarded to develop RIL population and vis-à-vis mapping of gene. A total of 71 lines (F_{5-6}) were planted in single line on five-meter bed and advanced to next generation during summer season 2022. Out of this 17 plant progenies were observed better compared to GJG-32 in terms of pod yield and shelling per cent. Further these 71 lines (F_{6-7}) were planted in single line on three-meter bed during *kharif* 2022 and advanced to next generation. RILs will be phenotyped for oil content over two seasons.

Seed multiplication of high oleic advanced breeding lines

Seeds of two high yielding and high oil content advanced breeding lines HOS 724 and HOS 395 were multiplied during *kharif* 2022 for further testing in AICRPG.

Project 7: Management of groundnut genetic resources and trait specific characterization

PI: *Kirti Rani*

Co-PIs: *Harish G, Ajay BC, Sushmita Singh and Ananth Kurella*

Field maintenance of wild Arachis germplasm

A total of 72 wild accessions from six sections viz., *Arachis* (12), *Erectoides* (6), *Caulorhizae* (1), *Heteranthae* (2), *Procumbentes* (6) and *Rhizomatosae* (45) were maintained in the field gene bank. Out of these six species (*Rhizomatosae* -5 and *Caulorhizae* -1) are maintained as fodder purpose species. The seeds of annual species from wild accessions are also conserved in cold storage. The seeds of four amphidiploid derivatives (synthetic groundnut) have also been established and regenerated in the field gene bank.

Large scale multiplication and conservation of germplasm accessions

A total of about seven thousand five hundred (7500) groundnut accessions have been maintained in the medium cold storage module (4-5 deg.C and 30 % RH) as working collection; and also a set is separately maintained through long term storage (10-12 years).

Trait specific characterization of germplasm accessions

During summer 2022, a total of 115 germplasm accessions (VUL) were grown in augmented randomized complete block design with five checks (JL 24, JL 286, TAG 24, TG 37A, and TG 26).The same set of genotypes were also evaluated in *kharif* 2022. Based on observation, germplasm namely, NRCG 8517, 10411, 12178, 12715, 12298 and 12459 were identified to be early maturing (90 days) based on three samplings at three CTT (cumulative thermal time temperature). Other germplasms *viz.*, NRCGs 11560, 11154, 14326, 12296, 6407, 10730, 11022, 10889, 99, 10888 and 10741 were identified to have 75-80 percent shelling outturn, while NRCGs 11518, 12619, 12718, 12715 and 10907 with more than 80 percent shelling outturn. Further, from summer-2022 observations based on CTTs harvest (three samplings), NRCGs 12240, 203, 99, 6133, 135, 145 and 9966 were confirmed with 85 days of maturity. Other, NRCGs 10340, 12352, 12374, 12698, 12428,10337, 6371, 10888, 10275, 10278, 10283, 10291, 10580, 10294, 12332, 12349, 12369, 12379, 12380, 12385, 12386, 12435, 10290, 13003, 11019, 6236 and 10569 for 90-95 days of maturity. During the year oil and protein analysis of ~2000 germplasm were undertaken, from two locations Anantapur and Junagadh, based on recorded data with NIR, NRCGs 13011, 12459, 10392, 12469, 14089, 1688, 1680, 4264, 11420, 15354, 13007, 15245, 15469, 9344, 14485, 6677,7326, 7063, 7128, 5239, and 13006 were identified with ~ 50 % oil content. Further,

Table 7.1: Performance of selected early - maturing peanut germplasms in staggered harvests over three seasons *viz*., summer 2021, *kharif* -2021 and summer-2022

Genotypes	Pod yield/plant (g/plant)			Sound mature seeds (g/plant)			Shelling %			100 seed weight (g)		
	1490 °Cd	1670 °Cd	1850 °Cd	1490 °Cd	1670 °Cd	1850 °Cd	1490 °Cd	1670 °Cd	1850 °Cd	1490 °Cd	1670 °Cd	1850 °Cd
NRCG 12240	4.1	6.2	6.9	2.4	3.2	4.1	64	69	69	21	30	32
NRCG 203	4.3	5.8	6.2	2.3	3.3	4.3	63	68	69	20	26	33
NRCG 99	4.6	6.6	6.7	2.9	4.1	4.8	65	71	71	25	32	33
NRCG 6133	3.7	5.7	5.9	2.4	3.3	3.7	64	67	69	22	31	34
NRCG 135	3.5	4.4	4.7	2.7	3.1	3.5	63	69	71	23	30	37
NRCG 145	2.7	3.7	4.2	2.1	2.7	2.9	62	69	67	22	27	32
NRCG 9966	3.8	4.8	4.9	2.3	3.2	3.7	52	67	69	20	28	29
Checks												
JL 24	3.5	7.1	7.2	2.9	3.7	3.9	60	71	73	26	37	39
TG 26	4.7	6.7	7.1	3.1	4.1	4.5	58	69	71	25	33	36
TAG 24	4.1	7.8	7.9	3.2	4.7	4.8	66	73	74	26	37	41
SE (±)	**0.18**	**0. 38**	**0.39**	**0.12**	**0.18**	**0.19**	**1.3**	**1.8**	**2.1**	**0.74**	**I.19**	**1.21**
CV (%)	**15**	**21**	**20**	**15**	**17**	**15**	**7**	**3**	**3**	**10**	**12**	**10**

NRCGs 14363, 6105, 6098, 16617, 8230, 11649 and 16982 with ~ 35 % protein content were recorded. From data recording in two replications from *kharif*-2021 harvested produce, NRCGs 16035, 11101, 11561 and 16955 were reported with high Fe content (85-90 ppm) and NRCGs 11518, 11448, 12469, 10470, 16696 and 12463 with Zn content ~ 40 ppm.

Evaluation of germplasm accessions for drought tolerance

Spanish germplasm set consisting of 500 germplasm accessions were screened for drought tolerance and yield attributes during rainy seasons of 2020 to 2022 under natural rainfed conditions at Regional Research Station, ICAR-DGR Anantapur. Drought tolerance attributes such as Relative water use efficiency was recorded. Yield related attributes such as Pod yield, Hundred kernel weight and Shelling percent were recorded at maturity. These germplasm accessions were tested against R 2001-2, KDG 128, K6, K 1812 and Dh 256. Number of germplasm accessions superior over the best check for respective characters are listed in Table below.

S. No	Parameter	Best Check	No. of Superior accessions
1	Pod yield (g/m^2)	KDG 128 (266)	28
2	Relative water Use efficiency (Kg/m^2-mm)	Dh 256 (6.76)	23
3	HKW	K6 (35.35)	43
4	SHP	K 6 (71.15)	68
5	Weight per pod (g)	K6 (0.85)	75

Second germplasm set consisting of 2000 germplasm accessions were screened for drought tolerance and yield attributes under during rainy seasons of 2022 under natural rainfed conditions at Regional Research Station, ICAR-DGR Anantapur. Sowing was done during 1st week of July and harvested during 4th week of October. Drought tolerance attributes such as Relative water use efficiency was recorded. Yield related attributes such as Pod yield, Hundred kernel weight and Shelling percent were recorded at maturity. These germplasm accessions were tested against R 2001-2, KDG 128, K6, K 1812 and Dh 256. Number of germplasm accessions superior over the best check for respective characters are listed in Table below.

S. No	Parameter	Best Check	No. of Superior accessions
1	Pod yield (g/m2)	KDG 128 (292.6)	64
2	Relative water Use efficiency (Kg/m2-mm)	Dh 256 (6.76)	70
3	HKW	K6 (35.35)	21
4	SHP	K 6 (71.15)	160
5	Weight per pod (g)	K6 (0.85)	110

2 Crop Production

Project 8: Climate resilient sustainable agriculture through low-cost natural farming in groundnut-based cropping system

PI: *CS Praharaj*

Co-PI: *KK Pal, Kiran K Reddy, Sushmita Singh*

Meteorological situation (2022)

The **monsoon,** the **lifeline** of the country's $3.2 trillion economy, delivers nearly **70%** of rains that India needs to water farms and recharge reservoirs and aquifers. Nearly half of India's farmland, without any irrigation cover, depends on annual June-September rains to grow crops including groundnut. Since both excess and deficient rainfall events have its role on the productivity realized by our farmers, water conservation plays a key role for scaling farm productivity in both the situations. This is more important in case of rainless rabi and spring-summer groundnut under Southern Saurashtra region of Gujarat.

Fig 8.1. Meteorological subdivision wise seasonal rainfall during June-September 2022 (Source:IMD, India)

Salient features of Monsoon 2022 in India indicated that south-west seasonal monsoon rainfall during 1^{st} June to 30^{th} September for the country as a whole has been above normal (105 -110% of LPA) and quantitatively it has been 92.5 cm (106*% of its Long Period Average, LPA)* against long period average of 87.0 cm rainfall based on data of 1971-2020. The Southwest monsoon seasonal (June to September) rainfall was above normal over South Peninsula (122% of LPA) and Central India (119 % of LPA). It was normal over Northwest India (101%) and below normal over East and Northeast India (82%). Southwest monsoon seasonal (June to September) rainfall over the monsoon core zone, which consists of most of the rainfed agriculture regions in the country had been above normal (120% of LPA).

Out of the total 36 meteorological subdivisions in India, 12 subdivisions constituting 40% of the total area of the country received excess, 18 subdivisions (43% of the total area) received normal rainfall and 6 subdivisions (17% of the total area) received deficient season rainfall **(Fig 8.1)**. These 6 Met subdivisions which got deficient rainfall were West Uttar Pradesh, East Uttar Pradesh, Bihar, Jharkhand, Gangetic West Bengal, and NMMT (Nagaland, Manipur, Mizoram & Tripura). Out of these six Subdivisions, majority of them lie in the Gangetic Plains. This year SW monsoon was also very unique with contrasting month to month variation; and the rainfall over the country as a whole was 92, 117, 104 and 108% of LPA during June, July, August and September, respectively. There were six Monsoon Depressions formed during the season, out of which one system only was intensified into Deep

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Depression during 19-23 August 2022.

These rainfall and soil characteristics influenced the overall production of *kharif* 2022 groundnut

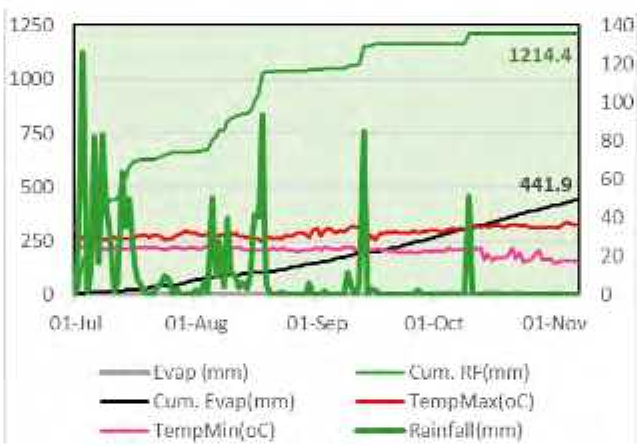


Fig 8.2. Weather situation at ICAR-DGR, Junagadh (Gujarat) during Kharif 2022

(Fig. 8.2) and later spring/summer groundnut (2022-23) in a particular agro-ecological region. Both *kharif* and summer (mostly dry) production were normal except some detrimental effect caused by flood (during kharif), leaf spot and root rot etc. in some locations. Nevertheless, a production (83.69 lakh tonnes) of groundnuts were produced during kharif 2022-23. Compared to this, a production of 82.54 lakh tonnes was realized during *kharif* (2021-22). Theme wise project details achieved during 2022 (Spring/summer and kharif) are given here in of under.

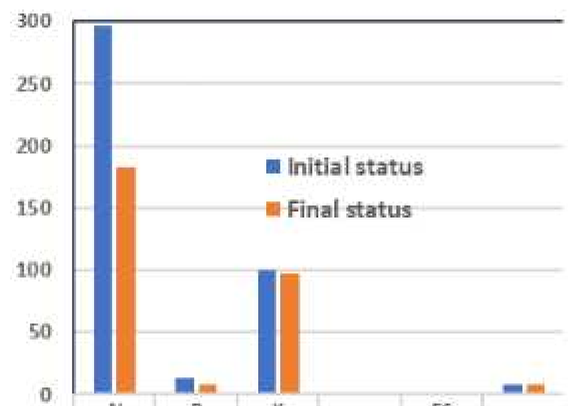
Natural Farming as an Alternative to Conventional Farming

Natural Farming or Zero Budget Natural Farming (ZBNF) is an alternative to chemical fertilizer-based agriculture and high input-cost agriculture **(Fig 8.3)**. It emphasizes on "*Enhanced soil conditions by managing organic matter and soil biological activity; diversification of genetic resources; enhanced biomass recycling; and enhanced biological interactions*". Thus, it advocates 100% elimination of synthetic chemical inputs (fertilizer and pesticides) and encourages the application of natural mixtures made using

Fig 8.3. Disadvantages of Conventional Farming Practices using agrochemicals (top); Components of ZBNF (bottom)

cow dung, cow urine, jaggery, pulse flour etc., mulching practices, and symbiotic intercropping. ZBNF has four pillars such as *Jeevamrutha* (cowdung based crop nutrition), *Bijamrita* (seed treatment), *Acchadana* (mulching) and *Whapasa* (efficient and less irrigation) which are integrated into it. 'Zero budget' does not literally mean that cost is 'zero' which implies that the need for external financing is zero, and that any costs incurred in ZBNF is offset by a diversified source of income accruing farm diversification rather than dependence on monoculture.

Keeping in view of importance of ZBNF, an experiment was initiated at the main campus of ICAR-DGR, Junagadh from spring/summer 2021-22 following sowing of an exhaustive fodder crop of pearl millet to have a uniformity at the beginning. On soil parameters, almost similar nutrient availability in soils is conspicuous in different plots (low to medium fertility) after completion of exhaustive crop of pearl millet before groundnut-wheat cropping system. Thus, soil homogeneity is maintained through exhaustive crop of Pearl millet (**Fig 8.4 a, b**). This was followed by groundnut and wheat in rotation during *Kharif* 2022 and *Rabi* 2022-23, respectively.



	N (Kg/ha)	P (kg/ha)	K (kg/ha)	OC (%)	EC (dS/m)	PH
Initial status	296.68	12.81	100.05	0.7	0.317	8.24
Final status	182.20	7.95	96.88	0.63	0.39	8.24

Fig 8.4a. Dynamics of soil chemical properties before sowing and after harvest of the Exhaustive crop of Pearl Millet (0-15 cm soil depth)

Methods	Preparation	Benefits
Jivamrita/ Jeevamrutha	It is composed of the cow-dung (20 kg), urine (5-10 l), jaggery (20 kg) and dicot flour (2 kg) and is applied to the crops with each Irrigation cycle.	It provides nutrients, but most importantly, acts as a catalytic agent that promotes the activity of microorganisms in the soil, as well as increases earthworm activity.It also helps to prevent fungal and bacterial plant diseases.It is only needed for the first 3-4 years of the transition, after which the system becomes self-sustaining.
Bijamrita	It is basically made up of water (20l), cow dung (5kg), urine (5l), lime (50gm) and just a handful of soil.	It is a seed treatment, equipped in protecting young roots from fungus as well as from soil-borne and seed-borne diseases
Acchadana-Mulching	It could be done by soil mulch, straw mulch or live mulch.	It conserves soil moisture, by reducing evaporation.
Whapasa – moisture	The irrigation should be reduced and irrigation should be practiced efficiently only, in alternate furrows.	Palekar challenges the idea that plant roots need a lot of water, in-fact, what roots need is water vapour, and therefore, Whapasa is the condition where there exist both air molecules and water molecules present in the soil.

Fig 8.4b. The details of methodology of Natural Farming adopted under field condition

During both *Kharif* and Rabi seasons, three farming practices *viz.*, 1) *Conventional Farming* (Control); 2) *Natural Farming* (Seed treatment with Beejamrutha/Bijamrita + application of Jeevamrutha at fortnightly intervals + mulching with organic residues + plant protection with natural pesticides /fungicides like, Neemastra, Agniastra etc.); and 3) *Organic Farming* (Use of FYM, Vermicompost, Biofertilizer and plant protection with organic products etc.) were taken up in both groundnut and wheat, respectively in main plot. Similarly, these farming practices are integrated with two varieties of groundnut (of different habit groups belonging to Spanish Bunch 'TG 37A' and Virginia Bunch 'GJG 22') and wheat (Lok 1 and GW 451) in sub plot. These treatments were laid out in split plot involving large plots (>90 m^2) and replicated 8 times (in order to accommodate precision irrigation schedules and tillage levels later). The groundnut crop was sown during last week of June with pre-sowing irrigation and was harvested during 3rd week of October; and was followed by wheat during Mid November (yet to be harvested). Thus the crop was raised entirely with seasonal rainfall. The prevailing agro-ecosystem involved medium black calcareous soil under Southern Saurashtra Agro-climatic Zone of Gujarat (falls under Niti Ayog's Gujarat Plain and hill region).

Fig 8.5. General view of the long-term experiment on natural farming, and performance of plants (left) and plants (right) in different treatments (CF, NF and OF, respectively)

The study revealed that pod yield to the tune of 1316 - 1630 kg/ha was realized with low cost natural farming (NF) practice (depending on the varieties and higher yields with Spanish Bunch) vis-à-vis 1448 -1779 kg/ha in organic farming (OF) practice. However, maximum yield (1679-1965 kg/ha) was realized with conventional farming practice (CF) employing improved production technologies as per recommended practice. Thus, on the main plot effect (Farming practice), significantly higher values were recorded in the following order: CF > OF > NF **(Fig 8.5)**; while on sub plot front, significantly greater productivity was recorded under TG 37A (compared to GJG 22). The values of all the growth and developmental parameters were also higher under the above treatments (TG 37A and CF). These include maximum values in respect of after-harvest parameters viz., haulm yield (2740 kg/ha), biological yield (4562 kg/ha), shelling per cent (69.2%), 100-kernel wt. (35.2g), net return (INR 67,267/ha) and BCR (1.50) under CF (compared to others). However, higher values in respect of harvest index (42.2%), and nodules count (174/plant) were observed under NF

Table 8.1. Agro-economic attributes of Groundnut as influenced by farming practices and varieties (*Kharif*, 2022)

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological Yield (kg/ha)	Nodule count (#/pl)	Nodule dry wt. (mg/pl)	Pods/ plant	Seed Index (g)	Shelli ng %	Dry wt. (g/pl)	Bran ches/ pl	HI (%)	NR (INR/ ha)	BCR
Farming Practices													
CF	1822	2740	4562	172	58.2	13.5	35.2	69.2	18.4	4.01	39.9	67267	1.50
NF	1473	2014	3486	174	63.6	14.4	31.5	68.2	16.1	4.16	42.2	53348	1.47
OF	1613	2564	4178	174	68.7	14.9	33.2	69.2	19.0	4.33	38.5	56301	1.29
Sem (±)	24.3	14.3	30.0	2.65	1.66	0.34	0.21	0.25	0.50	0.14	0.37	1,358	0.03
C.D (0.05)	74.3	43.7	92.0	NS	5.07	1.04	0.64	0.77	1.54	NS	1.14	4,158	0.10
Varieties													
TG-37 A	1791	2458	4249	185	71.0	13.2	29.6	67.9	16.8	3.73	42.1	67667	1.63
GJG-22	1481	2420	3901	161	56.0	15.3	37.1	69.9	18.8	4.60	38.3	50276	1.21
SEm(±)	21.9	13.3	27.7	2.24	1.31	0.49	0.23	0.33	0.52	0.13	0.32	1231	0.03
C.D.(0.05)	65.1	NS	82.0	6.64	3.87	1.45	0.68	0.97	1.54	0.39	0.96	3644	0.09
Interaction	NS	*	*	NS	*	*	NS	*	NS	NS	*	NS	NS

2

Fig 8.6. Demonstration showing higher performance of Groundnut under improved practice

practices. Similar to CF, TG 37A outperformed over GJG 22 in respect of all the parameters except some viz., shelling per cent, 100-kernel wt., dry wt. of plant, and number of branches & pods/plant. Interaction effect on pod yield was not significant **(Table 8.1)**.

Thus, it was inferred from the above that *kharif* groundnut responded to NF in the very first year of field experiment (with 19% reduction in yield compared to CF) although conventional farming practice comprising of chemical fertilizers, FYM and pesticides (BMPs) was far superior in realizing higher yield/return due to obvious reasons of adequate input supply as per crop requirement accompanied with favourable crop growth and development.

Bridging the Yield Gap through Improved Agro-technology

An experiment in groundnut with the sole objective of its productivity maximization has been taken up during both spring/summer 2022 and kharif 2022 at the main campus of ICAR-DGR, Junagadh. Three distinct treatments based on *in toto* package mode in groundnut (*viz.*, Farmers' practice as a Control, Practice adopted by the Progressive Farmers, and Improved Practice taken up by the research institution as recommended practice) were laid out in thrice replicated RBD. Varieties belonging to both Spanish ('TG 37A') and Virginia ('KDG 128') habit groups were taken up in large plots (>90 m^2) during both the above seasons.

Table 8.2. Yield and economics of Groundnut cultivars (TG -37A and KDG - 128) during Spring-Summer 2022

Treatment	Pod yield (kg/ha)		Biological Yield (kg/ha)		Nodule count (#/pl)		Nodule Wt. (mg/pl)		Shelling %		Seed index (g)		Net return (INR/ha)		BCR	
	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128
Farmers' Practice	2570	3135	5731	6953	75.5	172	27.7	50.7	61.9	68.6	30.5	28.4	112076	155797	2.32	3.15
Progressive Farmers' Practice	2639	3400	6023	7210	89.5	217	30.3	62.2	62.8	69.9	31.9	29.6	113790	168196	2.22	3.20
Improved Practice	**2925**	**3625**	**6444**	**8201**	**113.5**	**222**	**32.8**	**63.1**	**66.2**	**72.4**	**35.0**	**33.3**	**129875**	**182453**	**2.48**	**3.41**
SEm (±)	35.7	80.9	98.2	210	4.03	9.3	0.97	2.01	0.65	0.78	0.43	1.02	1956	4457	0.04	0.09
C.D. (0.05)	126	285	346	740	14.2	32.6	3.41	7.11	2.28	2.77	1.52	3.61	6901	15722	0.14	NS

Fig 8.7. Field performance of TG 37A and Demonstration showing higher performance of Groundnut under improved practice

The Improved Practice consisted of *Rhizobium* IGR 6 or IGR 40 at 1.25 kg/ha and PGPR 'NUTBOOST' at 1.25 kg/ha, FYM 5 t/ha, recommended NPK at 25:50:25 kg/ha and Gypsum for alkaline soils (at 500 kg/ha splited up as basal and at earthing up with 50% each), pre- and post-emergence herbicides, along with required plant protection practices including soil application of *Trichoderma viride* @ 2.5 kg/ha (amalgamated with 500 kg of FYM/ha) as per standard recommendation. The 'Control plot' is applied with no FYM, spacing at 30-45 x 10, seed rate of 130 -150 Kg/ha, DAP at 150 Kg/ha, hand weeding, seed treatment with only fungicide i.e. mancozeb + carbandizim, plant protection measures as per trader advise, 10-12 no. of Irrigations and without biocontrol agents. The 'Practice adopted by Progressive Farmers' included FYM at 7-8 t/ha, spacing at 30 x 10, seed rate of 120-125 kg/ha, NPK at 25-50-50 kg/ha, Foliar spray with Micronutrint mixture Grade-IV (30-35 g per 15 liter water) at flowering & pod formation, pre-emergence herbicide pendimethalin (stomp) accompanied with one and two hand wedding 30 & 60 DAS (if shortage of labor, only post emergence herbicide spray), fungicide (mancozeb + carbandizym), insecticide (Imidacloprid) + PSP + KSB + Rhizobium culture applied as per recommendation, 10-11 no. of irrigations and *Tricoderma* @2.5 Kg/ha with 500 kg FYM as soil application.The observations pertaining to growth and yield attributes, and production economics were also recorded for two varieties of two different habit groups during two seasons (2022).

The above study revealed that higher values of yield and its attributes in cultivar 'TG 37A' *viz.*, pod yield (2925 & 2064 kg/ha), shelling per cent (66.2 & 69.4 %), seed index (35.0 & 32.1) along with favorable economics such as higher net return

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Table 8.3. Yield and economics of Groundnut cultivars (TG -37A and KDG - 128) as influenced by farming practice during *Kharif* 2022

Treatment	Pod yield (kg/ha)		Biological Yield (kg/ha)		Nodule count (#/pl)		Nodule Wt. (mg/pl)		Shelling %		Seed index (g)		Net Return (INR/ha)		BCR	
	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128	TG 37A	KDG 128
Farmers' Practice	1724	2645	5406	8219	168	218	48.5	65.5	66.6	66.6	29.3	31.3	66353	123439	1.50	2.71
Progressive Farmers' Practice	1886	2940	5811	9022	180	241	64.5	76.5	67.8	67.8	30.9	32.1	73620	139154	1.57	2.88
Improved Practice	**2064**	**3221**	**6313**	**9733**	**205**	**286**	**78.9**	**88.2**	**69.4**	**68.7**	**32.1**	**33.6**	**83641**	**155303**	**1.74**	**3.13**
SEm(+/-)	32.5	45.2	105	109	3.2	6.4	3.98	5.82	0.19	0.27	0.47	0.11	2088	2721	0.05	0.05
C.D. (0.05)	115	159	372	384	11.3	22.6	14.1	NS	0.67	0.97	1.66	0.40	7367	9601	0.16	0.19

(129875 & 83641 INR) and BCR (2.48 & 1.74) were realized with improved practices followed during *spring-summer and kharif* seasons, respectively despite continuous rain and flooding condition persisted during critical stages of crop growth (including flowering, pegging, and later stages). This higher crop performance under Improved Practices **(Table 8.2-8.3, Fig 8.6-8.7)** was followed by progressive farmers' practices and control (farmers' practices). Similar was in the case of KDG 128 also (with similar values as in above viz., pod yield of 3625 & 3221 kg/ha, shelling per cent of 72.4 & 68.7%, seed index of 33.3 & 33.6g, net return of 182453 & 155303, and BCR of 3.41 & 3.13 during the seasons). It was due to appropriate input(s) supply and their utilization especially under improved practice. Higher productivity and economic output were also realized during spring-summer season due to lesser stresses. KDG 128, a Virginia Bunch

Table 8.4. Pod yield & its attributes and nodulation in groundnut under various weed control treatments during *kharif* 2022

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological Yield (kg/ha)	Nodule count (#/pl)	Nodule dry wt. (mg/pl)	Pods/ plant	100-kernel wt. (g)	Shelling (%)	Dry wt. (g/pl)	HI (%)
T_1	885	2788	3674	146	54.5	11.0	28.4	64.2	17.9	24.1
T_2	2189	4738	6926	160	66.7	13.6	30.3	67.3	21.8	31.6
T_3	2434	4527	6961	169	75.7	15.6	31.2	68.9	23.5	35.0
T_4	**2682**	**4744**	**7426**	**189**	**78.8**	**19.3**	**34.3**	**70.9**	**31.0**	**36.2**
T_5	2465	4609	7074	172	65.7	16.6	32.1	70.2	26.0	34.8
T_6	**2525**	**4476**	**7001**	**182**	**61.3**	**18.2**	**32.7**	**69.8**	**28.7**	**36.1**
T_7	2369	4568	6936	165	69.2	14.6	31.2	69.5	21.3	34.2
T_8	2480	4600	7080	166	55.3	15.8	31.8	69.5	19.6	35.0
SEm(±)	35.7	92.6	97.7	3.75	5.45	0.70	0.43	0.49	2.43	0.63
C.D.(0.05)	106	274	289	11.1	16.1	2.00	1.26	1.44	7.18	1.86

*HI : Harvest Index

Table 8.5. Weed attributes and economics of Groundnut under different weed control treatments during *kharif* 2022

Treatment	Weed count (#/m^2)			Weed dry wt. (g/m^2)			NR (INR/ ha)	BCR
	45 DAS	60 DAS	90 DAS	45 DAS	60 DAS	90 DAS		
T_1	110	127	149	66.1	113	139	21503	0.77
T_2	72	58.0	78.3	56.5	52.1	73.2	95617	2.40
T_3	58.3	66.0	50.0	41.9	63.6	52.9	108094	2.65
T_4	**29.3**	**26.0**	**19.0**	**24.0**	**28.4**	**22.5**	**124796**	**3.15**
T_5	52.3	60.8	44.3	41.2	50.8	46.4	110286	2.70
T_6	**47.5**	**53.0**	**43.5**	**35.8**	**40.1**	**42.7**	**115153**	**2.92**
T_7	74.5	104	122	52.2	95.0	113	107138	2.77
T_8	48.3	52.0	43.0	37.7	47.3	52.8	112728	2.85
SEm(±)	2.7	3.9	4.3	1.4	2.4	3.4	1997	0.04
C.D.(0.05)	7.9	11.5	12.9	4.1	7.2	10.2	5913	0.14

*DAS: Days after sowing, NR: Net return, BCR: Benefit Cost Ratio

Table 8.6. Pod yield and its attributes in groundnut under different irrigation and sulphur treatments

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological Yield (kg/ha)	Pods/ plant	100-kernel wt. (g)	Shelling (%)	HI (%)
Irrigation Levels (IW/CPE ratio)							
I_0 (Control)	1969	4247	6216	21.2	31.8	67.9	31.7
I_1 (0.6)	**2236**	**4284**	**6520**	**20.4**	**32.4**	**67.7**	**34.2**
I_2 (0.8)	2267	4431	6698	21.2	32.1	68.6	33.8
I_3 (1.0)	2242	4218	6460	20.4	32.4	68.9	34.7
SEm(±)	158	180	302	1.75	0.88	0.58	1.32
C.D.(0.05)	NS	NS	NS	NS	NS	NS	NS
Sulphur levels (kg/ha)							
S_0 (Control)	2050	4103	6153	21.1	32.0	67.7	33.3
S_1 (15)	**2263**	**4405**	**6668**	**20.8**	**32.7**	**68.8**	**33.9**
S_2 (30)	2202	4306	6508	20.6	31.3	67.8	33.7
S_3 (45)	2199	4366	6565	20.6	32.7	68.8	33.4
SEm(±)	51.5	86.7	116	0.70	0.62	0.41	0.55
C.D.(0.05)	151	NS	340	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS

Unweeded control (T_1) Hand weeding + Interculture (T_2) Diclosulam *fb* Fenoxaprop-p-ethyl (T_6)

Fig 8.8. Performance of weed control treatments (T1, T2 & T6) in the Kharif 2022 groundnut crop

outperformed over the Spanish Bunch variety (TG 37A) due to higher yield realization and favorable economics across the season and cultivation practice.

On soil parameters, almost similar soil nutrient availability with little variations under different plots (low to medium fertility and normal EC) both at start and end of the experiment. However, NPK uptake and economics were favoured with Improved Practice.

The study concludes for adoption improved practice for realization of higher and stable yields in groundnut as it is confirmed from across the seasons and varieties of both the habit groups taken up as above.

n economic point of view, there was reduction in total cost (22.55%) in ZBNF treatment with less yield (14.13 q/ha) as compared to RPP

Table 8.7. Growth, nodulation and economics in groundnut under different irrigation and Sulphur levels

Treatment	Plant height (cm)	Primary Branch (#/pl)	Nodule count (#/pl)	Nodule dry wt. (mg/pl)	NR (INR/ha)	BCR
Irrigation Levels (IW/CPE ratio)						
I_0 (Control)	31.0	4.86	176	72.3	76977	1.56
I_1 (0.6)	**31.3**	**4.86**	**177**	**61.1**	**91953**	**1.87**
I_2 (0.8)	30.2	4.67	179	68.0	93761	1.88
I_3 (1.0)	30.7	4.50	178	70.7	91020	1.81
SEm(±)	1.61	0.07	2.5	1.46	9197	0.18
C.D.(0.05)	NS	0.27	NS	5.15	NS	NS
Sulphur levels (kg/ha)						
S_0 (Control)	29.6	4.81	174	71.1	82548	1.73
S_1 (15)	**31.7**	**4.67**	**177**	**69.0**	**94226**	**1.92**
S_2 (30)	31.3	4.69	188	66.8	89114	1.77
S_3 (45)	30.6	4.72	171	65.3	87823	1.70
SEm(±)	0.52	0.18	1.9	1.42	3001	0.06
C.D.(0.05)	NS	NS	5.7	4.16	NS	NS
Interaction	NS	NS	*	*	NS	NS

Fig 8.9. Aerial view of the experiment involving irrigation and sulphur application in groundnut during kharif 2022

(17.46 q/ha). In economic point of view, there was reduction in total cost (22.55%) in ZBNF treatment with less yield (14.13 q/ha) as compared to RPP (17.46 q/ha).

Post-emergence Weed Control in Groundnut

An experiment with the objective of studying bio-efficacy of different post-emergence herbicides on weed dynamics, pod yield and economics of 'TG 37A' groundnut (*Arachis hypogea* L.) has been taken up during *kharif* 2022 at the main campus of ICAR-DGR, Junagadh. Eight treatment combinations involving weed control through pre- and post-emergence herbicides and hand weeding were taken up in four-times replicated RCBD. These treatments include **T_1**: Weedy Check, **T_2**: HW + IC, **T_3**: Diclosulam 26 g/ha as PRE *fb* Clethodim 180 g/ha as PoE, **T_4**: Diclosulam 26 g/ha as PRE *fb* Fenoxaprop-p-ethyl 78 g/ha as PoE, **T_5**: Oxyflourfen 200 g/ha as PRE *fb* Clethodim 180 g/ha as PoE, **T_6**: Oxyflourfen 200 g/ha as PE *fb* Fenoxaprop-p-ethyl 78 g/ha as PoE, **T_7**: Pre-mix Pendimithalin + Imazethapyr 450 + 450 g/ha as PRE and **T_8**: Oxyflourfen 200 g/ha as PRE *fb* Quizalofop ethyl 50 g/ha as PoE. The experiment was sown during last week of June with sowing-time irrigation and harvested during 1st week of November 2022. The crop was raised following standard recommended practice. The observations pertaining to growth and yield attributes including those related to weeds, and production economics were also recorded during the season **(Table 8.4 & 8.5)**.

The above study revealed that there was dominance of sedges (*Cyperus rotandus, and Cyperus Esculentus)* in the experiment. Few grasses including *Cyperus rotandus, Echinochloa colonum and Brachiaria spp.*, and some broad leaved weeds (viz., *Digera arvensis, Vernonia cinerea, Phyllanthus spp., Physalis minima, Wild moong bean (Vigna spp.),Eclipta alba,* *Alternanthera spp., 8. Ammania bacifera, Euphorbia hirta,* and *Commelina benghalensis*) were also present. The findings of the experiment showed that the herbicide treatment "Diclosulam 26 g/ha as PRE *fb* Fenoxaprop-p-ethyl 78 g/ha" as PoE (T_4) was superior in terms of yield attributes and weed control characteristics. As a result, the same combination of herbicide out-yielded over other treatments including both unweeded check (T_1) and manual weed control supplemented with interculture operation (T_2). An increase in the pod yield to the extent of 22.5% was recorded under this compared to manual weed control followed by interculture operation. Consequently, there was increase in net return (30.5%) and BCR (31.2%) was recorded under the treatment involving Diclosulam 26 g/ha as PRE *fb* Fenoxaprop-p-ethyl 78 g/ha as PoE (T_4). This was followed by the next best treatment where "Oxyflourfen 200 g/ha as PRE *fb* Fenoxaprop-p-ethyl 78 g/ha as PoE (T_6) was applied to the crop. Effective weed control practice involving efficient herbicide application through both pre-and post-emergence could be a boon as it resulted in season-long weed control. It further favoured higher crop growth and development leading in scaling crop productivity and monetary returns. Thus, our one-year study indicated the proven efficacy of "Diclosulam 26 g/ha as PRE *fb* Fenoxaprop-p-ethyl 78 g/ha" as PoE (T_4) for season long weed control that could result in higher yield and economics under Southern Saurashtra region of Gujarat **(Table 8.4, 8.5 and Fig. 8.8)**.

Irrigation and Sulphur requirements in *Kharif* Groundnut

An experiment with the objective of studying both irrigation (on IW/CPE basis i.e., irrigation water/Cumulative Pan Evaporation) and sulphur fertilization requirements of groundnut crop was carried out during *kharif* 2022 at the main campus of ICAR-DGR, Junagadh. Four treatments of irrigation levels in main plot and four Sulphur levels in subplots were laid out in thrice replicated split plot in groundnut 'TG 37A'. Irrigation levels included (I_0) Flood Irrigation (farmers' practice/control), (I_1) Irrigation at IW/CPE 0.6, (I_2) Irrigation at IW/CPE ratio 0.8, and (I_3) Irrigation at IW/CPE ratio 1.0; while Sulphur levels included (S_0) Control (no Sulphur), (S_1) 15 kg S/ha, (S_2) 30 kg S/ha, and (S_3) 45 kg S/ha. The crop was irrigated only once for I_2 and twice for I_3 (and no irrigation to I_0 and I_1 during the kharif season due to continuous rainfall and varied irrigation requirements) since it comes under high IW/CPE levels (1.0 IW/CPE with irrigation at 50 mm of CPE and 0.8 IW/CPE with irrigation at 62.5 mm of CPE). The observation included growth attributes, pod yield and yield attributes, and economics of groundnut. The experiment was sown during last week of June with sowing-time irrigation and harvested during 1st week of November 2022. The crop was raised following standard recommended practices **(Fig. 8.9)**.

The findings of the above experiment showed that irrigation treatments could not differentiate the crop performance during *kharif* season since water deficit during the season was non-existent due to more or less well distributed and frequent rainfall events occurred at the location **(Table 8.6 & 8.7)**. Number of irrigations applied was also very few (once in 0.8 IW/CPE under I_2 and twice in 1.0 IW/CPE under I_3) due to some intermittent dry period observed between two rainfall events resulting in scheduling of irrigation at lower (50 or 62.5 mm) Pan Evaporation values. Thus, under the above situation, irrigation scheduling at 0.6 IW/CPE is optimum as both the yield and economics are similar (to others with irrigation once at 0.8 IW/CPE or twice at 1.0 IW/CPE during the season with no additional irrigation-cost accrual).

On the contrary, sulphur being an element with a specific role in the synthesis of sulphur containing amino acids, like methionine and cysteine and synthesis of proteins, chlorophyll besides oil, and its action as a promoter for nodulation in legumes (thereby N fixation) and proper filling of grains (in oilseeds and thus, enhances market quality), has proved its requirements for application at lower doses (up to 15 kg S/ha). Despite some increases in both nodules count and its dry weight following higher sulphur application (at 30 kg S/ha), further increase in its doses beyond 15 kg S/ha could not yield additional advantages in terms of crop productivity and returns (and BCR). Thus, our one-year study indicated the efficacy of soil application of sulphur only at moderate doses (15 kg/ha) for realization of higher yield and economics under Southern Saurashtra region of Gujarat.

Project 9: Salinity- and heat- stress in groundnut: basis of tolerance and management

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In- vitro characterization of available PGPR, PSB, archaea, and DAPG-producers

So far, 53 well characterised cultures comprising PGPR, PSB and DAPG-producing fluorescent pseudomonads were screened for level of salinity tolerance. Out of these cultures, nine, seven, five, seventeen, and fifteen cultures were tolerant to

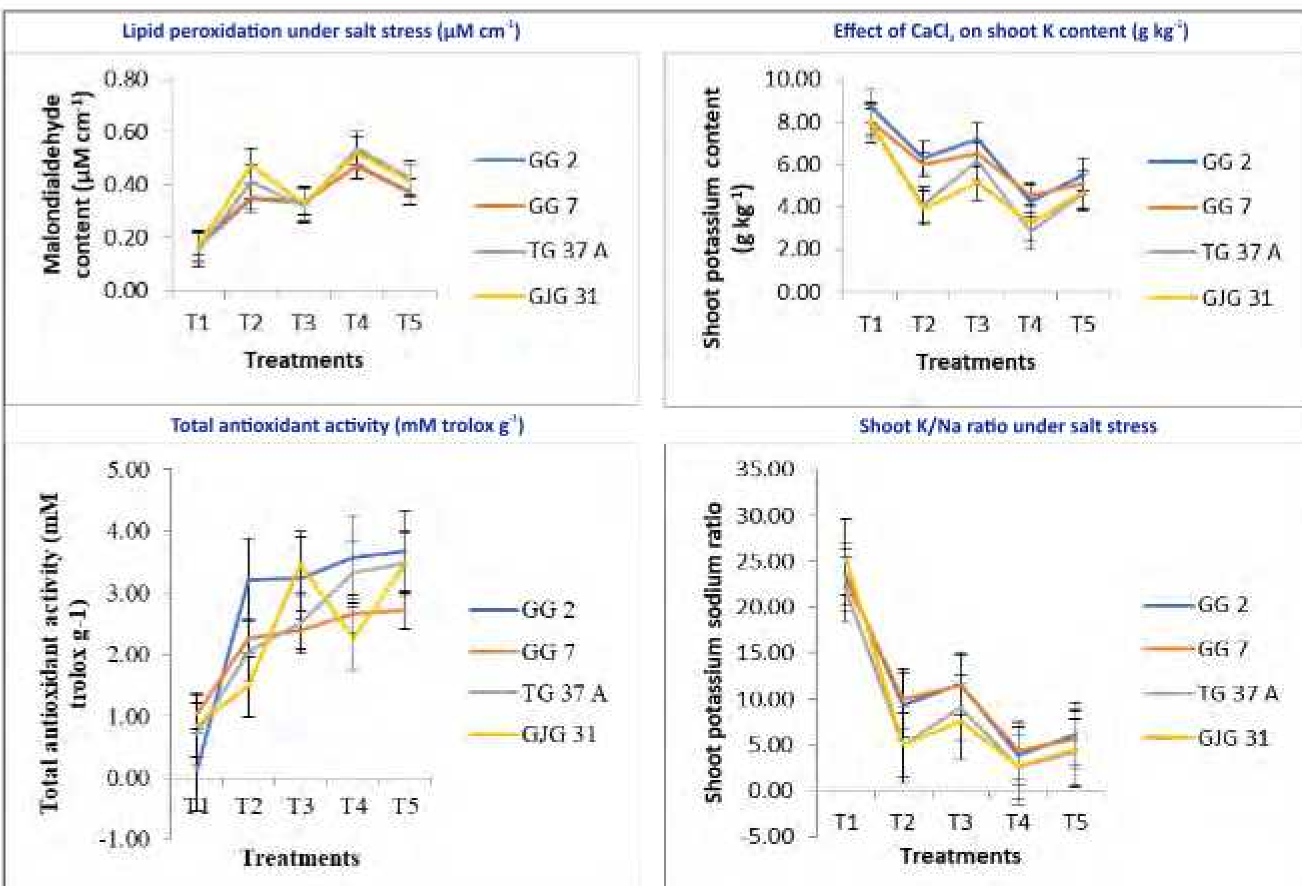

Fig. 9.1. Effect of external application of Ca on alleviation of salinity stress in groundnut

2.5M, 2.0M, 1.5M, 1.0M and 0.5M of NaCl in growth medium *in vitro*. On the basis of compatibility testing, five consortia were identified comprising one each of PGPR, KSB, rhizobia and endophytes for alleviation of salinity stress in groundnut in field conditions.

Salt stress alleviation in groundnut cultivars through foliar application of $CaCl_2$

A pot experiment comprising of four groundnut cultivars (TG 37A, GG2, GG 7 and GJG 31) was undertaken to evaluate the salt mitigating effect of $CaCl_2$ (20mM). The stress indicators like H_2O_2, MDA content and MSI recorded greater damage to GJG 31 and TG 37A suggesting greater degree of susceptibility in these cultivars. TG 37A and GJG 31 recorded a higher degree of lipid peroxidation (MDA content) ranging from 0.37- 0.42 µM cm^{-1} at 2 dSm^{-1} and 0.43-0.49 µM cm^{-1} at 4 dSm^{-1} when compared to GG 2 and GG 7 (0.11- 0.21 µM cm^{-1} at 2 dSm^{-1} and 0.31- 0.34 µM cm^{-1} at 4 dSm^{-1}) (Fig. 9.1). The osmotic adjustment was better in GG 2 and GG 7 with their proline content ranging from 92- 209% over the control at both the levels of salinity. The effect of exogenously applied Ca was more pronounced at higher level of salinity (4 dSm^{-1}) with a significant percentage increase in shoot K (34.3%), pod K (26.6%), K/Na ratio (51.4%), total antioxidants (44- 54%) and proline content (43.2%). $CaCl_2$ was, therefore, found to alleviate salt stress in groundnut cultivars through enhanced accumulation of proline, total soluble sugars, shoot K and total antioxidant activity.

Impact of heat stress on physiology and nutritional attributes of groundnut

A field experiment comprising of staggered dates of sowing was undertaken with 10 groundnut cultivars. The wax content was increased upon late sowing (D3) (0.6-1.4 mg g^{-1} tissue) while early (D1) and timely sown (D2) conditions recorded similar mean value (0.94 mg g^{-1} tissue). The photochemical maximum quantum yield was recorded for D1 (0.837) followed by D2 (0.803) and D3 (0.789). The total soluble sugar recorded maximum accumulation for D1 (5.85 g $100g^{-1}$) followed by D3 (5.20 g $100g^{-1}$) and D2 (5.13 g $100g^{-1}$). The phenolics profiling revealed that cultivars for D1 treatment accumulated maximum resveratrol (8.65 ppm), ferulic acid (111 ppm), coumaric acid (51 ppm) and salicylic acid (592 ppm). GJG 32, TAG 24, SG 99 and ICGS 44 accumulated maximum resveratrol and salicylic acid for all the treatments. GJG 32 distinctly recorded a very high accumulation of coumaric acid (61- 85 ppm) while the normal range for all the cultivars was 24- 68 ppm.

Evaluation of the effect of endophytes and mulching on yield parameters of groundnut

The experiment was conducted with six treatments and four replications in RBD design with TG37A variety. The average soil salinity measured at harvest was 3.85 dS/m, with initial soil salinity of 0.4 dS/m. The highest significant pod yield was found with treatment T6 (DGR endophyte 2 seed treatment + furrow soil application at sowing and 45 DAS) + Wheat straw mulch @ 10 t/ha) which was at par with T5 (DGR endophyte 2 seed treatment + furrow soil application at sowing and 45 DAS) + Wheat straw mulch @ 10 t/ha). Mulching in combination with endophytes improved the groundnut yield by 500-550 kg/ha over control (**Table 9.1**). There is an increase in yield by 250-350 kg/ha in endophytes alone treatments compared to control. Wheat straw mulch alone increased the yield by over 350 kg/ha compared to control. Due to the organic carbon and nutrients provided by decomposing straw mulch the endophytes performed very well in combination with straw mulch.

Evaluation of salinity tolerant rhizobia for BNF and yield of groundnut

During summer 2022, five newly identified

Table 9.1. Effect of application of endophytes and mulch on alleviation of salinity stress and yield of groundnut (cv GG7)

Treatment	PY (kg/ha)	HY (kg/ha)	HKW (g)	SOT (%)
Control	1015	2536	21.6	54.3
J22N (seed treatment+ furrow application at 45 DAS)	1258	2792	27.2	60.2
REN51N(seed treatment+ furrow application at 45 DAS)	1392	2864	22.1	60.4
Control + Wheat straw mulch @ 10 t/ha	1375	3064	24.4	59.4
J22N (seed treatment+ furrow application at 45 DAS) + mulch @ 10 t/ha	1571	3365	24.6	58.8
REN51N (seed treatment + furrow application at 45 DAS) + Mulch @ 10 t/ha	1595	3269	23.9	59.2
CD (0.05)	**238**	**485**	**4.6**	**5.8**

groundnut rhizobia viz., K508, K515, K521, K557, and Rh29 along with standard isolated NC92 were evaluated at soil salinity of EC 3.86 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 and haulm yield, nodule numbers, shelling outturn and hundred kernel mass significantly (**Table 9.2**). However, maximum yield was obtained with K557. Soil EC at harvest 3.87.

Evaluation of CAM variants for salinity tolerance and expression of CAM

To understand the phenomenon of CAM involved in imparting salinity tolerance, an experiment was

Table 9.2. Evaluation of salinity tolerant rhizobia for enhancing BNF and yield of groundnut (cv TG37A)

Trt	HY (kg/ha)	PY (kg/ha)	SOT (%)	HKW (g)	NN/p
Control	2267	1203	57.16	34.21	15.4
K 508	2493	1373	58.51	33.75	19.3
K 515	**2700**	**1613**	60.57	38.02	**34.0**
K 521	**2743**	**1547**	61.57	37.19	**37.3**
K 557	**2827**	**1623**	62.72	38.28	**40.0**
NC 92	2453	1367	58.75	35.02	23.3
Rh 29	**2750**	**1563**	61.67	37.27	**34.3**
CD (0.05)	**226**	**239**	**1.02**	**0.88**	**9.3**

undertaken with TG37A and two of its C3-CAM transited 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 TG37A by almost 48% (6143 kg/ha in normal soil condition to 3208 kg/ha in around 3.95 soil EC in TG37A), the over-expressive C3-CAM transited variants of TG37A like DGRMB19 minimized the biomass reduction (6787 kg/ha on normal condition to 4777 kg/ha) and maintained at 30% level of reduction **(Table 9.3)**. Both the CAM transited genotypes performed significantly superior than TG37A. For studying the genes involved in circadian rhythm, samples were collected in diel cycle and processed and prepared the required cDNAs.

Table 9.3. Evaluation of CAM variants for biomass production even under salinity stress

	HY (kg/ha)			PY (kg/ha)			SOT (%)			Biomass reduction (%)		
Trt.	Level of salinity			Level of salinity			Level of salinity					
	No salt	Salts	Mean	No salt	Salts	Mean	No salt	Salts	Mean	No salt	Salts	Reduc. (%)
TG37A	3893	2060	**2977**	2250	1148	**1699**	65.24	53.19	**59.22**	6143	3208	47.78
DGRMB19	4237	3060	**3648**	2550	1717	**2133**	67.22	59.34	**63.28**	6787	4777	29.62
DGRMB5	4117	2900	**3508**	2462	1503	**1983**	67.77	59.34	**63.56**	6578	4403	33.06
Mean	**4082**	**2673**	**3378**	**2421**	**1456**	**1938**	**66.74**	**57.29**	**62.02**			
LSD (0.05)												
Treatment (T)	269			109			1.33					
Level (S)	188			146			0.83					
TXS	325			254			1.44					

Isolation, identification and characterisation of high temperature tolerant rhizobia, PGPR and endophytes from Bikaner

From the plant and soil samples collected from RRS, Bikaner, 218 putative endophytes, 28 DAPG-producing fluorescent pseudomonads and 20 rhizobial isolates were obtained. Detailed characterisation is being taken up.

Identification and advancement of F_1s from two crosses effected during *Kharif*, 2021

A total 56 mature crossed pods were harvested

Table 9.4. Details of the crosses

S.No.	Cross	Number of crossed pods sown	Number of true /probable F_1s identified
1	DGRMB 5 X K 1812	24	7
2	DGRMB19 X K 1812	32	5

from two crosses using two donor sources, DGRMB 5 and DGRMB 19 during *Kharif*, 2021 and were sown in summer 2022. Total 12 true F_1 hybrids from two crosses were selected based on male parent characters as given in **(Table 9.4)**.

During kharif 2022, a total of two new crosses were effected targeting salinity tolerance with high yield using DGRMB 5 and DGRMB 19 donor parents. A total 128 mature crossed pods were harvested from two crosses (Table 9.5) with mean success rate 40.09%.

Generation advancement:

Total 12 true F_1s selected from two crosses during summer, 2022 were sown to generate F_2 generation during *Kharif*, 2022. Total 134 single plants (SP) from two crosses (DGRMB 5 x K 1812-95SP & DGRMB15 x K 1812- 39 SP) in F_2generation were selected and forwarded to next generation.

Table 9.5. List of crosses undertaken for salinity tolerance

S. No.	Name of Cross	Purpose	Bud pollinated	No. F_1 pods	Success (%)
1	DGRMB 5 × RG 638	Salinity tolerance with high yield	165	73	44.24
2	DGRMB 19 × DH 256	Salinity tolerance with high yield	153	55	35.95

Project 10: Microbial management of major foliar fungal diseases of groundnut and variability analysis in pathogens

PI: *Rinku Dey*

Co-PI: *Ananth Kurella, Chandramohan S., Narendra Kumar, and Raja Ram Choudhary*

Evaluation of epiphytes for management of Alternaria leaf blight in groundnut

Phyllosphere or epiphytic bacteria can be used as potential biological control agents for air-borne fungal pathogens. Five epiphytic bacteria viz. *Bacillus amyloliquefaciens* 13S3, *Bacillus subtilis* 1S1, *Bacillus subtilis* 5S1, *Bacillus subtilis* 7S2 and *Bacillus amyloliquefaciens* 9S2 were evaluated for their efficiency in minimizing the incidence of Alternaria leaf blight in groundnut. Evaluation of epiphytes during summer 2022 for management of Alternaria leaf blight indicated that the severity of leaf blight reduced from a score of 6.0 (1-9 scale) in uninoculated control to 4.0 when sprayed with *Bacillus subtilis* 5S1, *Bacillus subtilis* 7S2, and *Bacillus amyloliquefaciens* 9S2 (Table 10.1). 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 15%, which was at par that of 5S1 and 7S2. Inoculation with these epiphytes also resulted in enhancement of haulm yield, shelling outturn and hundred kernel mass.

Evaluation of epiphytes for management of leaf spots in groundnut

Five epiphytic bacteria viz. *Bacillus subtilis* 1S1, *Bacillus subtilis* subsp. *inaquosorum* 4S4, *Bacillus subtilis* subsp. *velezensis* 14E1, *Bacillus subtilis* 19S5 and *Bacillus* sp. 42S1 were evaluated for their efficiency in minimizing the incidence of leaf spots in groundnut. Evaluation of epiphytes during *kharif* 2022 for management of early leaf spot, late leaf spot and rust indicated that application of epiphytes, reduced disease severity of ELS from a score of 8.0 (1-9 scale) in uninoculated control to 6.0 in isolate 1S1, 4S4, 19S5 and 42S1, respectively (Table10.2). In case of LLS, it was 8.0 in uninoculated control to 6.0 in treatments with epiphyte isolates 4S4, and 19S5. In case of rust, the disease score was 8.0 in

2

Table 10.1. Effect of application of epiphytes on growth, yield and control of Alternaria leaf blight of groundnut (cv TG37A) during summer 2022

Treatment	HY (kg/ha)	PY (kg/ha)	SOT (%)	HKW (g)	Disease score
					(1-9 scale)
Control	4200	2167	61.86	38.23	6
Bacillus subtilis 1S1 (EPI-1)	4300	2370	62.65	38.93	5
Bacillus subtilis 5S1 (EPI-2)	4513	2480	64.92	39.77	4
Bacillus subtilis 7S2 (EPI-3)	4700	2417	63.75	39.59	4
Bacillus amyloliquefaciens 9S2 (EPI-4)	4553	2493	64.42	39.90	4
Bacillus amyloliquefaciens 13S3 (EPI-5)	4267	2223	62.19	38.53	5
CD (0.05)	**333**	**204**	**1.22**	**0.88**	

Note: Disease score in infector row was 8, 9, and 9 for ELS, LLS and rust respectively

uninoculated control and reduced to 6.0 with isolate 4S4 and 19S5. The disease score of ELS, LLS and rust in infector row was 8.0, 9.0 and 9.0, respectively. Simultaneously, there was improvement in pod (17-21%) and haulm yield of groundnut (cv TG37A) significantly when inoculated with *Bacillus subtilis* 19S5 and *Bacillus subtilis* subsp. *inaquosorum* 4S4.

Disease reaction of genotypes for identification

Table 10.2. Evaluation of epiphytes for management of foliar fungal diseases in groundnut (cv TG37A) during *kharif* 2022

Treatment	PY (kg/ha)	HY (kg/ha)	SOT (%)	HKW (g)	Disease score (1-9 scale)		
					ELS	LLS	Rust
Control	1840	2830	63.53	32.37	8	8	8
Bacillus subtilis 1S1	1903	2860	65.05	32.43	6	7	7
Bacillus subtilis subsp. *inaquosorum* 4S4	2153	3407	65.44	33.75	6	6	6
Bacillus subtilis subsp. *velezensis* 14E1	1887	2920	64.90	32.60	7	7	8
Bacillus subtilis 19S5	2237	3440	65.17	34.13	6	6	6
Bacillus sp. 42S1	2093	3106	65.10	32.68	6	7	8
CD (0.05)	272	397	NS	1.00			

of differential sets

A set of 40 genotypes were sown in field in summer 2022 to see their disease reaction (Alternaria especially), but due to less disease pressure Alternaria scoring was recorded in between 2-4 in all the genotypes. Besides, soil-borne disease incidence (Collar rot recorded highest 23% in RHRG- 6083 and stem rot recorded a highest 18% in GJG-17) were also recorded.

During *kharif* 2022, a set of 40 genotypes were sown to see their disease reaction in field, and net house conditions. In field condition, K-1812 and JL-776 showed resistance reaction to rust (3 score), and in net house condition no genotype showed resistant reaction, but genotypes VRI-6, Dh-4-3, HNG-10, ICGV-00350, JL-24, ICGV-86590, GJG-17, JS-88 and FDRS-79 showed moderate resistance reaction (4 score).

Evaluation of DAPG-producing fluorescent pseudomonads, endophytes, and epiphytes for antagonistic activity against *Fusarium* wilt (Bikaner)

A pilot experiment was conducted at Bikaner to evaluate fluorescent pseudomonads, epiphytes, and endophytes for antagonistic activity against Fusarium wilt at Bikaner. Application of nine epiphyte isolates reduced mortality from 35% in control (uninoculated) to 14-30% for Fusarium wilt at Bikaner. Application of endophyte isolate J31, as seed treatment, reduced mortality from 38% in

Table 10.3. Details of segregating materials forwarded and rejected in summer 2022

SN	Cross	Generation	SPP sown	Selection
1	GJG 34 × NRCGCS-298	F4	11	14
2	TG-37A × NRCGCS 298		10	8
3	TPG 41 × NRCGCS 298		9	3
4	TG-37A × PBS 22131		3	2
5	TPG 41 × PBS 22131		2	3
6	TG 37 A × CS 298		30	22
7	TPG 41 × CS 298		7	5
8	TG 37 A × PBS 22131		14	6
9	TPG 41 × PBS 22131		8	5
			94	**68**
1	GG 2 × CS 298	F5	7	2
2	Dh 86 × CS 298		4	2
3	GJG 31 × CS 298		7	2
4	Kadiri 6 × CS 298		5	2
5	Kadiri 6 × PBS 22131		3	2
6	TG 37 A × CS 298		17	11
7	TPG 41 × CS 298		14	6
8	TG 37 A × PBS 22131		15	4
9	TPG 41 × PBS 22131		13	12
			85	**43**
1	TG 37 A × CS 186	F6	7	2
2	TPG 41 × CS 74		1	0
			8	**2**
		Total	**187**	**113**

Table 10.4 Details of segregating materials forwarded and rejected in kharif 2022

SN	Cross	Harvest pod Generation	Sown SPP	SPP Selected
1	GJG 22 × KDG 128	**F3**	5	2
2	RG 559-3 × KDG 128		4	4
3	TG 37A × KDG 123		11	7
4	RG 559-3 × KDG 123		4	3
			24	**16**
1	TG 37A × KDG 128	**F4**	39	15
2	KDG 128 × TG37A		28	20
3	GG-20 × RHRG 6083		11	0
4	RHRG 6083 × GG-20		40	5
			118	**45**
1	ICGV 00351× NRCGCS-298	**F5**	10	3
2	KDG-128 × GJG-22		41	24
3	JL-776 × Dh 256		19	2
4	KDG-123 × GJG-19		19	15
5	GG 20 × (TG 37 A × GPBD 4)	BC2 F5	11	9
6	TG 37 A × (GG 20 × GPBD 4)	BC2 F5,	9	3
7	GG 20 × GPBD 4	F5,	8	5
8	TG 37 A × GPBD 4	F5,	28	12
9	GG20 × (GG 20 × GPBD 4)	BC1F5 P1,	16	16
10	TG 37 A × (TG 37 A × GPBD 4)	BC1F5 P1	8	7
			168	**96**
1	TG 37 A x KDG 128	F6	8	8
2	GG 20 x GPBD 4	F6	30	17
3	TG 37 A x GPBD 4	F6	43	20
4	GG-7 × KDG-128	F6	13	7
5	GG 20 × (GG 20 × GPBD 4))	BC2F6,	3	3
6	TG 37 A × (TG 37 A × GPBD 4))	BC2F6,	3	4
7	GG20 × F1(TG 37 A × GPBD 4)	F6	5	2
8	TG 37 A × F1(GG 20 × GPBD 4)	F6	3	1
9	TG-37A × GPBD-4 A Hetro	BC2 F6	7	4
10	TG-37A × GPBD-4 B Homo	BC2 F6	6	5
11	GG-20 × GPBD-4 A Hetro	BC2 F6	8	4

12	GG-20 × GPBD-4 B Homo	BC2 F6	3	3
13	TG-37A × (TG-37A × GPBD-4)	BC2 F6	24	12
14	GG-20 × (GG-20 × GPBD-4)	BC2 F6	34	19
15	GJG 34 × NRCGCS-298	F6	14	10
16	TG-37A × NRCGCS 298	F6	8	4
17	TPG 41 × NRCGCS 298	F6	3	0
18	TG-37A × PBS 22131	F6	2	4
19	TPG 41 × PBS 22131	F6	3	1
20	TG 37 A × CS 298	F6	22	18
21	TPG 41 × CS 298	F6	5	5
22	TG 37 A × PBS 22131	F6	6	5
23	TPG 41 × PBS 22131	F6	5	3
			258	**157**
1	GG 20 × GPBD 4	F7	10	PBS 22179
2	TG 37 A × GPBD 4	F7	15	PBS 12252 PBS 12253
3	GG-7 × KDG-123	F7	6	PBS 12254 PBS 12255
4	GG 2 × CS 298	F7	2	PBS 12256
5	Dh 86 × CS 298	F7	2	Rejected
6	GJG 31 × CS 298	F7	2	PBS 12257
7	Kadiri 6 × CS 298	F7	2	PBS 12258
8	Kadiri 6 × PBS 22131	F7	2	PBS 12259
9	TG 37 A × CS 298	F7	11	PBS 22180
10	TPG 41 × CS 298	F7	6	PBS 12260
11	TG 37 A × PBS 22131	F7	4	PBS 12261
12	TPG 41 × PBS 22131	F7	12	PBS 12262
			74	
53			**642**	**327**

Summer 2022

SN	Generation	Crosses (no.)	**SPP sown**	**SPP Selection (no.)**
1.	F4	9	94	68
2.	F5	9	85	43
3.	F6	2	8	2
		20	**187**	**113**

2

Kharif 2022

SN	Generation	Crosses (no.)	SPP sown	SPP Selection (no.)
1.	F2	4	24	16
2.	F3	4	118	45
3.	F4	10	168	96
4.	F5	23	258	157
5.	F6	12	74	13ABLs (SB-11, VB-2)
		53	**642**	**314**

control (uninoculated) to 11% for Fusarium wilt.

Generation advancement of segregating materials to different filial generations

A total of 187 single plant progenies of 20 crosses in F_4 (94), F5 (85), F6 (8) generation of *Alternaria* leaf blight resistance were advanced to next filial

SN	Cross	Harvest pod Generation	Objective
1	TG 37A × KDG 123	**F3**	Leaf spot and rust resistance
2	TG 37A × KDG 128	**F4**	Leaf spot and rust resistance
3	KDG 128 × TG37A	**F4**	Leaf spot and rust resistance
4	GG 20 × (TG 37 A × GPBD 4)	BC2 F5	Leaf spot and rust resistance
5	TG 37 A × (GG 20 × GPBD 4)	BC2 F5	Leaf spot and rust resistance
6	GG 20 × GPBD 4	F5	Leaf spot and rust resistance
7	TG 37 A × GPBD 4	F5	Leaf spot and rust resistance
8	GG20 × (GG 20 × GPBD 4)	BC1F5	Leaf spot and rust resistance
9	TG 37 A x KDG 128	F6	Leaf spot and rust resistance
10	GG 20 x GPBD 4	F6	Leaf spot and rust resistance
11	TG 37 A x GPBD 4	F6	Leaf spot and rust resistance
12	GG-7 × KDG-128	F6	Leaf spot and rust resistance
13	GG 20 × (GG 20 × GPBD 4))	BC2F6	Leaf spot and rust resistance
14	TG 37 A × (TG 37 A × GPBD 4)	BC2F6	Leaf spot and rust resistance
15	GG-20 × GPBD-4 A Hetro	BC2 F6	Leaf spot and rust resistance
16	GG-20 × (GG-20 × GPBD-4)	BC2 F6	Leaf spot and rust resistance
17	GJG 34 × NRCGCS-298	F6	Alternaria leaf blight resistance
18	TG-37A × NRCGCS 298	F6	Alternaria leaf blight resistance
19	TG-37A × PBS 22131	F6	Alternaria leaf blight resistance
20	TG 37 A × CS 298	F6	Alternaria leaf blight resistance
21	TG 37 A × PBS 22131	F6	Alternaria leaf blight resistance

generation in summer 2022 at DGR, Junagadh. Among them, a total of 113 single plants were selected in F_4 (68), F5 (43), F6 (2) generation at the time of harvesting based on good recombinants and presence of desirable trait in the recombinants. Highest number of selections were in the cross TG37A × NRCGCS-298 (22).

A total of 642 progenies of 53 crosses (F_2:4, F_3:4, F_4:10, F_5:23, F_6:12) of leaf spot and rust resistance were advanced to next filial generation in *kharif* 2022. Among them 315 progenies were rejected at the time of harvesting due to large proportion of poor recombinants and absence of desirable trait in the recombinants and 327 progenies were advanced to next filial generation. A total of 18 crosses were in early generations (up to F_4) and 35 in advanced generation. Single plant progenies of twelve cross were raised in F_6 generation and identified 13 new advanced breeding lines of Spanish bunch (11) and Virginia bunch (2).

Distribution of breeding materials to different AICRP-G centres

The breeding material of 21 different crosses from four segregating generations (F_3 to F_6 generation) were selected during *kharif* 2022 to supply to AICRP-G centres for location specific selections for leaf spot and rust and *Alternaria* leaf blight.

3 Crop Protection

Project 11: Management of White grubs, Bruchid beetle, Spodoptera and Helicoverpa in groundnut

PI: *Harish G.*

Co-PIs: *Rinku Dey; Nataraja MV*

Seasonal incidence of insect pests of groundnut

Seasonal incidence of insect pests of groundnut was studied by sowing groundnut every month under unprotected condition. Sucking pests and natural enemies were estimated using sweep net catches. Thrips and leafhopper population was found throughout the year, but we observed one significant peak during 8th Standard week during rabi-summer. In *kharif* thrips population was high at 34th standard week. Natural enemies like spider and lady bird beetles were observed. Spider population was high during *kharif* at 46th standard week.

Effect of different types of stickers and systemic insecticides in management of groundnut sucking pests

An experiment was conducted in Entomology experimental plots to manage sucking pests using three stickers i.e., Spreaders, wetting agent and surfactants were tested along with two systemic insecticides Imidacloprid 17.8 SL and Thiamethoxam 25% WG along with absolute control. Imidacloprid + Spreaders was found to be effective in managing sucking pests over control. Highest pod yield of 1623 kg per ha was also obtained from the same treatment.

Effect of combination insecticide in management of Groundnut sucking pests

An experiment was conducted in Entomology experimental plots to manage sucking pests using three combination insecticides along two systemic insecticides Imidacloprid 17.8 SL and Thiamethoxam 25% WG along with absolute control. Imidacloprid 17.8 SL was found to be effective in managing sucking pests over control. Among combination insecticide Acephate 50% + Imidacloprid 1.8% SP was found effective in managing the sucking pests.

Project 12: Development of rapid detection techniques of Peanut Bud Necrosis and Tobacco Streak Viruses in groundnut

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

PI: *Nataraja MV**

Co-PIs: *Ananth Kurella, Harish G and Paparao Vaikuntapu*

*On extended study leave from April 19, 2021 to April 11, 2022

Rabi-summer 2021-22

TSV was mechanically sap-transmitted with the samples obtained from ARS-Kadiri on the indicator hosts namely, Pusa Komal (cowpea) and K-6 (groundnut) in the net-house. No symptoms were observed on the indicator hosts even after repeated transmissions.

Kharif 2022

TSV and PBND were mechanically sap-transmitted with the samples obtained from ARS-Kadiri and Raichur on the indicator hosts namely, Pusa Komal (cowpea) and K-6 (groundnut) in the net-house. Mild symptoms (chlorotic spots) were observed on the indicator hosts.

4 Highlights of AICRP on Groundnut

Inputs: Praveen Kona* and Nataraja Maheshala**

*Nodal Officer, AICRP-G till December 2022

**Nodal Officer, AICRP-G since January 2023

1. Crop Improvement

Maintenance of groundnut germplasm

A total of 5457 germplasm accessions were being maintained at 10 centres till 2021. This included 32 wild accessions; 2994 Spanish bunch accessions; 40 Valencia accessions; 1190 Virginia Bunch accessions; 324 Virginia Runner accessions; and 877 wild derivatives.

Hybridization Program

For developing high-yielding groundnut cultivars possessing resistance to various biotic and abiotic stresses, which limit yield, a hybridization programme was undertaken in *rabi*-summer and *Kharif* seasons respectively at 11 and 17 AICRP-G centres. Altogether, 132 and 214 single-crosses using different cultivars/advanced breeding lines, germplasm accessions were made respectively during *rabi*-summer 2020-21 and *Kharif* 2021.

Advancement of generations and selections made in inter- and intra- varietal crosses

Segregating generations of objective-specific inter- and intra- varietal crosses effected at eleven AICRP-G centres earlier were advanced to their respective next higher filial generations during *rabi*-summer 2020-21. Progenies of 472 crosses were advanced to their respective next filial generation from which a very large number (4146) of selections were made. The selections comprised mostly of single plants (3779), rest were progeny bulks (367). Of the total crosses, which were advanced to different filial generations, most (301 crosses) crosses were in early generations (F1- F4) and only few (167) crosses in advanced generations (F4 onwards). Among selections made in early generation, most (2361) of them were of single plants and few (5) are of line bulks. Whereas in the advanced generations, 362 selections were of line bulks and 1418 were of single plants.

During *Kharif* 2021, different segregating generations of objective specific inter-varietal and intra-varietal crosses effected at 17 AICRP-G centres, were advanced to their respective next filial generations. Progenies of 961 crosses were advanced to their respective next filial generation from which very large numbers of (19524) selections were made. The selections comprised of large number (13176) of single plants and 6348 progeny bulks. Of the total crosses, which were advanced to different filial generations 619 crosses were in early generations (F_1- F_4) and 342 crosses in advanced generations (F_5 onwards). A vast majority (91%) number of single plant selections made during the last season were in early generations (11967) and the rest (1209) in advanced generations.

Varietal evaluation at multi-locations

A three-tier system of evaluation of groundnut entries under the nomenclature of Initial Varietal Trial, Stage I (IVT I) ; Initial Varietal Trial, Stage II (IVT II) and Advanced Varietal Trial (AVT) was adopted and the trials were allotted to different centres located in five Agro Ecological Zones of groundnut.

During *rabi*-summer 2020-21, under IVT I, 14 entries of Spanish Bunch group were tested in all the five zones along with national check (TAG 24), respective zonal checks and trial was allotted to 20 centres. The trials would be repeated as such in all the centres in *rabi*-summer 2021-22, by using the harvest of IVT-I at each centre as the source of seed for IVT II. Under IVT I & II (pooled), 12 entries of Spanish Bunch group were tested in five zones with respective zonal checks and the trial was allotted to 20 centres. Test genotypes, J-107 and AG 2015-10 were promoted to AVT in Zone II. In AVT (SB), one entry J 100 was tested in Zone I at two centers along with five high yielding check varieties namely, DH 86 (ZC), TAG 24 (NC), Avtar (ZC), SG 99 (ZC) and J 87 (ZC). Test entry, J 100 recorded lower pod and kernel yields than best check variety. Hence, J 100 was not recommended for identification. Likewise, in Zone IIIa, four entries J 100, K 1812, GKVK 27 and TG 84 were tested at four centres along with four high yielding check varieties namely TAG 24 (NC), R2001-3 (ZC) K. Harithandhra (ZC) and Dh 257 (ZC). Based on test results of 12 environments, test entry K 1812 recorded 3% higher pod and -0.5% kernel yield than Dh 257. However, K 1812 was already released in 2020 and recommended for cultivation during *Kharif* season in southern states. On the other hand Dh 257 was released in 2020 and recommended for cultivation during *rabi*-summer season in Zone IIIa. Since, test entry K1812 was released in 2020 and recommended for cultivation in *Kharif* season and also performed at par with the best check, Dh 257 which was also released in 2020 for *rabi*-summer cultivation in Zone IIIa. Hence, test entry K1812, a very high yielding and popular variety for *Kharif* cultivation was recommended for identification and release in Zone IIIa for *rabi*-summer cultivation. Under Salinity Tolerance Varietal Trial (SB), 12 entries were tested at salinity prone locations (Mahuva, Kothara, Mandvi, Kumta and Nimpith) against TG37A, GG2, GG7 and GJG 32 as check varieties. This trial is to be repeated as such at all the centres in *rabi*-summer, 2021-22 by using the produce of IVT I harvested at each centre as seed for IVT II.

During *Kharif* 2021, under IVT I, 10 entries of Spanish Bunch group were tested in all the five zones along with respective zonal checks and trial was allotted to 24 centres. Similarly, 8 entries of Virginia Bunch group were tested in four zones (except for zone III) with respective zonal checks and the trial was allotted to 22 centres. The trials would be repeated as such in all the centres in *Kharif* 2022, by using the harvest of IVT-I at each centre as the source of seed for IVT II. Under IVT II Spanish Bunch trial, two genotypes namely VG19721 and TCGS 1707 were promoted to AVT based on their performances respectively in Zone II and Zone IV. Similarly, in IVT II Virginia Bunch trial, one genotype VG 19535 was promoted to AVT based on its performance in Zone I. In AVT (VB), one entry RG 638 was tested in Zone I at seven centers along with four high yielding check varieties namely Raj Mungfali 3 (ZC), Divya (NC), HNG 123 (ZC), and HNG 69 (ZC). Across the six locations test genotype RG 638 recorded significantly higher (more than 10%) pod and kernel yield over the best check. Based on pooled analysis of IVT I, IVT II and AVT, test genotype RG 638 recorded more than 26%, 27% and 31% higher pod yield over check varieties, Divya, Raj Mungfali 3 and HNG 69, respectively. In addition to RG 638 recorded more than 32%, 34% and 40% higher kernel yield over check varieties, Divya, Raj Mungfali 3 and HNG 69, respectively. Moreover, RG 638 had very high shelling per cent (74%) and large kernel size (56 g per 100 kernel). Hence, test genotype RG 638 was recommended for identification in Zone I.

During *Kharif* 2021, under Large Seeded Varietal Trial (LSVT) I, five entries were tested with four checks at eight centres, all excepting Digraj centre have conducted and reported the trial data. Trial will be repeated as such in all the centres in *Kharif* 2022 by using the harvest of LSVT I at each centre as the source of seed for LSVT II. Under LSVT I & II (pooled), four entries were tested with three checks (GJG-HPS-1, GJG-HPS-2 and Mallika) at five centres. Across the four locations and over two years, the test genotype K 1736 recorded 10% higher kernel yield than best check, GJG-HPS-2 (ZC), hence promoted to AVT. Under Salinity Tolerant Varietal Trial (STVT) I & II (pooled), this trial, thirteen entries were tested with four checks (TG 37A, GG 2, GG 7 and GJG 32) at Mandvi and Kothara. Across the two locations and over two years test genotype TG 85 recorded more than 10 % higher pod and kernel yield than the best checks. Hence, TG 85 was promoted to AVT. However, performance of test entry, TG 85 under salinity stress must be tested in collaboration with ICAR-CSSRI, Karnal as approved in the 2021 AGM. In High Oleic Varietal Trial (HOVT) I (SB), 12 entries were tested at six centres along with five check varieties. The trial will be repeated as such in all the centres in *Kharif* 2022, by using the harvest of HOVT I at each centre as the source of seed for HOVT II. In High Oleic Varietal Trial (HOVT) I (VB), five entries were tested at six centres along with four check varieties. The trial will be repeated as such in all the centres in *Kharif* 2022, by using the harvest of HOVT I at each centre as the source of seed for HOVT II. In HOVT I & II (pooled) (SB), five entries were tested at six centres along with four check varieties. None promoted to AVT. Similarly, in HOVT I & II (pooled) (VB), four entries were tested at six centres along with three check varieties. None promoted to AVT.

During *Kharif* 2021, In Advanced High Oleic Varietal Trial (AHOVT) (SB), two high oleic entries ICGV 16668 and ICGV 16690 were promoted tested in six centres along with five high yielding varieties. Yield of test entries were lower than the check varieties. Hence, none of the test entries were recommended for identification. In Special Trial on Near Isogenic Lines (NILs) (SB), three NILs developed through MABC approach for enhancing resistance to LLS and Rust were tested against LLS and Rust in Junagadh, Dharward and Aliyarnagar locations under both field and artificial inoculated conditions. The NIL, ICGV 14421 was found superior over recurrent parent ICGV 91114 for LLS and Rust diseases. Moreover, ICGV 14421 had 44.8% and 45.8% pod and kernel yield superiority over recurrent parent ICGV 91114 which has been reported in AGM 2016 and AGM 2017. Hence, ICGV 14421 was recommended for identification in Zone V for cultivation during *Kharif* season subjected to fulfilling the national guidelines for release of NIL.

Status of Groundnut Breeder Seed Production 2021-22

During *Kharif* 2021, DAC indents to the tune of 9144.65q (9151.65q) of breeder seeds were received for 60 groundnut varieties. Based on the availability of nucleus/breeder seed stage I, a production target of 9377.95q was assigned for 58 groundnut varieties to 23 centres. During *Kharif* 2021, a total quantity of 4718.10q breeder seed could be produced. To mitigate the short fall, a compensatory programme was undertaken during *rabi*-summer 2021-22 and the anticipated production is about 11483.30q. Thus, the total expected production of groundnut breeder seeds during 2021-22 would be 16201.40q.

2. Crop Production

A. Rabi-summer 2020-21

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

This experiment was being conducted at Puducherry and Rahuri for continuously for three years. At Puducherry, an application of Fluorescent Pseudomonas FP 86 recorded significantly the highest pod yield (3953 kg/ha) as compared to over control (2887 kg/ha) whereas at Rahuri, an application of FP-98 recorded higher pod yield (3052.37kg/ha).

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

This experiment was conducted at three centres for consecutive three years. At all the centres viz., Akola, Tindivanam and Vriddhachalam significantly highest dry pod yield was recorded with an application of 75 % RDF + 2.0 % WSF (water soluble fertilizer) at 45, 60 and 75 DAS.

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

This experiment was conducted at seven centres for consecutive three years. At Bhubaneswar, Jhargram, Puducherry and Tirupati, an application of 60 kg/ha of P to Groundnut with DGRC strain treatment obtained higher yield, while at Junagadh, Tindivanam and Vriddhachalam, an application of 40kgP /ha + PSB culture @ 15 g/kg recorded significantly higher pod yield.

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

This experiment was conducted at Akola, Bhubaneswar and Kadiri for three years in sequence. At both the centres, significantly highest dry pod yield recorded by treatment consisting of two manual weeding at 20 and 40 DAS and was at par with treatments "Pendimethalin 30EC + Imazethapyr 2EC @ 1.0 kg/ha PE (Ready mix) + quizalofop-p-ethyl @ 50 g/ha at 15-20 DAS" and "Pendimethalin 30EC + Imazethapyr 2EC @ 1.0 kg/ha PE (Ready mix) + manual weeding at 25-30 DAS".

5. Identification of optimum sowing window and irrigation scheduling in *rabi* groundnut

This experiment conducted at Palem for three successive years. Highest pod yield ha^{-1} was obtained with irrigation scheduling at 1.0 IW/CPE ratio and was on par with 0.8 IW/CPE ratio. The sowing of groundnut on October 15th was found beneficial in terms of dry pod yield per ha.

6. Optimization of seed rate in *rabi* groundnut

This experiment conducted at Palem for three successive years. Line sowing with seed rate @ 200 kg ha^{-1} has recorded significantly higher pod yield over farmers practice with seed rate of 250 and 300 kg ha^{-1}.

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

This experiment was conducted at Palem for three successive years. Highest pod yield ha was obtained with irrigation scheduling at 1.0 IW/CPE ratio and was on par with 0.8 IW/CPE ratio. The sowing of groundnut on January 15th was found beneficial in terms of dry pod yield per ha.

8. Evaluation of groundnut cultivars for dates of sowing in summer

This experiment conducted for two years with different sowing window and varieties at Rahuri and Kadiri. At Rahuri, pooled data of two years indicated that the sowing of summer groundnut on 15th February (6th MW) produced significantly highest dry pod yield. Groundnut variety Phule Unnati and Phule-6021 performed equally. At Kadiri, pooled data of two years showed that groundnut cultivar Kadiri Chitravathi recorded higher pod yield but on par with Kadiri Amaravathi and both were significantly superior over Dheeraj and Kadiri 6. Among the different dates of sowings, varieties sown on 5th May recorded higher pod yield but on par with the varieties sown on April 20th and significantly higher over sowings on 5th April and 20th March.

9. Effect of green manure incorporation on yield of groundnut crop

This experiment conducted at Tindivanam. Pooled data of two years indicated that sunhemp and Daincha was incorporated one month prior to the groundnut crop sowing. After well decomposition of green manures groundnut crop sown along with different nutrient management practices. The higher pod yield was recorded from the treatment having sunhemp incorporation along with 75% RDF application and it was on par with 100% RDF.

10. Response of groundnut to limited irrigation during post rainy/summer season

This experiment conducted at nine different centres and it was first year of experimentation.

Bhubaneswar: Application of 420 mm of water to groundnut crop incurred significantly highest yield and at par with application of 336 mm of water. Dharwad and Hiriyur: The significantly higher yield was noticed with 420 mm of water and was at par with limited irrigation of 70% of normal without and with foliar application of 0.5% KNO_3 at 50 DAS.

Junagadh: Significantly higher pod yield was recorded by application of 100 % irrigation (420 mm of water) was remained at par with 80% of normal irrigation and 70% of normal irrigation with foliar application of 0.5% KNO_3 at 50 DAS.

Kadiri: Higher pod yield with normal irrigation (420 mm of water) and it was at par with 70% of normal irrigation with and without foliar application of 0.5% KNO_3 at 50 DAS and 60% of normal irrigation with foliar application of 0.5% KNO_3 at 40 and 60 DAS.

Jhargarm: Significantly highest pod yield of groundnut was observed under plot received 100% of recommended irrigation (420 mm of water.)

Palem: Application of 420 mm of water at different growth stages recorded highest pod yield and on par with an application of 294 mm of water and foliar application of 0.5 % KNO_3 at 50 DAS.

Tirupati: Groundnut irrigated with 420 mm (check) has recorded significantly higher per hectare pod yield. While 80% of normal irrigation remained statistically at par with

70% of normal irrigation with and without foliar application of 0.5% KNO_3 at 50 DAS and 60% of normal irrigation with foliar application of 0.5% KNO_3 at 40 and 60 DAS. Tindivanam: The result of the experiment revealed that the treatment 70% of normal irrigation with foliar application of 0.5% KNO_3 at 40 and 60 DAS performed superior over other treatments with respect to pod yield.

11. Effects of potash solublizing bacteria and levels of potash on growth, yield and quality of summer groundnut

This experiment conducted at only one centre. The summer groundnut sown with application of 100% RDK (Recommended dose of potassium) dose produced significantly highest dry pod yield and B: C ratio (2.90) and it was at par with 75 % RDK with potash by seed treatments of Potash solubilizing bacteria.

12. Alleviation of salinity stress in groundnut by application of endophytic microorganisms

This experiment was conducted at Kothara, Mandvi, Puducherry, Nimpith, Kadiri, Dharwad, Hiriyur and Goa. At Kothara and Mandvi, Endophyte 5 whereas at Puducherry, Endophyte 3, while at Nimpith, Kadiri and Hiriyur, endophyte 2 and at Dharwad, all the entophytes (1-5) performed equally in alleviating soil salinity in coastal sandy soil.

13. Agronomic management of AVT

At Dharwad, the optimum plant spacing for AVT entries TG 84 and J 100 would be 30 x 10 cm with 100% RDF *i.e.*, FYM @ 7.5 t ha^{-1}, N: P2O5:K2O @ 18: 71: 25 kg ha^{-1} and $FeSO_4$ and ZnSO4 @ 25 kg ha^{-1}. At Rahuri, AVT Entry: GKVK-27: GKVK-27 produced significantly higher dry pod yield with existing 100% RDF of 25.0:50.0:00 kg ha^{-1}.

B. Kharif

1. Integrated water management in rainfed groundnut

This experiment was conducted at Durgapura. Three years results indicated that combined application of hydrogel, endophytic bacteria and mulching (Use of hydrogel @ RR or 2.5 kg/ha + Mulching of agrowaste/ 5 t/ha+ Endophytic bacteria) produced comparable pod yield with application of one life saving irrigation and significantly higher over farmers practice and individual application of hydrogel, endophytic bacteria, interculture and mulching.

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

At Durgapura, mean of 3 years results after three cycles of wheat-groundnut rotation indicated that groundnut sown on permanent beds with and without residue produced significantly higher pod over reduced till (without residue) and conventionally till plots. Likewise, the wheat sown on permanent beds with and without residue produced significantly higher grain over reduced till and conventionally till plots. The system wise result shows that sowing of both the crops (wheat and groundnut) on permanent beds with and without residue produced significantly higher groundnut equivalent yield over reduced till and conventionally till plots.

At Jalgaon, mean of three years data indicated that after harvesting of wheat, the groundnut crop sown on reduced tillage (one blade harrowing just after harvesting of wheat) with residue incorporation produced favourable effect on growth, yield and monetary returns over rest of the treatments.

3. **Integrated weed management in *kharif* groundnut**

At Palem, three years mean data showed that higher yield of pod was obtained with two manual weedings at 20 and 40 DAS (24.2) over other treatments and was on par with Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} PE (ready mix) + manual weeding at 25-30 DAS (22.4) and Pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} PE (ready mix) + quizafop – p-ethyl @ 50 g ha^{-1} at 15-20 DAS.

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

At Durgapura, based on three years results it can be concluded that planting of medium and bold seeded groundnut cultivars namely RG-510 (HKW-50 gm), RG-578 (HKW-55 gm) and RG-559-3 (HKW-75 gm) considering HKW and recommended plant population with seed rate of 111, 122 and 166 kg ha^{-1}, respectively is recommended for fetching higher productivity and profitability over their recommended seed rate (80, 80 and 80 kg ha^{-1}, respectively) without considering HKW. However, small seeded cultivars namely TG 37A (HKW 40 gm) and TAG 24 (HKW 45 gm) yielded statistically similar under recommended seed rate (100 kg ha^{-1}) and seed rate as calculated by considering HKW and recommended plant population (3.33 lakh plants/ha).

5. **Identifying optimum row ratio for rainfed groundnut + maize intercropping system**

At Dharwad, mean of *Kharif* 2019, 2020 and 2021 indicated that 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 was at par with sole groundnut. Significantly highest land equivalent ratio, gross monetary returns, net monetary returns and benefit: cost ratio was registered with intercropping of groundnut + maize (5:1) and was at par with sole groundnut and intercropping of groundnut with maize in 4:1 and 3: 1 row proportion.

6. **Identifying optimum row ratio for rainfed groundnut + bajra intercropping system**

At Bikaner, mean of *Kharif* 2019, 2020 and 2021 pod yield increase with increase in ratio of groundnut in intercropping situation, the highest pod yield was obtained under sole groundnut and yield decrease with intercropping except 5:1 (Groundnut: Bajra) which yielded at par with sole groundnut during all three seasons and on pooled mean basis. As far as system productivity is concerned the highest groundnut equivalent yield was obtained at sole groundnut followed by 5:1 and 4:1 (Groundnut: Bajra) ratios during three seasons and on pooled mean basis.

7. **Identifying suitable crop geometry and nutrient dose for Spanish bunch groundnut during *Kharif***

At Junagadh, mean of 2019, 2020 and 2021 showed that the crop geometry had significant effect due to different spacing (plant population). Significantly a higher pod yield was recorded by spacing of 22.5cm x 10cm. It was at par with spacing of 30cm x 10cm in pooled results. In respect to fertilizer, application of 100% RDF + Bio-fertilizer (*Rhizobium*, PSM, and KMB) recorded highest pod as compared to other treatments, which remained at par with the treatment of 75% RDF + Bio-fertilizer (*Rhizobium*, PSM, and KMB) and 100%RDF + Bio-fertilizer (*Rhizobium*, PSM, and KMB). Interaction was found significant effect on pod, significantly higher pod yield was recorded by 30cm x 10cm (3.33 lakh/ha pp) with 100% RDF + Bio-fertilizer (*Rhizobium*, PSM, and KMB).

8. **Effect of paclobutrazol on productivity of groundnut**

At Vijayanagram, mean of 2019, 2020, and 2021, foliar application of paclobutrazol @ 50 ppm conc. reduced the plant height by 16.9% and showed significant improvement in yield attributing characters like number of filled pods per plant, 100 kernel weight and shelling percent as compared to control. The same treatment (50 ppm conc.) has also recorded 9.6% improvement in pod yield, 15.9% improvement in haulm yield, 13.2% improvement in net income and 10.3% improvement in benefit cost ratio as compared to absolute control. Among different time of sprayings, paclobutrazol single spray at 50 DAE recorded higher yield attributing characters, pod yield, net income and benefit cost ratio as compared to single spray at 30DAE and double spray at 30 and 50 DAE.

C. FRONT LINE DEMONSTRATIONS (FLDS)

1. *Rabi*-summer

In the *rabi*-summer 2020-21, FLDs were allotted in 9 states and 1 UT having 15 groundnut research FLD centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Puducherry, Tamil Nadu, Telangana, Odisha and West Bengal. The FLDs were allotted on Whole Package (WP). The FLDs allotted were 275 FLDs and the results were received for 245 FLDs, from 13 centers which indicated 89 per cent of implementation. There were 9 new varieties' production potential and profitability was compared with 12 old ruling varieties which are cultivated with farmers' traditional cultivation practices. The average pod yield achieved was 2596 kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 2155 kg/ha with farmer's traditional practices. The yield increase observed was 21 per cent. The minimum yield difference observed was 11 percent and the maximum was 39 per cent.

The average cost of cultivation with improved practice was Rs.53982/ha in comparison with Rs.51887/ha with farmer's practice. The average Gross Marginal Returns with improved practice was Rs.145216/ha and Rs.120694/ha with respect to traditional practices. An average increase of 21% in gross returns was recorded with improved practices over the traditional farmer practices. Net returns observed was Rs.89802/ha and Rs.68756/ha for improved practice and farmer's practices respectively. An average increase of 34% in net returns was recorded with improved practices over the traditional farmer practices. The average B:C ratio was 2.68 and 2.31 for improved practice and farmer's practices respectively.

2. *Kharif*

During *Kharif*- 2021 FLDs were allotted in 9 states having 22 groundnut research FLD centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. The FLDs allotted were 597 FLDs for 22 centers and results were received for 587 FLDs, from 20 centers which indicated 98 per cent of implementation. There were 15 new varieties' production potential and profitability were compared with 16 old ruling varieties which are cultivated with farmers' traditional cultivation practices. The average pod yield achieved was 2346kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 1861 kg/ha with farmer's traditional practices. The yield increase observed was 31 per cent. The minimum yield difference observed was 3 percent and the maximum was 204 per cent. The average cost of cultivation with improved practice was Rs. 48764/ha in comparison with Rs.45137/ha with farmer's practice. The maximum observed was Rs. 83507/ha in improved practice and Rs. 81373/ha with farmer's traditional practice. The average Gross Marginal Returns with improved practice was Rs.125054/ha and Rs.103531/ha with respect to traditional practices. Net returns observed was Rs.81764/ha and Rs.56380/ha for improved practice and farmer's practices respectively. The average B: C ratio was 2.67 and 2.32 for improved practice and farmer's practices respectively.

3. Crop Protection

A. Plant Pathology

1. *Rabi*-summer

1.1. Monitoring of major diseases of groundnut

Highest disease severity (1-9 scale) for foliar diseases and highest disease incidence (%) for soil-borne diseases was observed at specific centres as 8 grades of Rust and LLS at Aliyarnagar; 19% disease incidence of collar rot at Bikaner; 23 % and 27.5% of stem rot and dry root rot, respectively at Kadiri; 9 grades of LLS at Vridhachalam; 6 grade of Alterneria leaf blight at Dharwad.

1.2. Screening of IVT-I, IVT-II, AVT and other coordinated trial entries for resistance/ tolerance to major diseases

There were total 12 genotypes showing multiple disease resistance across the centres. RST-I-2020-8, INS-I-2019-19, AIS-2019-2 and AIS-2020-6 genotypes at Junagadh showed resistance to both Collar rot and stem rot. AIS-2020-6 genotype showed multiple disease resistance for Collar rot and stem rot at Junagadh, dry root rot at Vriddhachalam, LLS & Rust at Aliyarnagar and PBND at Raichur. Genotypes, INS-I-2020-26, INS-I-2020-8, AIS-2020-7, RST-I-2020-12, INS-I-2019-12 showed stem rot resistance at Junagadh. At Raichur, RST-I-2020-12, INS-I-2020-8, RST-I-2020-3, INS-I-2020-23, AIS-2020-4 showed resistance to PBND. At Jalgaon, INS-I-2019-12 RST-I-2020-3, INS-I-2020-23 genotypes showed resistance to collar rot and INS-I-2020-26 for stem rot. AIS-2020-4 genotype at Aliyarnagar showed resistance to both LLS & Rust.

1.3. Relationship between thrips species and PBND

Predominant thrips species existed were *Scirtothrips dorsalis* Hood and *Thrips palmi* Karny in all the hotspot locations.

2. *Kharif*

2.1. Screening of NILs (ICGV 14421, ICGV 13189

4

Centre	PBND (%)	Thrips (No.)		Predominant weeds	Weed density (per 25 m^2)
		On Foliage	On flowers		
Kadiri	6.0 to 8.0	2-3	Nil	*Parthenium hysterophorus* and *Boerhavia erecta*	26 to 42
Pavagada	15-23	49-69	60-73	*Tridax procumbens* and *Argemone mexicana*	3 to 11
Raichur	16.33 to 26.50	16-26	28-38	*P. hysterophorus* and *T. procumbens*	16 to 36

PBND: Peanut bud necrosis disease

and ICGV 13207) against LLS and rust

Among the 8 NILs (coded ones) evaluated for their reaction against foliar diseases (LLS and Rust) both under field and artificial condition at DGR, Junagadh, Dharwad and Aliyarnagar.

- NIL 2021-2 recorded resistant reaction across the centres against LLS and rust
- NIL 2021-6 recorded resistant reaction against LLS and Rust in three centers for rust and two centers for LLS.
- NIL 2021-7 moderately resistant against Rust across three centers

2.2. Bio-intensive management of collar rot disease in groundnut

Seed treatment with *T. asperellum* @ 10 g/kg seed followed by Soil application of *T. asperellum* @ 6 kg/ ha enriched in 500 kg FYM/ha (T2) gave highest germination of seed (87.33 %) minimum collar rot incidence of 6.25 % with highest pod (4041 kg/ha) and haulm (5257 kg/ha) yield and having ICBR of 20.95 at Bikaner; significantly low collar rot % (8.8 %) with high pod (2198kg/ha) and Haulm yield (2590 kg/ha) by following Deep summer ploughing with mould board plough + Soil application of *Trichoderma asperellum* @ 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 *T. asperellum* @ 4 kg/ ha enriched in 250 kg FYM/ha at 35 and 80 DAS at Vriddhachalam.

2.3. Validation of storage bags against peanut storage pests

Among different types of bag used for storage of groundnut against bruchid infestation, PICS (Purdue Improved Crop Storage) bags was found most efficient with high germination of seed (67.0%) without damaged pods and bruchid infestation with or without release of bruchid before experiment even after eight months of storage at Kadiri; less pod damage (5.17 %), with low bruchid and corcyra population using PICS bags at Vriddhachalam; less per cent damage of pods with bruchid release (7.53 %) and no damage without release of bruchid even after 8 months of storage at Jalgaon using PICS bags.

2.4. Influence of dates of sowing and plant stand on incidence of peanut stem necrosis disease (PSND)/peanut bud necrosis disease (PBND) of groundnut

After three years of investigation (*kharif*, 2019, 2020 and 2021) on influence of agronomic practices like dates of sowing (4 Main levels; D1: 21-06-21;D2:05-07-21;D3: 20-07-21; D4: 05-08-21) and seed rate (2 sub-levels; P1: Normal population; seed rate @ 150 kg/ha; P2: Additional population; seed rate @165 kg/ha) against incidence of viral diseases *viz.*, peanut bud necrosis disease (PBND) and peanut stem necrosis disease (PSND) of groundnut, among main factors, early sowing (First date of sowing) with normal population has recorded significantly low PSND (14.8 %), thrip damage per cent (14.0 %) and significantly high pod yield (1569 kg/ha) and haulm yield

(2553 kg/ha) with high B.C ratio of 1:4.0 at Kadiri; Low PBND (6.25 %), thrips damage (30.0%), pod yield (2845 kg/ha) and haulm yield (4996 kg/ha) with high ICBR of 2.01 at Raichur; Low PBND (5.0 %), thrips damage (30.0 %), pod yield (813 kg/ha) haulm yield (2016 kg/ha) with high ICBR of 1.78 at Pavagada. Hence, it is concluded that groundnut sowings in June second fortnight and July first fortnight were best with respect to PBND and PSND incidence on groundnut during *kharif* season (Rainy season).

2.5. Bio-intensive integrated pest management in groundnut

Bio-intensive method (T1: Border crop (4 rows with jowar) + Tolerant groundnut variety Kadiri lepakshi + Seed treatment with *Trichoderma asperellum* @ 10 g/kg seed + Basal application of FYM (250 kg) based *T. asperellum* @ 4 kg/ha and *Pseudomonas fluorescens @ 4 kg/ha* at 30 DAS + Foliar application of neem seed kernel extract (10 %) at 20,40, 60 and 80 DAS + Foliar application of *Metarhizium rileyi* @ 1 kg/ha at 30 DAS + Need based foliar application of 10 % aqueous leaf extracts of *Ocimum, lawsonia and Neem at* 40, 50 and 60 DAS respectively + Erection of pheromone traps for *Spodoptera, Helicoverpa* separately @ 10 no./ha and leaf miner @ 20 no./ha + Erection of Blue and yellow sticky traps @ 25 /ha + Growing of trap crops *viz*., castor and cowpea and marigold) and chemical method (T2) were tested against management of groundnut diseases and insects. Reduction of collar rot, dry root rot and stem rot was at par in both bio-intensive and chemical methods at Kadiri, Junagadh, Dharwad, Vriddhachalam, Jalgaon and Raichur.

2.6. Management of leaf blight and wilt disease of groundnut occurring at Rajasthan

On the basis of three years pooled data from Bikaner and Jodhpur (*kharif* 2019 to 2021), following recommendations were emerged out of which includes seed treatment, cultural practice, biological control and chemical control for effective management of leaf blight and wilt disease of groundnut occurring at Rajasthan state.

- Seed treatment with tebuconazole 2 DS @1.5 g /Kg/seed
- Four rows of bajra in between groundnut (6 groundnut: 4 bajra: 6 groundnut per plot) with 43.0 % decrease of diseases over contol having 506 I.C.B.R.
- Application of neem cake @ 200 kg/ha (Basal) with 20.3 % decrease of disease over control having 2.0 of I.C.B.R and soil application of *Trichoderma* powder 10 kg/ha at basal, 30, 55 and 75 DAS with 24.0 % decrease over control having 7.4 I.C.B.R.
- Spraying of Carbendazim 12% + Mancozeb 63% WP (SAAF 75% WP) (10 g SAAF in 5 L water for 100 sq m area) with 20.5 % decrease over control having 22.7 of I.C.B.R.
- Tebuconazole 430 SC (@7.5 ml folicure in 5L water for 100 sq m area) at 30, 55 and 75 DAS with 30.0 % decrease of disease over control having 10.5 of .IC.B.R.

A. Entomology

1. Rabi-summer

Highest incidence of thrips and leafhoppers (47 and 21, respectively) was recorded at Pavagada. Similarly, in Raichur highest Spodoptera and leafminer damage of 35 and 27 per cent were recorded. Hairy caterpillar incidence was observed only at Dharwad. Maximum trap catch of 82.8 *Spodoptera* moths per trap was recorded at Raichur on 5th standard week followed by 43 at Dharwad on 8th standard week. Raichur has recorded maximum incidence of *Helicoverpa* (40.8 moths per trap) and Dharwad recorded leafhopper (130 adults per trap) and thrips (40 adults per trap) on 7th and 10th standard week, respectively. *Helicoverpa* and leaf miner population showed significant interaction with weather parameters with R square values of 0.97 and 0.90 respectively followed by leafhopper, thrips and *Spodoptera* at Raichur. Maximum temperature, rainfall and morning humidity has highly influenced on population of *Helicoverpa* with P- values of 0.06, 0.08 and 0.08, respectively

2. *Kharif*

Highest incidence of leafhopper (20) was recorded in Latur whereas, Pavagada recorded highest incidence of thrips, leafminer and *Helicoverpa* (23, 27 and 11 respectively). Similarly, in Raichur highest *Spodoptera* damage of 25 per cent was recorded. Four per cent damage by hairy caterpillars was observed at Dharwad. Dharwad recorded maximum trap catch of *Spodoptera* and *Helicoverpa* 355 and 30 moths per trap on 36th standard week, leafhopper and thrips 75 and 30 adults per trap on 30th standard week and 3.2 adult leaf miners on 25th standard week. Similarly, HOVTVG-I-2021-2 and 10 was found promising for *Spodoptera* where check JL 24 recorded 6 Score at Latur. Chlorantraniliprole 18.5 SC @ 0.3 ml/l recorded lowest population of both the defoliators, *Spodoptera* and *Thysano plusia at* Dharwad, *Helicoverpa* at Junagadh, *Spodoptera at* Lathur , both *Spodoptera* and leaf miner at Raichur and Vridhachalam with highest pod yield of 2146 kg per ha at Dharwad and followed by 1831.9 kg per ha at Raichur. ICBR of 1:25 was obtained at Raichur.

5 Externally Funded Projects

Project : Effect of Poly4 (Polyhalite) on yield and quality of rainfed groundnut and on soil properties in semiarid Alfisols of Telangana and arid Alfisols of Andhra Pradesh

PI: *G A Rajanna*

Funded by: Anglo American Crop Nutrients and/or Sirius Minerals India Pvt Ltd investigators

Project Duration: 3 years; Start Date: June 2021 End Date: May, 2024

Budget details for RRS Ananthapur:

Year	Sanctioned amount (Rs.)	Budget released (Rs.)
2021-22	540107	324064
2022-23	702100	456250
Total	**12,42,207**	**7,80,314**

Objectives of the study

- To assess the comparative effect of POLY4 vis-à-vis other K sources on groundnut yield
- To study the effect of POLY4 on groundnut quality and soil properties
- To analyse the economics of POLY4 in rainfed groundnut

Work-done report

A field experiment was conducted during the *kharif* season of 2020-21 at the Regional Research Station of the ICAR-DGR in Ananthapur, Andhra Pradesh. Red sandy loam was the texture of the soil in the experimental field. There were ten treatments and three replications in the study. Immediately following rainfall, 30×10 cm row spacing seed furrows were opened. At the time of planting, the desired fertilizers were applied according to the recommended rates of 20:40:50:30 kg NPKS per ha. DAP, Urea, MOP, and Polyhalite were the fertilizer sources. Applied fertilizers were thoroughly mixed into the soil and K-6 seeds were sown manually in the seed furrows. At 25 days after sowing, when the soil contained adequate moisture, 500 kg/ha of gypsum was applied at a rate of 500 kg/ha. All growth and yield observations were collected and analysed statistically at various growth stages.

Table 1 demonstrates that the varying rates of conventional fertilizers and polyhalite fertilizer greatly affected groundnut pod and haulm production. NP + 100% polyhalite significantly enhanced groundnut pod yields by 12.8% and

Field view of poly4 experiment

Table 1. Effect of poly 4 fertilizers on growth and yield of groundnut

Treatment	Haulm yield (kg/ha)	Pod Yield (kg/ha)	Kernel yield (kg/ha)	Harvest index (%)	100 seed weight	Pods/plant
Control	3239 ab	1373a	879 a	42.5abc	37.88a	10a
MOP(50%)	3620 cd	1462abc	1044 bcd	40.4ab	41.5abc	10.67ab
NP only	3265 ab	1436abc	1013 bc	44.0bcd	41.76bc	10a
NP + Gypsum(500 kg/ha)	3661 d	1433abc	954 ab	39.2a	42.12bc	10.67ab
NPK only	3201 ab	1421ab	951 ab	44.5bcd	39.81ab	10.67ab
NPK + Gypsum(500 kg/ha)	3242 ab	1409a	998 b	43.7bcd	41.47abc	11.33b
POLY4 (100%) + Gypsum(310 kg/ha)	2996 a	1521cd	1129 de	50.8e	43.31bc	11.67b
POLY4(50%) + Gypsum(310 kg/ha)	3336 bc	1435abc	998 bc	43.1abcd	40.81abc	11.67b
POLY4(50%)	3379 bcd	1512bcd	1106 cde	44.8cd	42.01bc	11.33b
POLY4 (100%)	3394 bcd	1590d	1166 e	46.9de	44.44c	11.67b

Table 2. Effect of poly 4 fertilizers on quality parameters of groundnut

Treatment	Linoleic acid%	Oil %	Oleic acid %	Palmitic acid%	Stearic acid %
Control	38.6e	46.6a	42.6a	12.23ab	3.31bcd
MOP(50%)	38.1cde	46.9ab	43.3bc	12.37abc	3.38cd
NP only	38.5de	46.8ab	42.9ab	11.96a	3.43d
NP + Gypsum(500 kg/ha)	37.9bc	47.3bc	43.4bcd	12.4abc	3.11ab
NPK only	38.1cd	47.2abc	44.0defg	12.72cd	3.28bcd
NPK + Gypsum(500 kg/ha)	37.7abc	47.7cd	44.3fg	12.75cd	3.34cd
POLY4 (100%) + Gypsum(310 kg/ha)	37.4a	48.1d	44.2efg	13.13d	3.05a
POLY4(50%) + Gypsum(310 kg/ha)	37.6abc	47.9cd	43.8cdef	12.56bc	3.23abc
POLY4(50%)	38.1cd	47.5bcd	43.6cde	12.6bc	3.23abcd
POLY4 (100%)	37.5ab	47.9cd	44.4g	12.56bc	3.21abc

15.8% in comparison to NPK+ gypsum (500kg/ha) and control plots, respectively. In contrast, only plots treated with NP and gypsum (500 kg/ha) produced considerably greater haulm yield (3,661 kg/ha) than other plots. However, it was comparable to NP + 50% MOP plots. Even though these plots produced substantially more haulm, they were unable of converting accumulated source into sink. Likewise, the 100 seed weight and harvest index of polyhalite-applied plots were significantly greater than those of traditional fertilizer-applied and control plots. Thus, increased yields under polyhalite applied plots resulted in significantly higher oil content (~48.1%) than other plots. This increase in production and yield characteristics under polyhalite-applied plots may be a result of increased availability of K and secondary nutrients such as Ca, Mg, and S to the groundnut crop. Interestingly, the combination of polyhalite and gypsum resulted in lower crop yields than either fertilizer alone.

The data presented in Table 2 show that the variable rates of conventional fertilizers and polyhalite fertilizer significantly influenced groundnut quality parameters. Oleic content and palmitic acid in groundnut were significantly enhanced by polyhalite applied plots as well as potassium applied plots as compared to control and no K applied plots. Interestingly, Linoleic acid and steric acid content were reduced with the application of poly 4 fertilizers along with K applied plots over control and only NP applied plots.

Project: AICRP on Seeds (Crops) - Quality Seed Production (QSP) (Formerly- ICAR Seed Project on Seed Production in Agricultural Crops)

Nodal Officer & PI: *Dr. SK Bera*

Co-Nodal Officer: *Dr. Praveen Kona (from January, 2023)*

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

Duration: 2020-2025

Fund outlay: Rs. 9.0 lakh (2022-23)

Summary

Seed production of groundnut varieties released by ICAR-DGR was done under AICRP on Seeds-QSP component during *kharif* 2022. Nucleus seed of 1.8 q, 1.5 q, 41.30 q and 16.16 q was produced for Girnar 2, Girnar 3, Girnar 4 and Girnar 5, respectively. Besides, breeder seed of 2.10 q, 295.75q and 72.10 q was produced for Girnar 3, Girnar 4 and Girnar 5, respectively during kharif 2022. A total grant of Rs.9.0 lakh was received till February 2022 under this project during the FY 2022-23, while about Rs.6.50 lakh was accrued as profit. Under HRD component One day "Farmers orientation cum Training programme on High Oleate groundnut Girnar-4 and Girnar-5 seed production and Felicitation of Farmers" was held at ICAR-Directorate of Groundnut Research, Junagadh on 13.01.2023. More than 65 Farmers from Saurashtra region of Gujarat who were involved in seed production of Girnar 4 and Girnar 5 were present for the training program.

Project: Molecular marker assisted introgression of ahFAD2 mutant alleles conferring high oleic acid content and high oleic to linoleic acid ration in ten high yielding groundnut varieties

Fig. Farmers' orientation cum Training programme on High Oleate groundnut Girnar-4 and Girnar-5 seed production

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PI : *SK Bera*

Co. PI : *Kirti Rani*

Duration of the project: 3 years

Starting date of the project: 20/01/2022

Closing date of the project: 19/01/2025

Total amount sanctioned for the project: 4072356/- (Forty Lakh Seventy-Two thousand Three Hundred and Fifty six)

Amount sanctioned for current year (2022-23): 1564052/- (Fifteen Lakh Sixty-Four Thousand and Fifty-Two)

Objectives of the Project:

- To develop breeding lines with high oil and oleic acid content

Project: All India network project on soil biodiversity-biofertilizers

PI: *KK Pal*

Co-PI*: Rinku Dey*

Funding agency: ICAR

Duration: 01.04.2017-31.03.2023

Fund: Rs. 14.70 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

Table 3 : Number of pollination and crossing details of ten crosses:

Sr. No.	Cross name	No. of pollination	No. of pods	No. of kernels
1	Dh 257 X ICGV 15080	249	86	135
2	SG 99 X Girnar 4	123	13	17
3	JL 501 X ICGV 15080	173	46	61
4	KDG 128 X Girnar 4	70	19	23
5	Girnar 2 X Girnar 4	120	19	13
6	TG 51 X ICGV 15080	235	13	16
7	K 6 X Girnar 4	88	25	25
8	GJG 32 X Girnar 4	163	39	35
9	K 1812 X HFS 62	21	5	5
10	J 87 X HFS 24	215	37	33

Preliminary work done so far:

- The seeds of male and female parents were collected for hybridization
- The seeds of both male and female parents were sown in hybridization blocks as per cross combinations
- Hybridization was taken for ten cross combinations. The details are mentioned in Table 3

Achievements:

- Isolated 154 putative rhizobia, 78 PSB, and 29 DAPG-producing fluorescent pseudomonads from root nodules and rhizosphere samples of groundnut collected from Kutch, Junagadh and surroundings. All the 154 putative rhizobial isolates were screened for presence of *nod* and *nif* genes using gene specific primers and 97 isolates were both *nif*$^+$ and *nod*$^+$. Diversity will be studied by sequencing

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of 16S rRNA of *nod⁺nif⁺* rhizobia.

- Formulation(s) of efficient strains of salinity-tolerant rhizobia has been made at different combinations of preservatives and cryoprotectants and shelf-life is being studied at room temperature and refrigerated conditions.

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: *Rinku Dey*

Funding agency: ICAR through AMAAS project

Duration: 01.04.2017-31.03.2023

Fund: Rs. 62.43 lakh

Objectives:

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

Significant Achievements:

- The alternate route of carbon gain as mechanism of osmotolerance found in extreme halophilic archaea and bacilli has been extended to eukaryote system utilizing the genome sequence data of *Aspergillus sydowii* BF5 which is capable of growing at 0-35% of NaCl gradient with least growth at 0% NaCl in growth medium.
- Using gene specific primers and 18S rRNA genes as reference, so far presence of genes encoding malate dehydrogenase (MDH), phosphoenolpyruvate carboxylase (PPC), Na-H antiporter, malate synthase (MS), carbonic anhydrase (BCA), isocitrate lyase (ICL), serine hydroxymethyl aminotransferase (SHMAT), and phosphoserine aminotransferase (PsAT) have so far been confirmed.
- While expression of MDH, PPC, Na-H antiporter, MS, BCA, ICL. SHMAT, and PsAT were 6.76, 4.78. 6.49, 3.68. 5.14, 3.91, 5.74, and 3.68 folds higher respectively at 15% of NaCl in growth medium as compared to 0% NaCl in growth medium, it was 4.13, 2.96. 5.18, 3.24, 4.46, 3.74, 4.19, and 3.32 folds higher, respectively, for MDH, PPC, Na-H

Table 4. Real time validation of over-expression of genes of the enzymes linked to alternate route of carbon gain in *Aspergillus sydowii* BF5 using 18S rRNA as reference gene

Treatments	Fold expression of genes involved in alternate route of carbon gain vis-à-vis osmotolerance							
	MDH	MS	Na-H antiporter	CA	PPC	ICL	PsAT	SHMAT
BF5 (0% NaCl)	1.00^{c}	1.00^{c}	1.00^{c}	1.00^{c}	1.00^{c}	1.00^{c}	1.00^{c}	1.00^{c}
BF5 (15% NaCl)	6.76^{a}	3.68^{ab}	6.49^{a}	5.14^{a}	4.78^{a}	3.91^{ab}	3.68^{ab}	5.74^{a}
BF5 (30% NaCl)	4.13^{b}	3.24^{ab}	5.18^{b}	4.46^{b}	2.96^{b}	3.74^{ab}	3.32^{ab}	4.19^{b}

MDH= Malate dehydrogenase; MS= Malate synthase; CA= β-Carbonic anhydrase; PPC= Phosphoenolpyruvate carboxylase; ICL= isocitrate lyase; PsAT= Phosphoserine aminotransferase; SHMAT= Serine hydroxymethyl aminotransferase

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antiporter, MS, BCA, ICL. SHMAT, and PsAT at 30% NaCl (Table 1).

Project : Exploiting cross-talk of cam (crassulacean acid metabolism) photosynthetic transition for management of drought- and salinity- stress in groundnut

PI: *K. K. Pal*

Co-PI: *R. Dey, Sushmita Singh, Praveen Kona*

CC-PI: *Renjith PS, ICAR-CAZRI, Kukma, Bhuj*

Funding agency: NASF

Duration: 01.08.2022 to 31.07.2023

Fund: Rs. 37.32 lakh**Objectives:**

- To select CAM transited Variants of groundnut for drought- and/or salinity- tolerance

Achievements:

- A total of 700 germplasm accessions (350 each of Valencia and Spanish group) were screened for salinity tolerance at ICAR-CAZRI, Kukma, Bhuj with checks ((GG2, GG5 and GG7 (popular and moderately tolerant to salinity), GJG32 (high yielding and popular but susceptible to salinity)) in augmented block design during kharif 2022 in single row of 5 m length. A total of seven irrigations with salinity of 2.86 to 6.71 dS/m was applied and the gradual development of salinity in different blocks were given in **(Table 1)**.
- On the basis of pod yield, level of salinity in block and final plant stand as compared to the checks, 19 germplasm accessions of Spanish Bunch habit group (Table 2) and 11 of Valencia group **(Table 3)** were selected for further evaluation with elevated salinity during summer 2023
- Whereas pod yield of the 19 selected Spanish germplasm accessions was in the range of 6.02 to 8.00 g/plant with soil salinity (ECe) of 3.41 to 4.16 dS/m with final plant stand of 40-80% (Table 2), the yield of best check in respective block ranged from 3.10 to 6.23 g/plant with plant stand of 44-80%.
- From Valencia group, pod yield of the 11 selected Valencia germplasm accessions was in the range of 5.65 to 7.85 g/plant with soil salinity (ECe) of 4.03 to 5.90 dS/m with final

Table 5. Development of salinity in different tiers of the experiment (ECe: dS/m)

Tier	Days after sowing							
	0	25	46	62	74	84	96	105
Tier 1	0.94±0.13	0.81±0.10	1.11±0.17	1.52±0.16	1.80±0.16	2.30±0.28	2.94±0.32	3.42±0.27
Tier 2	0.90±0.10	0.73±0.11	0.84±0.06	1.25±0.15	2.22±0.24	2.89±0.45	2.98±0.36	3.56±0.39
Tier 3	0.87±0.09	0.97±0.07	1.08±0.11	1.34±0.21	2.10±0.25	3.87±0.29	3.89±0.34	4.03±0.48
Tier 4	1.24±0.11	1.03±0.11	1.07±0.10	1.40±0.10	1.99±0.31	2.85±0.30	4.00±0.37	4.16±0.57
Tier 5	**0.71±0.05**	0.69±0.06	0.92±0.06	1.25±0.13	1.85±0.14	2.75±0.25	3.09±0.25	**3.41±0.36**
Tier 6	1.08±0.13	0.93±0.06	1.04±0.12	1.26±0.12	2.39±0.25	3.30±0.22	4.93±0.52	5.16±0.55
Tier 7	**1.38±0.13**	1.34±0.15	1.51±0.14	1.87±0.12	2.78±0.25	3.51±0.39	5.39±0.60	5.85±0.54
Tier 8	0.96±0.07	0.95±0.09	1.48±0.10	1.84±0.20	2.46±0.16	3.30±0.31	4.98±0.48	**5.90±0.39**
Tier 9	1.26±0.08	1.04±0.07	1.37±0.12	1.88±0.18	2.57±0.29	3.96±0.28	4.32±0.30	4.48±0.54
Tier 10	1.31±0.12	0.96±0.08	1.56±0.14	1.93±0.14	2.95±0.31	3.78±0.33	4.62±0.40	5.42±0.52

Table 6. Performance of selected accessions of Spanish habit group for salinity tolerance

Accession number	Pod yield (g/plant)	Tier	Plant stand (%)	Final Soil Salinity (dS/m)	PY of Best Check (g/plant)
NRCG7076	6.42	T1	62	3.42±0.27	3.10 (80%, GG7)
NRCG10406	6.50	T2	68	3.56±0.39	5.00 (80%, GG7)
NRCG10343	6.34		70		
NRCG13966	7.24		76		
NRCG12379	6.13	T3	60	4.03±0.48	6.23 (62%, GG5)
NRCG12380	8.00		42		
NRCG12371	7.90		40		
NRCG4121	7.00		40		
NRCG14377	6.61	T4	46	4.16±0.57	5.81 (62%, GG5)
NRCG13523	6.38		58		
NRCG12240	6.25		80		
NRCG14923	6.10		42		
NRCG11474	6.02		80		
NRCG3396	7.28	T5	72	3.41±0.36	3.73 (44%, GG7)
NRCG11134	6.48		50		
NRCG3450	6.45		80		
NRCG14361	6.37		64		
NRCG14121	6.29		48		
NRCG13922	6.13		76		

Fig. 1. Evaluation of germplasm accessions for salinity tolerance at ICAR-CAZRI, RRS, Kukma, Bhuj during *kharif* 2023

Table 7. Performance of selected accessions of Valencia habit group for salinity tolerance

Accessions	Pod yield (g/plant)	Tier	Plant Stand (%)	Final Soil Salinity (dS/m)	PY of Best Check (g/plant)
NRCG6402	6.22	T6	54	4.03±0.48	3.86 (44%, GG5)
NRCG4409	7.85		52	5.85±0.54	3.00 (42%, GG2)
NRCG16080	7.79		38		
NRCG10733	6.90		40		
NRCG15032	6.89		58		
NRCG15010	6.80	T7	50		
NRCG2151	6.67		36	5.90±0.39	4.00 (36%, GG7)
NRCG6972	6.41		34		
NRCG4369	5.73		52		
NRCG14388	5.59	T8	52		
NRCG12678	5.65	T9	40	4.48±0.54	2.83 (60%, GG2)

plant stand of 34-58% (Table 3), the yield of best check in respective block ranged from 2.83 to 4.00 g/plant with plant stand of 36-60%. The level of salinity was in the high range and a number of genotypes could not survive **(Fig. 1)**

Project Title: Development, refinement and area-wide implementation of IPM technology for groundnut crop

Center PI: *Harish G*

Centre Co-PI: *Ananth Kurella and Natraja M V*

Total amount: 10 L

Duration: April 2022- March 2026

Objectives:

1. Development, validation and refinement of location specific Integrated Pest Management Technology in Groundnut Crop.
2. Horizontal Dissemination of the IPM technology in Groundnut Crop.
3. Socio-economic impact analysis of groundnut IPM technology.

Experiment has been taken up at ICAR-DGR with following treatments Natural Farming, IPM Module, Farmers Practice, Control. Under treatment Natural farming neem based insecticides like NSKE 5% and Neem oil 2% will be used for pest management (Need based spray). Under IPM module Imidacloprid spray will be done at 15 and 30 DAS + Yellow sticky traps will be installed for management of insect pests. In farmers practice Thiomethaxam spray will be given at 15 and 30 DAS. In control no plant protection will be carried out. Sowing was done on 08.02.23

6 Publications

Research Articles

1. Aman Verma, M.K. Mahatma, L.K. Thawait, Sushmita Singh, K. Gangadhar, Praveen Kona, A.L. Singh (2022). Processing techniques alter resistant starch content, sugar profile and relative bioavailability of iron in groundnut (*Arachis hypogaea* L.) kernels. *Journal of Food Composition and Analysis* 112: 104653. (**NAAS rating: 10.56**)

2. Aman Verma, Sushmita Singh, Lokesh K. Thawait, Mahesh K. Mahatma and A. L. Singh (2022). An expedient ion chromatography-based method for high- throughput analysis of phytic acid in groundnut kernels. *J Food Sci. Technol.* (**NAAS rating: 8.75**) https://doi.org/10.1007/s13197-022-05527-9.

3. Asik Dutta; Narendra Kumar Lenka; Kali Krishna Hazra; C S Praharaj (2022). Impact of elevated CO_2 on soil-plant phosphorus dynamics, growth, and yield of chickpea (*Cicer arietinum* L.) in an alkaline Vertisol of central India. *Journal of Soil Science and Plant Nutrition*. (**NAAS rating 9.87**) (https://doi.org./ 10.1007/s42729-022-00781-4).

4. Basavalingaiah, K., Paramesh, V., Parajuli, R., H.C. Girisha, M. Shivaprasad, G.V. Vidyashree, Thoma, G., M. Hanumanthappa, G.S. Yogesh, Misra, S.D., Bhat, S., M.M. Irfan and G.A. Rajanna (2022). Energy flow and life cycle impact assessment of coffee-pepper production systems: An evaluation of conventional, integrated and organic farms in India. *Environmental Impact Assessment Review* 92:106687. (**NAAS rating: 12.12**)

5. Choudhary, R.R., Prajapat, A.L., Yadav, H.L., Mehta, S., and Jat, R.P. (2022). Effect of varieties and nutrient management practices on nutrient content, uptake and quality parameters of wheat (*Triticum aestivum*). *The Pharma Innovation Journal*, 11(6): 1078-1081.

6. Dass, A., Rajanna, G.A., Babu, S., Lal, S.K., Choudhary, A.K., Singh, R., Rathore, S.S., Kaur, R., Dhar, S., Singh, T. (2022). Foliar application of macro- and micronutrients improves the productivity, economic returns, and resource-use efficiency of soybean in a semiarid climate. *Sustainability* 14, 5825. https://doi.org/10.3390/su14105825 (**NAAS rating: 9.89**)

7. Didal, V.K., Vidyasagar, G. E., Kumar, R.M., Surekha, K., Reddy, S.N., Brijbhooshan, Shivakumar, R., Choudhary, R.R. (2022). Energetics assessment of rice-rice cropping system under different nitrogen management practices. *Agricultural Mechanization in Asia*, 53(2):5707-5721.

8. Gangadhar K, Kirti Rani, Ajay BC, Sushmita Singh, Praveen Kona, Kiran K Mori, Narendra Kumar, Bera SK, and Praharaj CS (2022). Multi-seasons evaluation of Spanish bunch advanced breeding lines for fresh seed dormancy in groundnut (*Arachis hypogaea* L.). *Annals of Agricultural Research New Series*. 43 (4): 450-456

9. Gopinath, K.A., Rajanna, G.A., Venkatesh, G., Jayalakshmi, M., Kumari, V.V., Prabhakar, M., Rajkumar, B., Chary, G.R., Singh, V.K. (2022). Influence of crops and different production systems on soil carbon fractions and carbon sequestration in rainfed areas of semi-arid tropics in India. *Sustainability*, 14, 4207. https://doi.org/10.3390/su14074207 (**NAAS rating: 9.89**)

10. Harish, M.N., Choudhary, A.K., Bhupenchandra, I., Dass, A., Rajanna, G.A., Singh, V.K., Bana, R.S., Varatharajan, T., Verma, P., George, S., Kashinath, G.T., Bhavya, M., Chongtham, S.K., Devi, E.L.,

Kumar, S., Devi, S.H., Bhutia, T.L. (2022). Double zero-tillage and foliar-P nutrition coupled with bio-inoculants enhance physiological photosynthetic characteristics and resilience to nutritional and environmental stresses in maize–wheat rotation. *Frontiers in Plant Science* 13:959541. (**NAAS rating: 12.63**)

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Book chapters

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15. Sejal Parmar, Vinay Sharma, Deekshitha Bomireddy, Pooja Soni, Pushpesh Joshi, Sunil S. Gangurde, Jianping Wang, Sandip K. Bera, Ramesh S. Bhat, Haile Desmae, Kenta Shirasawa, Baozhu Guo, Rajeev K. Varshney, and Manish K. Pandey (2022). Recent Advances in Genetics, Genomics, and Breeding for Nutritional Quality in Groundnut In: Accelerated Plant Breeding, Satbir Singh Gosal and Shabir Hussain Wani (eds), Volume 4 (Oil crops) pp.111-138.

16. Singh A.L., K.K Reddy., Sushmita Singh, Kirti Rani (2022). Salt Stress Alleviation Strategies to Maintain Potassium Homeostasis in Plants. In: Iqbal N., Umar S. (eds) Role of Potassium in Abiotic Stress. Springer, Singapore. https://doi.org/10.1007/978-981-16-4461-0_9.

17. Singh A.L., Kirti Rani, Rupak Jena, Praveen Kona, Kiran K. Reddy, Gangadhara K. (2022). Microbes-based bio-stimulants towards sustainable oilseeds production: Nutrient recycling and genetics involved. New and Future Developments in Microbial Biotechnology and Bioengineering (Sustainable Agriculture: Microorganisms as Biostimulants), Elsevier publishers. 111-130.

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Technical bulletins/manual

1. Dutta, A., Trivedi, A., Kumar, N., Nath, C.P., Hazra, K.K., Praharaj, C.S., Jatav, H.S. and Sathyanarayana, E. (2022). Nitrogen Management in Field Crops and Strategies for Enhancing Its Efficiency. Agriculture Issues and Policies, p.61.

2. Kumar N, Hazra KK, Nath CP, Praharaj CS, Datta Asik, Das K and Sewak Shiv (2022). Technical Bulletin on "*Long-term benefits of pulses in sustaining rice-based cropping systems* (3/2022), ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh- 208 024, India. 67pp.

3. Kumar Rajesh, Nath CP, Devraj, Bhat S, Kumar Ravi, Praharaj CS, Krishna Radha, Tripathi C, Kumar P, Shivakant, Chandra S, Yadav MPS (2022). Technical Bulletin on "*Technological Interventions for sustainable socio-economic development: Farmer FIRST*

Programme (2/2022), ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh-208 024, India. 59pp.

Books edited

1. Kumar Narendra, C.P. Nath, Uma Sah, C.S. Praharaj (2022). Sustainable production of pulses in Diverse Agroecosystems, Vol 2. (Eds) Stress management and livelihood security. Scientific Publishers. 301pp.

Technical /Popular articles

1. Kiran K. Mori., Jagdish Patel, Kirti Rani, Vaishali K. Mori, Mithlesh Kumar, B. C. Ajay. (2022). Deciphering higher order non-allelic interactions for quantitative characters through twelve generation mean analysis in castor (*Ricinus communis* L.). *Genet Resour. Crop Evol*., https://doi.org/10.1007/s10722-021-01339-6
2. Praharaj C S. (2022). Recent status and strategies in peanut production in India. In: Special Issue on Agriculture: A saga of Success *on the occasion of Azadi Ka Amrit Mahotsav.* JUST AGRICULTURE, pp 1-3.
3. Praharaj CS, Singh Ummed, Nema Ram and AK Parihar (2022). *Rabi Dalhan Badhane Hetu Uttam Krishi Kriyaen. Khad Patrika* 63 (9):25-34.
4. Kumar Narendra, CP Nath, Aditya Pratap, KK Hazra, CS Praharaj, and NP Singh (2022). Performance of mungbean varieties under CA based rice-wheat system in IGP. Pulses Newsletter Vol. 32 (3): 5 (July-Sept, 2022)

Technology developed

1. Ajay B.C., Abdul Fiyaz R., S. K. Bera, Narendra Kumar, K. Gangadhar, Praveen Kona, Kirti Rani and T. Radhakrishnan (2022). Higher Order AMMI (HO-AMMI) analysis: A novel stability model to study genotype-location interactions. *Indian J. Genet. Plant Breed.*, 82(1): 25-30

Compilation/documentation

1. Compilation of Annual Report (*Rabi*-summer 2020-21 and *kharif* 2021). All India Coordinated Research Project on Groundnut. ICAR-Directorate of Groundnut Research, Junagadh-362001, Gujarat.
2. Compilation of Annual Report (*kharif* 2021). All India Coordinated Research Project on Groundnut. ICAR-Directorate of Groundnut Research, Junagadh-362001, Gujarat.

Any other (please specify)

1. Kumar, N. In-charge, Regional research Station, Directorate of Groundnut Research, Bikaner
2. Kumar, N. Accredited for teaching and

7 WORK PLAN 2022

Programme 1: Crop Improvement

- Management of drought stress in groundnut at Anantapur and adjacent areas

  Ajay BC, KK Pal, Rajanna GA, KK Reddy, Praveen Kona, Rinku Dey, Paparao V

- Management of groundnut genetic resources and trait discovery

  Kirti Rani, Harish G, Ajay BC, Sushmita Singh, Ananth Kurella

- Breeding groundnut for earliness, fresh seed dormancy and confectionery types

  Praveen Kona, Narendra Kumar, Chandramohan Sangh, Kirti Rani

- Development of groundnut pre-breeding materials for biotic and abiotic stresses and quality traits

  SK Bera, Narendra Kumar, Ajay BC, Chandramohan Sangh, Ananth Kurella

- Genetic enhancement of groundnut through genome editing and molecular approaches

  Chandramohan Sangh, SK Bera, Papa Rao V.

- Optimization of mineral nutrition in groundnut for better human and soil health

  Sushmita Singh, KK Pal, Rinku Dey, KK Reddy, Rajanna GA, Rajaram Choudhary

- Development of groundnut production technologies for arid region of Rajasthan

  Narendra Kumar, Rajaram Choudhary, Kirti Rani, BDS Nathawat

Programme 2: Crop Production and Social Sciences

- Microbial management of major foliar fungal diseases of groundnut and variability analysis in pathogens

  Rinku Dey, Ananth Kurella, Chandramohan Sangh, Narendra Kumar, Rajaram Choudhary

- Salinity and Heat stress in groundnut: basis of tolerance and management

  KK Pal, Rinku Dey, Sushmita Singh, KK Reddy, Papa Rao V, Praveen Kona, Narendra Kumar, Rajaram Choudhary

- Climate resilient sustainable agriculture through low-cost natural farming in groundnut-based cropping system

  CS Praharaj, Kiran K Reddy, KK Pal, Sushmita Singh

Programme 3: Crop Protection

- Management of White grubs, Bruchid beetle, Spodoptera and Helicoverpa in groundnut

  Harish G., Rinku Dey, Nataraja MV

- Development of rapid detection techniques of Peanut Bud Necrosis and Tobacco Streak Viruses in groundnut

  Nataraja MV, Ananth Kurella, Harish G, Papa Rao V.

8 Training and Capacity building

Trainings/workshops organised:

Dr. Praveen Kona

- As a Nodal Officer, AICRP- Groundnut organised 'Annual Groundnut Workshop' during April 25-26, 2022 on virtual mode.
- As a Co-Convenor and Co-Nodal Officer organized a one day "Farmers orientation cum Training programme on High Oleate groundnut Girnar-4 and Girnar-5 seed production" at ICAR-Directorate of Groundnut Research, Junagadh on 13.01.2023.

Dr. C.S. Praharaj

- Organized "9th World Soil Day" on 5th December 2022 wherein Dr Bhaskar Suryanaraya acted as the Chief Guest (Both physical and virtual mode). With the theme of WSD "Soils: Where Food Begins" this programme served as an Awareness Programme on the Importance of the Soil on food production and life on the earth. Around 160 persons including 50 farmers participated in this grand function.
- Organized INSTITUTE FOUNDATION DAY on October 1, 2022 at ICAR-DGR, Junagadh where Dr AR Pathak, Hon'ble Former VC, JAU, Junagadh (acted as Chairman), Dr NK Gontia, Hon'ble Former VC, JAU, Junagadh (acted as Co-Chairman), DDG CS, Dr TR Sharma (In absentia, message was read out), ADG Seed Dr DK Yadava, and ADG (O & P) Dr Sanjeev Gupta and around 220 delegates and 50 farmers participated (offline and online) 2022
- Organized/Convened Task Force Committee Meeting of Agro-climatic Zone XIII (13) covering Gujarat Plains/hills on 23.06.2022 and was attended by 41 participants from different SAUs and ICAR institutes of Gujarat.

Training attended:

Dr Chandramohan Sangh

- Attended training programme "Prediction of Non-Coding RNA" during 16th to 18th February, 2022 at IASRI, New Delhi
- Attended "RNA world: Advance Bioinformatics for deciphering regulatory molecules" during (3rd November, 2022 to 9th November, 2022) at IASRI, New Delhi

Dr. Praveen Kona

- Completed the Workshop on "Current trends in Agricultural Bioinformatics (online mode) organised by SKILL-BIF, ICAR-NAARM, Hyderabad during 14-16th December, 2022.

Dr C.S. Praharaj

- Participated in one-week training programme on "Managing Technology Value Chains for Directors and Division Heads" Organized by ASCI (ADMINISTRATIVE STAFF COLLEGE OF INDIA), HYDERABAD during July 25-29, 2022 sponsored by DST, GoI, New Delhi.
- Participated in a Training Programme/ WORKSHOP on "Drones for Agricultural Development" Organized by MANAGE, HYDERABAD during July 11-15, 2022. This five-days' workshop is meant for Agri-ecosystem stakeholders.
- Participated in short TRG Program on "Recent developments in nano-technological application in agriculture" by Dr. S. Subramanian, Director Research, TNAU, Coimbatore on January 31, 2022 by ICAR-SBI, Coimbatore.

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Participation and papers presentation in Conferences/ seminars/ symposia/ meetings/ Conferences/ seminars/ symposia/ meetings

Dr. GA Rajanna

- Delivered oral presentation in First International Conference-ICRA2022 on Reimagining Rainfed Agro-ecosystems: Challenges & Opportunities, 22-24 December 2022 held at ICAR-CRIDA, Hyderabad, Telangana, India.
- Delivered oral presentation in Annual Co-operators' Conference at Hyderabad in collaboration with ICAR- Central Research Institute for Dryland Agriculture (CRIDA) during 17-18 October 2022.
- Delivered oral presentation in National Symposium on 'Self-Reliant Coastal Agriculture' scheduled during 11-13 May 2022 at ICAR-Central Coastal Agricultural Research Institute, Goa.


Indian Society of Dryland Agriculture
First International Conference
Reimagining Rainfed Agro-ecosystems: Challenges & Opportunities (ICRA - 2022)

Certificate

The organizers of the ICRA - 2022 hereby present the Best Oral Presentation Award to the research paper presented during the ICRA-2022 held at ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, India, during 22-24 December 2022.

Paper Title: [illegible]
Author(s): [illegible]
Symposium: [illegible]

(K V Rao)
Secretary, ISDA

(V K Singh)
President, ISDA

Dr. S.K. Bera

- Attended ICVO-2023 Interaction Meeting with ADG(OP)-IIOR on 09-12-2023

Dr. C.S. Praharaj

- Participated in One-day symposium on "*Soils: Where Food Begins*" on November 30, 2022 organized by Division of Soil Science & Agricultural Chemistry, ICAR-IARI, New Delhi in association with the Delhi Chapter of the Indian Society of Soil Science (ISSS) on hybrid mode.
- Participated in Virtual Workshop on Global Food and Nutritional Security and sustainable development through major and minor pulses held on 14.10.2022 and organized by NAAS, New Delhi in collaboration with World Food Prize Foundation, USA where T. Mohapatra, Chairman, Dr H Pathak, Secy DARE and DG ICAR, Convener, Dr Rajeev Varshney, DG from ICARDA, and ICRISAT participated.
- Participated in XXVI (26th) Meeting of Regional Committee-II organized at ICAR-NRRI, Cuttack on 14.10.2022 on Hybrid mode where Shri Kailash Choudhary, Hon'ble MoS, MAFW, GOI acted as the Chief Guest of the Function and Dr Himanshu Pathak, Secy DARE and DG ICAR acted as Chairman.
- Acted as a Panelist in Webex Webinar on Special Campaign 2.0 for disposal of pending matters from 2nd October to 31st October, 2022 (1st Meeting was held under the Chairmanship of Secy DARE and DG ICAR on 26.9.2022 on virtual mode.
- Participated in Brain storming Meeting on Seed organized by Council and DAC & FW on dated 14.9.2022 on regulation of unnotified varieties being marketed by private sector, quality control of Truthfully Labelled Seeds, licenses by seed production unit and certification of seed being produced by ICAR/KVK/SAU units.

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- Participated in Meeting of the Zonal Committees for conductance of KRITAGYA 03 (Hackathon) for discussion and presentation on screening of the online entries/proposal on Speed Breeding for Crop Improvement chaired by DDG (Education) on 14.09.2022. Dr CS Praharaj, Director Acting is the Zonal Level Committee Member nominated.
- Participated in International Conference on "Advances in Agriculture and Food system towards sustainable development goals (AAFS2022) held during 22-24 August, 2022 organized by University of Agricultural Sciences, Bengaluru, All India Agricultural Students Association (AIASA) and ICAR, New Delhi.
- Presented a paper on *Precision water management in pulse crops for higher productivity and profitability in an ICAR-sponsored Short Course on* "Pulses as the climatic smart crops for resource conservation and economic intensification /diversification of cropping systems" held at ICAR-IIPR, Kanpur during 02-11 March, 2022.
- Participated/Co-chaired in Annual Zonal Workshop of KVKs of Zone VIII, ICAR-ATARI, Pune held during July 07-09, 2022 at AAU, Anand, Gujarat (Hon'ble DDG, AE, Dr AK Singh, Hon'ble VCs of JAU, Junagadh, SDAU, SK Nagar, NAU, Navsari, AAU, Anand, Chairman of Kaneri Math, Kolhapur, and Director, ICAR-ATARI, Pune participated).Also participated in Workshop on Drone Tecchnolgy at AAU, Anand on 7.7.2022.
- Participated as Guest of Honour in SEEG Seminar organized by Society of Extension Education of Gujarat and Junagadh Agricultural University, Junagadh held during 24-25 June, 2022 at JAU, Junagadh.
- Organized and participated as Convenor in 3rd Task force of 13th Agroclimatic zone consisting of Gujarat Plains and adjoining region on 23rd June 2022 (Chaired by Hon'ble VC, AAU, Anand, Gujarat).
- Participated in Annual Group Meet of AICRP on Castor, Sunflower, Sesame and Niger - 2022 (Hybrid Mode) during May 25-27, 2022 organized by IIOR, Hyderabad. And also acted as Co-Chairman in a session (Crop Production and FLDs under AICRP on Sunflower on dated 27.5.2022.
- Participated in National Symposium on INDIAN AGRICULTURE AFTER INDEPENDENCE held on May 24, 2022 at DARE, New Delhi (on Virtual mode). This meeting was organized by Council where Hon'ble DG, DDGs and ADGs, Directors and other experts participated.
- Organized, participated and presented Achievements in AICRP on Groundnut in Annual Group Meeting of AICRP on Groundnut held at ICAR-DGR, Junagadh during April 25-26, 2022. Presented highlights of AICRPG as Director/Nodal Officer for ICAR-DGR, Junagadh before Hon'ble DDG, ADG and experts for the Group Meeting.
- Presented a lead paper on "*Importance of groundnut in edible oils*" in *National Workshop on Self-sustainability in Edible Oils in India"* held online and offline mode (hybrid mode) at NAARM, Hyderabad, India on April 20,2022.
- Participated in Special meeting for Vice Chancellors of SAUs and Directors of ICAR Institutes at NASC, New Delhi during 12-13 April, 2022 and participated in deliberations/discussions chaired by Hon'ble Secy DARE and DG ICAR and Inauguration meeting chaired by Hon'ble Agriculture

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Minister, Shri Narendra Singh Tomar and State Agric Minister, GoI.

- Participated in a Brainstorming webinar on "*Sustaining growth in pulses*" organized on 10th February, 2022 (9.30 to 5.00 PM) at ICAR-IIPR, Kanpur organized by ICAR-IIPR, Kanpur and ISPRD, Kanpur and ICAR. Also presented a Lead Paper on "Endophytes and rhizobia for enhancing yield of groundnut' (PPT) presented by Praharaj CS and Pal KK, ICAR-DGR, Junagadh in the webinar at 4.p.m.

Dr. Rinku Dey

- Attended and conducted the 78th IRC Meeting of DGR from 12-13 January, 2022 as Secretary, IRC.
- Participated in the celebration of National Girl Child Day on 24-1-22, and addressed the gathering
- Conducted the online Surveillance Audit of ICAR-DGR for ISO 9001:2015 certification through URS representative on 27-01-2022
- Attended a budget webinar on SMART AGRICULTURE, organized by Govt of India, on 24th Feb 2022- session 3 on Bringing Back Glory of Millets; Moving towards Atma Nirbhar in Edible Oil under the chairpersonship of Ms. Shobha Karandlaje, Hon'ble MoS (Agriculture) and moderated by Dr T. Mohapatra, Secretary, DARE & DG, ICAR & Mr Rohit Kumar Singh, Secretary, Dept of Consumer Affairs
- Attended 23rd RAC meeting of DGR on 26-27 March, 2022.
- Attended the AGM of AICRPG on 25-26 April, 2022
- Conducted and attended the 79th IRC meeting (*kharif* 2022 IRC) of DGR from 30-31 May, 2022 in hybrid mode
- Attended the online surveillance audit conducted by representative of URS India Ltd. on 1st June 2022 for ISO 9001-2015 certification, as chairperson.
- Attended National Campaign cum Kisan Goshthi on 'Awareness on balanced use of fertilisers' and 'Awareness on region specific Agroforestry' as a part of '*Azadi ka Amrit Mahotsav*' on 21-6-22.
- Attended an IP Awareness/Training program under National Intellectual Property Awareness Mission (NIPAM) organized by Intellectual Property Office, India from 1st – 5th August, 2022
- Attended the 17th Parthenium Awareness Week programme at DGR from 16-22 August 2022
- Attended a virtual meeting on 14-9-22 held under the Chairmanship of Additional Secretary (DARE) & Secretary (ICAR) to review the progress of implementation of CPGRAMS 7.0 and to monitor the pendency related to Public Grievances and Public Grievance Appeals
- Hosted and coordinated the 44th Foundation Day programme of DGR on 1st October 2022.
- Attended Swachchata Pakhwada programme of DGR from 15 to 31 Dec 2022

Dr KK Pal

- Attended the 18th AGRESCO Basic Science Sub-Committee Meeting 2022 of JAU, Junagadh held from February 10-11, 2022 as Invited Member, Basic Science
- Attended a budget webinar on SMART AGRICULTURE, organized by Govt of India, on 24th Feb 2022- session 3 on Bringing Back Glory of Millets; Moving towards Atma Nirbhar in Edible Oil under the chairpersonship of Ms. Shobha Karandlaje, Hon'ble MoS (Agriculture) and moderated by

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Dr T. Mohapatra, Secretary, DARE & DG, ICAR & Mr Rohit Kumar Singh, Secretary, Dept of Consumer Affairs

- Attended 23rd RAC meeting of DGR on 26-27 March, 2022.
- Attended the Experts' Meet on Self-sufficiency in Edible Oil Production under the Convenership of Dr. Sanjeev Gupta, FNAAS on March 28, 2022 through Hybrid mode, organised by the National Academy of Agricultural Sciences, N. Delhi.
- Visited Mungpoo, West Bengal, to participate in the discussion and guiding of scientists of Directorate of Cinchona and other medicinal plants (Gorkhaland Territorial Administration, Govt. of West Bengal) on use of microflora in restoration of soil and enrichment of FYM by microbes, on 2nd April, 2022.
- Attended the AGM of AICRPG on 25-26 April, 2022
- Attended the Empowered committee meeting of NASF for considering new project proposals in the Call IX of NASF, and presented the project proposal on CAM transition in groundnut
- Participated in the '*Kisan Bhagidari Prathmikta Hamari*' campaign on 28 April 2022, under '*Azadi Ka Amrit Mahotsav*', held at Ivnagar village, Junagadh
- Attended the virtual Meeting of Stakeholders for Crop Diversification and Achieving Self-Sufficiency in Oilseeds and Pulses on 10-5-2022, organized by ICAR-IIFSR; hosted by Sri Krishna Mohan, DA&FW
- Attended the 79th IRC meeting (kharif 2022 IRC) of DGR from 30-31 May, 2022 in hybrid mode.
- On International Yoga day on 21 June 2022, attended *Rajbhasha karyashala* and *prashikshan* on '*Yog ka mahatva*'
- Coordinated and attended National Campaign cum *Kisan Goshthi* on 'Awareness on balanced use of fertilisers' and 'Awareness on region specific Agroforestry' as a part of '*Azadi ka Amrit Mahotsav*' on 21-6-22
- Attended as member (Expert), Assessment Committee Meeting of ARS Scientist for the discipline of Agril. Microbiology on 13-07-2022 at ICAR-CAZRI, Jodhpur.
- Visited ICAR-CAZRI, RRS, Kukma, Bhuj on 04-08-2022 for conducting experiments on screening of groundnut germplasm accessions for salinity tolerance and evaluation of CAM variants
- Attended an IP Awareness/Training program under National Intellectual Property Awareness Mission (NIPAM) organized by Intellectual Property Office, India from 1st – 5th August, 2022
- Organised and attended the 17th Parthenium Awareness Week programme at DGR from 16-22 August 2022.
- Attended the Annual Review Workshop of AMAAS projects 2022 in virtual mode on 22-8-22 and presented work done report
- Conducted the programmes of Vigilance week, 2022 of ICAR-DGR as Vigilance Officer.
- As Member secretary, QRT, organized the First Interface Meeting of QRT of ICAR-DGR with DDG (CS) on 09-12-2022
- Attended the Expert committee meeting of the NASF Strategic area "Abiotic and biotic stresses and, quality traits in plants, animals and fisheries' on 05-01-2023 and presented the achievements of the project "Exploiting cross-talk of CAM ....in groundnut"
- Attended the 1st Advisory committee meeting

of NASF project and presented the work done report of the project on 30-12-22.

Extended Summaries/ abstracts

1. Rajanna G.A., Ajay B. C., Reddy K. K.and Praharaj C. S. 2022. Modified Agronomic Practices for Enhancing Efficiency of Hydrogels in Groundnut under Semi-arid Ecologies of Andhra Pradesh. International Conference on Reimagining Rainfed Agro-ecosystems: Challenges & Opportunities during 22-24, December 2022 at ICAR-CRIDA, Hyderabad. Pages 9-11.
2. Ajay BC, Narendra kumar, Rajanna GA, Praveen Kona Kirti Rani, Praharaj CS, Bera SK. 2022. Study of genotype-location interactions without the confounding impact of years using HO-AMMI model. (In) 10th International Coference on legume genomics and genetics-2022 (10th ICLGG-2022), organized by ICRISAT, Hyderabad on 8th November 2022.
3. Praharaj Chandra Sekhar 2022. Importance of groundnut in edible oils. National Workshop on Self-sustainability in Edible Oils in India" held online and offline mode (hybrid mode) at NAARM, Hyderabad, India on April 20,2022 (Lead Lecture presented).
4. Praharaj Chandra Sekhar 2022. Research strategies in Groundnut for attaining self-sufficiency in seed production and edible oils in India. In: 11th National Seed Congress on "Recent Advances in Research on Quality Seeds for self-sufficiiency in Oilseeds and Pulses held at RVSKVV, Gwalior 474 002 (M.P.), India in collaboration with Nat. Seed Res. & TRG Centre, Varanasi (U.P.), MoA & FW, GoI during 21-23 August 2022.
5. Praharaj CS, Raghavendra Singh, Ummed Singh and Umakant Behera 2022. Pulses as candidate crops for NEH Region of India. National Conference on *"Natural Farming Systems and Biodiversity Conservation under Changing Climate Scenario"* held at COA, CAU, Kyrdemkulai, Meghalaya, India during December 5-7, 2022, 110-112 (keynote Address presented).
6. Rajanna GA, KA Gopinath, VK Singh, and CS Praharaj 2022. POLY4 can be alternative of MOP and Gypsum for rainfed groundnut in Telengana and Andhra Pradeh. (In) Annual Cooperators' Conference during 17-18 October 2022, ICAR-CRIDA, Hyderabad, India.

AWARDS/ RECOGNITIONS

Dr. Praveen Kona

1. Prof. N.G. Ranga and Bharathi Devi Ranga Memorial Gold Medal (1900-1995) for securing highest OGPA grade in Ph.D program in Faculty of Agriculture during 51st Annual Convocation held at Tirupathi on 04.03.2022 from ANGRAU, Lam, Guntur.
2. Sri Vaddadi Narasimha Swamy Memorial Gold Medal for securing highest OGPA grade in Ph.D in Genetics and Plant Breeding during 51st Annual Convocation held at Tirupathi on 04.03.2022 from ANGRAU, Lam, Guntur.
3. Sri G. Sriramulu Memorial Gold Medal for securing highest OGPA grade in Ph.D program in Faculty of Agriculture during 51st Annual Convocation held at Tirupathi on 04.03.2022 from ANGRAU, Lam, Guntur.

Dr. GA Rajanna

1. Received best oral presentation award in First International Conference-ICRA2022 On Reimagining Rainfed Agro-ecosystems: Challenges & Opportunities, 22-24 December 2022 held at ICAR-CRIDA, Hyderabad, Telangana, India.

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Dr. Sushmita Singh

1. Attended the viva-voce examination as External subject expert for Masters' thesis submission on 29.06.2022 at Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, UP, India.

Dr. CS Praharaj

1. Nominated as JOURNAL EDITOR for Indian Journal of Agronomy by ISA, New Delhi 2022-23.
2. Selected/elected as JOINT SECRETARY in Indian Society of Pulses Research and Development (ISPRD) 2021-23.
3. Member of Institute Management Committee (IMC) of ICAR-Directorate of Groundnut Research, Ivnagar Road, Junagarh 362001 (Gujarat) for a period of 3 years during 25.12.2020 to 24.12.2023.
4. Member of IMC of ICAR-Agricultural Technology Application Research Institute, Zone II, CAZRI Campus, Jodhpur 342005 (Rajasthan) for a period of 3 years during 16.02.2020 to 15.02.2023.
5. Member of IMC of ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh during 16.11.2018 to 15.11.2021 and 19.12.2021 to 18.12.2024.
6. Participated as CHIEF GUEST in the Valedictory Function and delivered/ presented his Address on 25.11.2022 in the WORKSHOP CUM HANDS ON TRAINING PROGRAMME on "Next Generation Sequencing" jointly organized by Gujarat Biotech Research Centre, Ahmedabad and JAU, Junagadh held during November 21-25, 2022 at JAU, Junagadh (Gujarat).
7. Participated and delivered Key Note Address in 37th ZREAC (Zonal Research and Extension Action Committee) of JAU, Junagadh for Rabi-Summer held during October 11-12, 2022 at Junagadh Agril University, Junagadh organized by Zonal Research and Extension Action Committee for Rabi-Summer of Junagadh Agril Univ., Junagadh held during October 11-12, 2022 at Junagadh (Gujarat).
8. Nominated by Council as Acting Director, ICAR-Directorate of Groundnut Research, Junagadh w.e.f. 14.02.2022 to 08.11.2022.
9. Delivered a Keynote Speaker on "Pulses as climate smart crops for NEH region of India". (In): National Conference on "Natural farming systems and Biodiversity Conservation under Changing Climate Scenario" held at COA, CAU, Kyrdemkulai, Meghalaya, India held during December 5-7, 2022 (Organized by NAAS Chapter Barapani, Meghalaya, UOA, Shillong and CAU, Kyrdemkulai, Meghalaya).

9 Important events

1. भा.कृ.अनु.प- मूँगफली अनुसंधान निदेशालय, जूनागढ़ में हिन्दी सप्ताह (14-21 सितम्बर, 2022) का आयोजन

इस निदेशालय के राजभाषा कार्यान्वयन समिति द्वारा 14 से 21 सितम्बर, 2022 तक हिन्दी सप्ताह मनाने का निर्णय लिया गया | हिन्दी सप्ताह का शुभारंभ (उद्घाटन समारोह) 14 सितम्बर, 2022 को माननीय निदेशक महोदय, डॉ के. के. पाल, श्री दिलीप कुमार, विशिष्ट अतिथि श्री विक्रम सिंह मीणा, हिन्दी स्नातकोत्तर शिक्षक, केन्द्रीय विद्यालय, जूनागढ़ तथा इस निदेशालय के सभी कर्मचारियों/अधिकारियों की गरिमामयी उपस्थिति में संपन्न हुआ | दिनाँक 15 सितम्बर, 2022 को निबंध लेखन प्रतियोगिता का आयोजन हुआ, इस प्रतियोगिता में कुल 23 प्रतिभागियों मे हिस्सा लिया | दूसरे दिन दिनाँक 16 सितम्बर, 2022 को आशुभाषण प्रतियोगिता आयोजित किया गया, इसमें कुल १६ प्रतिभागियों मे हिस्सा लिया | सभी प्रतिभागियों ने समसामयिक एवं ज्वलंत मुद्दों पर आधारित विषयों पर अपना विचार रखें | दिनाँक 19 सितम्बर, 2022 को प्रश्नोत्तरी प्रतियोगिता तथा कविता पाठ प्रतिस्पर्धा का आयोजन निदेशालय के कर्मचारियों/अधिकारियों के लिए किये गये | प्रश्नोत्तरी प्रतियोगिता में 34 प्रतिभागियों ने उत्साहपूर्वक हिस्सा लिया तथा इस प्रतियोगिता के सभी राउंड में प्रतिभागियों की सह-भागिता, जोश एवं उत्साह को शब्दों में बयान कर पाना मुश्किल हैं | कविता पाठ प्रतियोगिता में कुल 17 प्रतिभागियों ने हिस्सा लिया | हिन्दी सप्ताह का समापन दिनाँक 21 सितम्बर, 2022 को सभी विजेता प्रतिभागियों को पुरस्कृत करके किया गया एवं प्रमाण पत्र भी बांटें गए | समापन समारोह के मुख्य अतिथि श्री देवांग व्यास, ब्रांच मैनेजर, स्टेट बैंक ऑफ इंडिया, दीवान चौक, जूनागढ़ थे | इस समारोह में माननीय निदेशक महोदय सहित इस निदेशालय के सभी कर्मचारी गण उपस्थित थे | निदेशक महोदय एवं मुख्य अतिथि महोदय ने हमारे निदेशालय के सभी कर्मचारियों को संबोधित करते हुए हिन्दी कि उपयोगिता, सहजता एवं प्रभावशीलता के बारे में अपना विचार साझा किया | प्रभारी-राजभाषा अधिकारी के धन्यवाद ज्ञापन से इस सफल कार्यक्रम का समापन हुआ |

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ICAR- DGR celebrated 44th Foundation Day on 1st October 2022.

The programme was chaired by Dr. A.R. Pathak (Hon. Former VC, JAU, Junagadh), and the chief guest of the event was Dr. T.R. Sharma, DDG (CS), ICAR. Guest of Honor of the event was Dr. N. K. Gontia, Former Principal and Dean, College of Agril. Engineering, JAU, Junagadh. Special invitees of the event were Dr. Sanjeev Gupta, ADG (O&P) and Dr. D. K. Yadava, ADG (Seed), ICAR. Dr. CS Praharaj, Director (A), ICAR-DGR, in his foundation day

ADDRESS BY DR SANJEEV GUPTA, ADG (O&P)

ADDRESS BY DR D K YADAVA, ADG (SEED)

RELEASING OF ICAR-DGR PUBLICATIONS

address mentioned that DGR has been upgraded to IIGR (Indian Institute of Groundnut Research) and thanked the council for the same. Dr. Sanjeev Gupta ADG (O&P), mentioned that due to concerted efforts of all scientists we could cross 10 mt of groundnut production in the country. He also stressed upon using the innovative tools like gene targeting, genomics etc. Dr. DK Yadava, ADG (Seed) said that the SRR is very low in groundnut. He said that AICRPG centers and SAU's should coordinate for increasing the breeder seed indent. He said that currently 59 varieties (48 varieties new) are in the seed chain, which represent around 70% of varieties in seed chain and the VRR is good, but the availability of seeds of new variety should be high. Dr. T R Sharma DDG (CS) could not join virtually; however, he had sent his message congratulating DGR for completing the 43 years of existence and also for preparing the road map for the self-sufficiency in edible oil sector. Dr. NK Gontia, (Hon. Former VC, JAU, Junagadh) congratulated all the employees on the 44th foundation day. He mentioned that mechanization should be used effectively and said that per hectare productivity should be increased to 3000 kg/ha from the current 1700 kg/ha. Dr SK Bera introduced the Chief Guest of the event by mentioning his magnanimous achievements in his life long career. Dr. AR Pathak (Chief Guest of the event) mentioned that the information and scientific knowledge generated by DGR should be used by the farmers for enhancing groundnut productivity.

Four employees were awarded for their contributions in R&D activities and institutional developmental activities - Dr. Ajay BC (Best scientist award); Sh. Ranvir Singh (Best Technical officer); Sh. CG Makhwana (Best Administrative staff), Sh. C.G Moradiya (Best skilled support staff); Smt Santha Venugopalan (Best Finance & Accounts staff). Three employees due for retirement in the next year, Dr. S.D. Savaliya (CTO), Smt Santha Venugoplan (Assistant), Sh. N.G. Vadher (SSS) were also felicitated. Three progressive farmers adopting improved groundnut production technologies were also felicitated on the occasion. Dr. Rinku Dey (Pr. Scientist) gave vote of thanks by thanking the dignitaries and guests, staff, farmers and others who had joined both online and offline.

"FIT INDIA FREEDOM RUN 3.0" organized on 02 October 2022

In reference to Office order F.No.2l -51/2022-CDN Date: -28. 09.2022 from Under Secretary (GAC), ICAR and guidelines given by Government of India Ministry of Youth and sports, Department of Sports, FIT India Mission was conceptualized as FIT INDIA FREEDOM RUN 3.0 to commemorate "Azadi Ka Amrit Mahotsav (AKAM)" the 3rd edition of Fit India freedom Run. It started on 02 October 2022 with the theme "Azadi ke 75 saal, fitness rahe bemisaal". In this regard ICAR- Directorate of Groundnut Research, Junagadh, Gujarat had organized "FIT INDIA FREEDOM RUN 3.0" on 02 October 2022 at 8:00 am. DGR staff actively participated in the event, 25 persons had registered for the event and successfully participated in the event. Dr. C S Praharaj, Director (A), ICAR-DGR, started the freedom run 3.0 by waving the flag with a message to stay fit and healthy. Dr. Harish G, Chairman Sports Committee, organized the entire event which was successfully concluded after the freedom run by DGR staff.

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ICAR-DGR Celebrates Vigilance Awareness Week, 2022

The Vigilance Awareness Week 2022 (31[st] October 2022 to 6[th] November 2022), with the focus ''Corruption Free India for a Developed Nation'' was organized at ICAR-

Pledge taking ceremony

Essay writing competition

Closing ceremony and distribution of prizes

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Directorate of Groundnut Research, Junagadh. The week began with the Pledge taking ceremony with the oath administered to the DGR staff by Director, DGR. Two events were organized *viz*. elocution and essay writing competition for all the employees of the Directorate. The elocution competition on the topic ''Corruption Free India for a Developed Nation'' was organized on 2[nd] November 2022 in both Hindi and English languages, and 11 employees participated in the competition. Similarly, on 3[rd] November 2022, Essay Writing Competition was organized on "Self-Reliance with Integrity'' in both English and Hindi languages and 23 employees participated in the event. On 4[th] November closing ceremony was held at 5:00 pm. Winners of different events were awarded with prizes and a certificate. In his remarks in the closing ceremony, Director (Incharge), Dr. S. K. Bera highlighted the need for self-introspection and making everyone aware about maintaining absolute integrity in public life to take country forward towards a developed nation. Dr. K. K. Pal, VO of the institute, emphasized the importance of making integrity a part of heart and soul to make society corruption free.

Foundation laying ceremony of RRS, ICAR-DGR Anantapur

ICAR-Directorate of Groundnut Research, Junagadh in association with Central Public Works Department (CPWD) held a foundation laying ceremony for office-cum research building for its Regional Research Station (RRS) at Anantapur. Foundation was laid on 29[th] December 2022 by Mr. Kanaka Raju, Chief engineer, CPWD Vijayawada in the gracious presence of Dr. B Sahadev Reddy, Principal Scientist and Head, Agricultural Research Station (ARS)- Acharya N.G Ranga Agricultural University, Anantapur; Dr. SK Bera, Director, ICAR-Directorate of Groundnut Research, Junagadh; Dr. Ajay BC, Sr. Scientist (Plant Breeding) and in-charge, RRS ICAR-Directorate of Groundnut Research, Anantapur; Dr. Rajanna GA, Scientist RRS ICAR-Directorate of Groundnut Research, Anantapur; Shri GSS

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Srinivas, Executive engineer, CPWD Kurnool; Shri B Satyanarayana Executive engineer (E), CPWD Kurnool and Shri Mukund Reddy, Asst. Engineer (C), CPWD Anantapur. Scientific faculty from ARS-ANGRAU, Anantapur and Horticultural Research Station (HRS)-YSR Horticultural university, Anantapur; CPWD officials were part of this occasion.

Celebration of Swachhata Pakhwada at ICAR-DGR, Junagadh from 16th to 31st December 2022

As a part of Swachhata Pakhwada at ICAR-Directorate of Groundnut Research, Junagadh, a cleanliness drive was organized with a preplanned sequence of events to clean the Office premises, Residential quarters and Guest house. The entire DGR campus was extensively cleaned by DGR staff in this fortnightly organized event. Besides, masks were distributed to the farm labor and they were also sensitized about the importance of Swachhata. On 23rd December, 2022 Kisan Diwas was celebrated wherein 40 farmers were invited from Muktapur village and tarpaulins were distributed to them. Awareness and demonstration on "Solid Waste Management" was organized at ICAR-DGR, near farm section. Dr. K. K. Pal, Principal Scientist, Agril. Microbiology demonstrated the solid waste microbial decomposition process to the staff, which is an appropriate

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economic and eco-friendly way-out. All the plant waste materials were put in the compost pit and microbial culture for biodegradation was also added to the pit. A quiz competition was organized for the school children to create awareness about Swachhata among them. On the day of valedictory function, the winners of quiz competition were given prizes and the school teachers were also felicitated. Guest of honor Sh. Niraj Ratanpara addressed the children on the importance of Swachhta in their surroundings and village. Director Dr. S. K. Bera gave his concluding remarks on Swachhata Pakhwada and its way forward for a better society. Sh. Ananth Kurella, Scientist, Plant Pathology proposed formal vote of thanks and the fortnightly organized event was successfully concluded.

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ICAR-DGR observed Parthenium Awareness Week

ICAR-DGR, Junagadh observed *Parthenium* Awareness Week (PAW) with full zeal during 16-22 August, 2022. About 80 SC farmers under SCSP Scheme from Ravni village (Junagadh dist.) and 40 staff members participated in the event on 17.08.2022. The committee consisting of chairman, Dr. KK Pal, I/c Head, social sciences and members, Dr. Harish G, chairman SCSP, Dr. KK Reddy and Dr. SD Savaliya organized the programme. Dr. CS Praharaj, Director ICAR-DGR gave the detailed presentation on congress grass origins, its botany, deteriorative effects of congress grass on the human and farm animal health and its control measures. He emphasized that the congress grass cause allergy, dermatitis, skin lesions and bronchitis in milch animals and human beings. Congress grass produces 25,000 seeds/plant and 0.62 billlion pollen/plant. Congress grass inhibits the germination (allelopathy), radical growth, activity of nitrogen fixing and nitrifying bacteria and acts as collateral host for many diseases caused by viruses in crop plants. He also pointed out that the parthenium weed can be controlled effectively by uprooting before seed setting, spray of 2, 4-D or glyphosate, application of leaf-feeding beetle (*Zygogramma bicolorata*) and the stem galling moth (*Epiblema strenuana*). Farm kits were distributed to the farmers at the end of the programme.

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दिनाँक 23 दिसंबर २022 को आयोजित राजभाषा कार्यशाला एवं प्रशिक्षण

भा.कृ.अनु.प -मूँगफली अनुसंधान निदेशालय, जूनागढ़ में दिनाँक 23 दिसंबर २०२२ को ऑनलाइन "राजभाषा कार्यशाला एवं प्रशिक्षण" का आयोजन किया गया | इस कार्यशाला एवं प्रशिक्षण में नराकास-जूनागढ़ के सदस्य एवं भाकृअनुप-मूँगफली अनुसंधान निदेशालय के कुल 20 अधिकारियों/कर्मचारियों ने हिस्सा लिया | कार्यक्रम के शुरुआत में श्री लोकेश कुमार थवाईत, प्रभारी-राजभाषा अधिकारी ने कार्यशाला विशेषज्ञ एवं सभी प्रतिभागियों का स्वागत करते हुए, कार्यशाला विशेषज्ञ डॉ. मोहन चंद्र बहुगुणा का संक्षिप्त परिचय प्रस्तुत किया तत्पश्चात सभी प्रतिभागियों ने अपना परिचय दिया | कार्यशाला में व्याख्यान देने के लिए डॉ. मोहन चंद्र बहुगुणा, सहायक निदेशक (राजभाषा), गृह मंत्रालय, नई दिल्ली को आमंत्रित किया गया | उन्होंने "कंप्यूटर पर उपलब्ध ऑनलाइन/ऑफलाइन अनुवाद सुविधाएं" विषय पर रोचक एवं ज्ञानवर्धक व्याख्यान दिया | उपरोक्त कार्यशाला में उन्होंने कंप्यूटर पर उपलब्ध ऑनलाइन/ऑफलाइन अनुवाद सुविधाओं को सरल एवं कंप्युटर पर लाइव उदाहरण द्वारा सभी प्रतिभागियों को अनुवाद करके दिखाया | डॉ बहुगुणा ने अनुवाद टूल्स जैसे कि अनुस्मारक, शक्ति, अनुवाद ई-लर्निंग प्लेटफ़ॉर्म, मंत्र राजभाषा, टीडीआईएल अनुवाद, स्मृति आधारित अनुवाद सॉफ्टवेयर कंठस्थ, गूगल ट्रांस्लेट एवं बर्ड ट्रांसलेसन का उदाहरण सहित प्रतिभागियों को इनकी महत्त्व एवं उपयोगिता को विस्तारपूर्वक व्याख्या किया | इसके अलावा उन्होंने अनुवाद में कंप्यूटर एवं स्मार्ट फोन की भूमिका, हिंदी ई-टूल, ई-लर्निंग प्लेटफ़ॉर्म तथा ई-महाशब्दकोश पर भी प्रकाश डाला |

डॉ. एस. के. बेरा, निदेशक एवं अध्यक्ष, राजभाषा कार्यान्वयन समिति ने सभी प्रतिभागियों को संबोधित करते हुए कहा कि ऐसे कार्यशालाओं के आयोजन से राजभाषा हिन्दी के प्रति जागरूकता एवं कार्यक्षमता बढ़ेगी | अंत में डॉ. सुष्मिता, सदस्य, राजभाषा कार्यान्वयन समिति, ने डॉ. मोहन चंद्र बहुगुणा, अध्यक्ष राजभाषा कार्यान्वयन समिति, समिति के सभी सदस्यों एवं प्रतिभागियों का हार्दिक आभार प्रकट किया |

10 Staff list/ General Information

Staff List – 2022 / General Information / Finance & Accounts

1.Staff List 2022

Sl.No	Name	Designation
1.	Dr. S.K.Bera	Director (w.e.f. 09.11.2022)
2.	Dr. C.S.Praharaj	Principal Scientist (Agronomy) (Director (A) w.e.f. 14.02.2022
3.	Dr. K.K. Pal	Principal Scientist (Microbiology)
4.	Dr. Rinku Dey	Principal Scientist (Microbiology)
5.	Dr. Harish G.	Senior Scientist (Entomology)
6.	Dr. Narendra Kumar	Senior Scientist (Plant Breeding, RRS, Bikaner)
7.	Dr. Ajay BC	Senior Scientist (Plant Breeding, RRS Ananthpur)
8.	Dr. M.V. Nataraja	Scientist (Senior Scale) (Entomology)
9.	Dr. Sushmita	Scientist (Senior Scale) (Plant Physiology)
10.	Dr. Sangh Chandramohan	Scientist (Senior Scale) (Plant Biotechnology)
11.	Dr. G.A. Rajanna	Scientist (Senior Scale) (Agronomy, RRS Ananthpur)
12.	Dr. K.K. Reddy	Scientist (Senior Scale) (Soil Science)
13.	Dr. Kona Praveen	Scientist (Senior Scale) (Plant Breeding)
14.	Sh. Ananth Kurella	Scientist (Plant Pathology)
15.	Dr. Raja Ram Choudhary	Scientist (Agronomy, RRS, Bikaner)
16.	Dr. Kirti Rani	Scientist (Plant Breeding) (Transfered on-28.10.2022)
17.	Dr. Papa Rao Vainkuntapu	Scientist (Biotechnology)
18.	Sh. P.V. Zala	Chief Technical Officer
19.	Dr. M.V. Gedia	Chief Technical Officer
20.	Sh. Ranvir Singh	Chief Technical Officer
21.	Dr. S.D. Savaliya	Chief Technical Officer
22.	Mrs. V.S. Chaudhari	Chief Technical Officer(Superannuated on-31.05.2022)
23.	Sh. R.D. Padvi	Technical Officer
24.	Sh. C.B. Patel	Technical Officer
25.	Sh. N.M. Safi	Technical Officer (Driver)
26.	Sh. Lokesh Kumar Thawait	Technical Officer
27.	Sh. Pitabas Dash	Senior Technical Assistant
28.	Sh. M.A. Shaikh	Driver
29.	Sh. M.B. Shaikh	T-1
30.	Sh. K.T. Kapadia	T-1 (Superannuated on-31.05.2022)
31.	Sh. V.N. Kodiatar	T-1

32.	Sh. Dilip Kumar	Administrative Officer
33.	Sh. Anupam Chaubey	AAO (on deputation)
34.	Sh. Y.S. Kariya	Personal Secretary
35.	Sh. L.V. Tilwani	Personal Assistant
36.	Mrs. Santha Venugopalan	Assistant
37.	Sh. C.G. Makwana	Assistant
38.	Sh.J.G. Agravat	Skilled Support Staff (Superannuated on 30.06.2022)
39.	Sh.V.M. Chawada	Skilled Support Staff
40.	Sh.G.S. Mori	Skilled Support Staff
41.	Mrs.D.S. Sarvaiya	Skilled Support Staff
42.	Sh.P.M. Solanki	Skilled Support Staff
43.	Sh.N.G. Vadher	Skilled Support Staff
44.	Sh.B.J. Dabhi	Skilled Support Staff
45.	Sh.C.G. Moradia	Skilled Support Staff
46.	Sh. D.A. Makwana	Skilled Support Staff
47.	Sh. Jay R. Purohit	Skilled Support Staff
48.	Sh.M.B.Kandoliya	Skilled Support Staff
49.	Sh.Pola Haji	Skilled Support Staff
50.	Sama Roshan Allarakha	Skilled Support Staff
51.	Sumara Amin Pirmahamadbhai	Skilled Support Staff
52.	Dafada Ratanben Govindbhai	Skilled Support Staff
53.	Hariyani Hitendra Jejerambhai	Skilled Support Staff
54.	Vachhani Jagadishbhai Ratilal	Skilled Support Staff
55.	Solanki Bharatiben Karshanbhai	Skilled Support Staff
56.	Jotaniya Bharat Khimajibhai	Skilled Support Staff
57.	Odedra Shanta Karshan	Skilled Support Staff
58.	Sachania Sureshkumar Raghav	Skilled Support Staff
59.	Makawana Babubhai Kalubhai	Skilled Support Staff
60.	Shihora Rajesh Naran	Skilled Support Staff
61.	Seta Hanifbhai Habibbhai	Skilled Support Staff
62.	Gohel Jyotsanaben Babubhai	Skilled Support Staff
63.	Sumara Bhikhubhai Jamalbhai	Skilled Support Staff

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2. Staff position on (01.01.2022 to 31.12.2022)

Category	Sanctioned Strength as on 31.12.2022	Filled as on 31.12.22	Vacant As on 31.12.22
Scientific	35+01RMP	16+01 RMP	19
Technical	39	12	27
Admn.	18	06	12
SSS	30	25	05

3. DPC held (01.01.2022 to 31.12.2022)

1. DPC Held on 02.05.2022 for Admin Staff , 01 employees
2. DPC Held on 14.02.2022 for Admin Staff, 03 employees

4. IMC held on 24.05.2022

Sr No.	Institute Management Committee	Designation	Period
1	Director, ICAR-DGR, Junagadh	Chairman	Ex-Officio
2	Assistant Director General (OP), ICAR, KB, New Delhi	Member	25.12.2020 to 24.12.2023
3	Vice Chancellor, JAU, Junagadh	Member	
4	Dr. Akshay Talukdar,PS, Division of Genetics, IARI,New Delhi	Member	25.12.2020 to 24.12.2023
5	Dr. R.D. Prasad, PS, IIOR,Hyderabad	Member	25.12.2020 to 24.12.2023
6	Dr. Anita Rani, Principal Scientist, IISR, Indore	Member	25.12.2020 to 24.12.2023
7	Dr. C.S. Praharaj, PS, IIPR,Kanpur	Member	25.12.2020 to 24.12.2023
8	Director of Agriculture (Gujarat), Krishi Bhavan, Gandhinagar, Gujarat	Member	
9	Director of Agriculture (Rajasthan) Pant Krishi Bhavan,Jaipur, Rajasthan	Member	

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10	Shri S.V. Kasabe, Finance & Accounts Officer, ICAR-CIFE, Mumbai	Member	30.03.2022 to 29.03.2025
11	Administrative Officer, ICAR - DGR, Junagadh	Member Secretary	Ex-Officio
12	Dr. K.K. Pal, Principal Scientist, ICAR-DGR, Junagadh	Special Invitee	
13	Shri Anupam Kumar Chaubey, Finance & Accounts Officer,, ICAR-DGR, Junagadh	Special Invitee	
14	Sh. Y.S.Karia, DDO, ICAR-DGR, Junagadh	Special Invitee	
15	Sh. C.G.Makwana, Store Officer, ICAR-DGR, Junagadh	Special Invitee	

5. Retirement:-

1. Mrs. V.S. Chaudhari, CTO (Retired on-31.05.2022)
2. Sh.K.T. Kapadia, T-1 (Retired on-31.05.2022)
3. Sh.J.G. Agravat, SSS (Retired on-30.06.2022)

6. Transfer:-

1. Dr. Kirti Rani, Scientist, (Genetics & Plant Breeding, got trasfer from ICAR-DGR, Jungadh to NBPGR-RS-Jodhpur (Date-28.10.2022)

7. Institute Joint Staff Council:-

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

Members:

Staff side

1. Shri Pitbas Das, Member, Technical Category
2. Shri V.N.Kodiatar, , Member, Technical Category
3. Shri Y.S.Karia, Member, Administrative Category
4. Mrs. Anupam Chaubey, Member, Administrative Category
5. Shri Suresh Sachaniya, Member, Supporting Category
6. Shri Amin Pirmohammed, Member, Supporting Category

Office side

1. Dr.Rinku Dey, Principal Scientist, DGR, Junagadh.
2. Administrative officer, DGR, Junagadh.

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8. Contractual Staff

1.	RA	04
2.	SRF	03
3.	YP-2	01
4.	YP-1	22
5.	Data Entry Operator	01
6.	Security Staff -Ex. Army	22
7.	Cleaning Staff	07
8.	Farm Tractor Driver	04+1(Bikaner)
9.	Reception	05
10.	Electrician/Plumber	02+01
11.	DPL	08

9. Members of Research Advisory Committee of ICAR-DGR

Sr. No	Details of Person	Nominated as
1.	Dr. A. Bandyopadhyay, Former National Coordinator,NAIP, ICAR	Chairman
2.	Dr. B.B. Singh, Former ADG (O&P) 281, Utsav 1 Appartments' Flat No 201, Lakhanpur, Vikas Nagar, Kanpur 208 024	Member
3.	Dr. I.U. Dhruj Associate Director of Reserch (Rtd), Junagadh Agriculural University, Junagadh – 362991, Gujarat	Member
4.	Dr. L.M. Garnayak, Former Dean, Collage of Agriculture, Orissa University of Agriculture and Technology, Bhuneshwar	Member
5.	Prof. P.B. Kirti, University of Hyderabad, Prof. C.R. Rao Road, P.O. Central University, Hyderabad, Telgana 500046	Member
6.	Director, Directorate of Groundnut Research, Junagadh	Member
7.	ADG(OP), ICAR, Krishi Bhawan, New Delhi-110001	Member
8.	Sh. Mahendrabhai Pithiya NR, Nagdada Temple, Talala Road, At Gundran, Ta Talala, Dist Gir Somnth - 362150	Member
9.	Sh. Vraj Lai(Vajubhai), Jiva Bhai, Hirpara A-107, Chankya Apartment, Nr. Nehru Park Junagadh – 362001	Member
10.	Dr. S.K.Bera, Principal Scientist , ICAR- DGR, Junagadh	Member Secretary

10. Member Of Institute Research Committee

Chairman-Director ICAR-DGR, Junagadh
Member Secretary-Dr. Rinku Dey
Principal Scientist (Microbiology) ICAR-DGR, Junagadh
Members-All Scientists

10 Finance & Accounts

ICAR-DGR (1.01.2022 to 31.12.2022)

Budget DGR Main Scheme (Rs.In Lakhs)	Allocation	Total Expenditure
Establishment charges	731.99	723.88
Wages	0	0
Admininstrative Expenses	305.33	333.89
Pension	165.9	121.96
T.A.	14.69	12.04
Research and Operational Expenses	234.78	221.09
HRD	0	0
Works	162.77	64.74
Equipment	50.92	88.88
Furniture	2.13	1.15
IT	0.81	0.78
Books	0	0
Vehicle	0	0
Miscellaneous	6.65	5.66
TSP	14	9.92
NEH capital	0.34	12.2
SCSP	22.5	36.04
Total	**1712.81**	**1632.23**

AICRPG (1.01.2022 to 31.12.2022)

Budget AICRPG (Rs.In Lakhs)	Allocation	Total Expenditure
Capital	3.82	15.26
Pay & Allowance	893.19	710.19
TA	13.91	13.91
Recurring Contigency& Need Based Research	112.51	134.89
TSP	11.25	7.5
NEH	0	0
Total	**1034.68**	**881.75**


हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
ICAR
Agrisearch with a human touch