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ANNUAL REPORT
2023

स्वास्थ्य से समृद्धि
भाकृअनुप – डीजीआर

भाकृअनुप–मूँगफली अनुसंधान निदेशालय
(आई.एस.ओ 9001 : 2015 प्रमाणित संस्थान)
इवनगर रोड, जूनागढ 362 015, गुजरात, भारत

ICAR-Directorate of Groundnut Research
(An ISO 9001 : 2015 Certified Institute)
Ivnagar Road, Junagadh-362 015, Gujarat, India

भाकृअनुप
ICAR

डीजीआर
DGR

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- उपयुक्त किस्मों तथा प्रौद्योगिकियों के विकासार्थ जानकारियों ज्ञान तथा आनुवंशिक सामग्री को उपलब्ध करवाना।
- स्थान विशिष्ट किस्मों तथा तकनीकियों के विकास हेतु अनुप्रयुक्त अनुसंधान का समन्वयन।
- प्रौद्योगिकियों का प्रचार-प्रसार तथा क्षमता निर्माण।

Mandate

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

परिकल्पना

खाद्य तेल उत्पादन, पोषण और आजीविका सुरक्षा में आत्मनिर्भरता प्राप्त करने के लिए 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

Agriculture and its allied sectors are the mainstay of livelihood for more than half of Indian population and contribute significantly to the socio-economic development of the country. Even though our country has witnessed unprecedented progress in all the sectors of agricultural production systems, in view of multilateral challenges, viz., climate change, associated biotic and abiotic stresses, shrinking arable land and natural resources, sustaining growth in future will be a daunting task. Despite these challenges, India has huge advantage in terms of its rich biodiversity and vast human resource pool. ICAR-Directorate of Groundnut Research (ICAR-DGR), an institution of excellence is committed to steer knowledge and innovation driven groundnut production in holistic manner by undertaking basic and applied research.

I feel extremely happy in presenting the Annual Report of ICAR-DGR for year 2023. For the groundnut farmers, this was again a good rainfall year as they reaped a bumper harvest. According to the tentative estimates there was a production of 10.29 million tons from an area of 5.01 million ha with a yield of 2075 kg/ha.

In this year, two Spanish bunch varieties VG 17008 (Odisha and West Bengal) and JL 1291 (Rajasthan and Gujarat) as well as three Virginia varieties NRCGCS 637 (Rajasthan, Uttar Pradesh, Punjab and Haryana), RG 575-1 (Rajasthan, Uttar Pradesh, Punjab and Haryana) and RG 648 (Rajasthan, Uttar Pradesh, Punjab and Haryana) were recommended for identification. Besides, a few crop production and crop protection technologies have also been recommended.

During *Kharif* 2023, a total quantity of 2852.07q breeder seed was produced and production of about 4087.6q is targeted during ensuing *Rabi*-summer 2023-24. Under seed hubs, 2520.75 q certified seed was produced from six seed hub centers during *Kharif* 2023 and *Rabi*-summer 2023-24. The directorate produced about 3227q of breeder seed of high oleic groundnut varieties (2678.00 q of Girnar 4 and 549.00 q of Girnar 5) through PPP mode and conducted 48 trainings across the country in 2023-24.

Utilization of the grants was to the tune of Rs. 1933.97 lakhs for DGR and Rs. 1086.11 lakhs for AICRP-Groundnut, a nearly cent per cent utilization. In addition, the funds received through the externally funded projects were also utilized effectively. The Directorate also scaled up its resource generation and deposited Rs. 36.78 lakhs to the Council during the financial year 2022-23.

All the scientists and a few other officials have contributed the material for compilation of this report. Dr. Sushmita, Dr. Rajanna, Dr. Raja Ram Choudhary, Dr. Aaradhana Chilwal 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, Administration and contractual staff for their hard work towards generating the data reported in this volume.

I express my sincere gratitude to Dr. Himanshu Pathak, Secretary, DARE and Director General, ICAR for his inspiring guidance and all out support to the Institute. I would also like to thank Dr. T. R. Sharma, DDG (Crop Science), ICAR, Dr. Sanjeev Gupta, ADG (O&P), ICAR and Dr. D. K. Yadava, ADG (Seeds), ICAR for their continuous support and encouragements. 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

- कॉलर रॉट के प्रति प्रतिरोधी उन्नत किस्में विकसित करने के लिए खरीफ 2023 में चार संकर बनाये, जिसमे संकरण की सफलता दर 17% थी।
- खरीफ, 2023 के दौरान कम अवधि (90 दिन) और ताजा बीज सुसुप्तता (3 सप्ताह) को लक्षित करते हुए छह क्रॉस किए गए जिसमें 1509 संभावित संकर फलियाँ प्राप्त की गई।
- ठंड और गर्मी सहनशीलता के लिए कुल 117 जीनोटाइप की जांच की गई। प्रति पौधा औसत फली उपज, सामान्य (5 ग्राम) और देर से बुआई (2 ग्राम) की तुलना में पहले की बुआई (7 ग्राम) में सबसे अधिक थी।
- ख़रीफ़ 2023 के दौरान 71 संकरों की कुल 719 सन्ततियों को अलग-अलग वंशीय पीढ़ियों (F2-F7) में उन्नत किया गया।
- खरीफ 2023 के दौरान स्पेनिश बंच (35) और वर्जीनिया बंच (14) की 49 नई उन्नत प्रजनन लाइनें विकसित की गईं।
- दो साल के पूल मूल्यांकन (खरीफ 2022-2023) के आधार पर फली और बीज उपज के लिए सर्वोत्तम जाँच किस्म TAG 24 के मुकाबले चार बेहतर स्पेनिश बंच उन्नत प्रजनन लाइनों जैसे पीबीएस 12247, पीबीएस 12230, पीबीएस 12245 और पीबीएस 12239 की पहचान की गई जिनको एआईसीआरपी-जी के अंतर्गत परीक्षण के लिए प्रस्तावित किया गया।
- दो साल के मूल्यांकन के आधार पर, खरीफ 2023 के दौरान फली उपज के लिए सर्वोत्तम चेक किस्म एचएनजी 39 और बीज उपज के लिए गिरनार 2 के बराबर दो वर्जीनिया बंच (पीबीएस 22156 और पीबीएस 22157) उन्नत प्रजनन लाइनों की पहचान की गई इनमे से एक सर्वोत्तम लाईन को एआईसीआरपी-जी के अंतर्गत परीक्षण के लिए प्रस्तावित किया गया।
- चार अलग-अलग पीढ़ियों (एफ 3 से एफ 6 पीढ़ी) से 44 अलग-अलग क्रॉस की प्रजनन लाइन का चयन किया गया जिन्हें खरीफ 2024 के दौरान एआईसीआरपी-जी केंद्रों को आपूर्ति की जाएगी।
- दो साल (खरीफ 2022, 2023) के दौरान रोगग्रस्त भूखंड में कॉलर रॉट के प्रतिरोध के लिए 100 मूँगफली जीनोटाइप की जांच की गई।, दो साल की स्क्रीनिंग के आधार पर 70 में से 15 जीनोटाइप जिनमें 25% से कम पौधों की मृत्यु दर है।
- खरीफ 2023 के दौरान प्राकृतिक स्थिति में मूँगफली के कॉलर रॉट के प्रतिरोध के लिए 400 मूँगफली जर्मप्लाज्म की जांच की गई।
- दो साल (खरीफ 2022, 2023) के दौरान बीकानेर में फ्यूजेरियम लीफ ब्लाइट के प्रतिरोध के लिए 150 मूंगफली जीनोटाइप की जांच की गई। दो साल की स्क्रीनिंग के आधार पर 150 में से 24 जीनोटाइप जिनमें 20% से कम पौधों की मृत्यु दर है।
- खरीफ 2023 के दौरान गिरनार-2 का 36.0 क्विंटल टीएफएल बीज और गिरनार 4 का 60.3 क्विंटल प्रजनक बीज उत्पादित किया गया।
- किसानों को गिरनार-2 किस्म का 2020 किलोग्राम टीएफएल बीज दिया गया। बीज, चारा और सामान्य उपज की बिक्री से 403050/- रुपये का राजस्व अर्जित किया।
- एकल क्रॉस (K 1812 x PBS 14064) से 13 एकल पौधों का चयन किया गया।
- खरीफ 2023 के दौरान 18 क्रॉस से चुने गए कुल 129 संभावित F1 को F2 पीढ़ी उत्पन्न करने के लिए बोया गया।
- ख़रीफ़ 2023 के दौरान पुरुष अभिभावक के चरित्रों को ध्यान में रखते हुए, प्रारंभिक परिपक्वता, सुप्तता और गुणवत्ता जैसे लक्षणों के लिए 93 संकरों की कुल 2248 सन्ततियों को अलग-अलग वंशीय पीढ़ियों (F2-F8) में उन्नत किया गया।
- सात उन्नत प्रजनन लाइनों (पीबीएस 16004,

16015, 16021, 16031, 16037, 16039, 16041) ने 21 दिनों तक 100% सुप्तता दर्ज की। CTT=1580°Cd और 1850°Cd पर दो नमूनों और उपज आँकड़ा के आधार पर, उन्नत प्रजनन लाइनों अर्थात, पीबीएस 16023, 16032, 16039 को जल्दी पकने वाली और उच्च फली उपज (>10 ग्राम/पौधा) के रूप में पहचान किया गया।

- ग्रीष्म 2022 और ग्रीष्म 2023 के एकत्रित आंकड़ों में, स्पेनिश बंच लाइनें, पीबीएस 19040 (2892.66 किग्रा/हेक्टेयर), पीबीएस 19041(2646.24 किग्रा/हेक्टेयर), पीबीएस 19050(2874.9 किग्रा/हेक्टेयर), और पीबीएस 19052 (2719.5 किग्रा/हेक्टेयर) हेक्टेयर) लाइनें सर्वश्रेष्ठ चेक टीकेजी 19ए (2335.4 किग्रा/हेक्टेयर) से बेहतर पाई गईं और गुणवत्तापूर्ण लक्षणों का अच्छा संयोजन है। इसी प्रकार, वर्जीनिया लाइनें, जैसे कि पीबीएस 29236 (2786.1 किग्रा/हेक्टेयर), पीबीएस 29239(2393 किग्रा/हेक्टेयर) में गुणवत्तापूर्ण लक्षणों के अच्छे संयोजन के साथ सर्वश्रेष्ठ चेक जीजेजीएचपीएस 2 (1931.4 किग्रा/हेक्टेयर) से बेहतर पाई गईं।
- रबी-ग्रीष्म 2023-24 में दो जीनोटाइप (पीबीएस 14085 और 14086) एआईसीआरपी-जी परीक्षण के लिए भेजी गई तथा खरीफ 2023 के दौरान एआईसीआरपी-जी परीक्षण के लिए दो जीनोटाइप (पीबीएस 29272 और पीबीएस 29273) लाइनें भेजी गईं।
- FAD2B जीन के लिए दो गाइड आरएनए को विभिन्न गुणों के लिए डिजाइन और परीक्षण किया गया।
- P201N वेक्टर में gRNA2, प्रमोटर और स्कैफोल्ड को क्लोन किया गया।
- सत्यापन के बाद, सेंगर अनुक्रमण के माध्यम से, अंतिम वेक्टर को एग्रोबैक्टीरियम में डाला गया।
- भ्रूणरहित बीजपत्र एक्सप्लांट्स को CRISPR/Cas9 प्लास्मिड को आश्रय देने वाले एग्रोबैक्टीरियम ट्यूमफेशियन्स स्ट्रेन LBA4404 के साथ सह-संवर्धित किया गया।
- डिफेंसिन जीन वाले 190 ट्रांसजेनिक मूँगफली में से 189 पौधों को जीन विशिष्ट प्राइमरों के साथ जांच के बाद सकारात्मक पाया गया।
- ताजा बीज सुप्तता के लिए दो एसएसआर मार्कर (डी-23 और डी-98) की पहचान की गई।
- मूँगफली की 10 किस्मों में रूट एक्सयूडेट अध्ययन से पता चला कि जीजेजी 32 ने मध्य-मौसम (50-70 दिन बुवाई के बाद) में पानी की कमी के दौरान राइजोस्फीयर में अधिकतम कार्बनिक अम्ल (विशेष रूप से ऑक्सेलिक एसिड और ऑक्सेलोएसेटिक एसिड) उत्सर्जित किया और अन्य प्रजातियों की तुलना में अधिक Fe और Zn संग्रह किया।
- जड़ पेरिप्लास्मिक झिल्ली के ट्रांसपोर्टरों अर्थात् आईआरटी1 , वाईएसएल3 और ज़िप 5 ने अति-संवेदनशील चेक की तुलना में Fe की कमी की स्थिति में अत्यधिक अभिव्यक्ति दर्ज की।
- तीन मैंगनीज घुलनशील आइसोलेट्स, ब्रेविबैसिलस पैराब्रेविस Mn-1, ब्रेविबैक्टीरियम प्रजाति Mn12-1, और अल्कालिजेन्स प्रजाति Mn12-2 के साथ बीज टीकाकरण के परिणामस्वरूप फली की उपज में उल्लेखनीय वृद्धि हुई, जो Mn-1 और Mn12-2 के साथ समान और Mn12-1 (13%) के साथ अधिकतम वृद्धि प्राप्त हुई।
- 50 किग्रा P_2O_5/हेक्टेयर + डीजीआरसी कल्चर के प्रयोग से उल्लेखनीय रूप से उच्च फली उपज 2063 किग्रा/हेक्टेयर प्राप्त हुई, जो 25 किग्रा P_2O_5/हेक्टेयर + डीजीआरसी कल्चर और 25 किग्रा P_2O_5/हेक्टेयर + डीजीआरसी कल्चर + मल्च के प्रयोग के बराबर थी।
- जब डीजीआरसी कल्चर को कंट्रोल में डाला गया तो लैबाइल-पी पूल में 28% की वृद्धि दर्ज की गई और जब डीजीआरसी कल्चर को 25 किलोग्राम पी P_2O_5/हेक्टेयर के साथ डाला गया तो लैबाइल-पी पूल में 46% की वृद्धि दर्ज की गई।

फसल उत्पादन

- भारत में मानसून 2023 की मुख्य विशेषताओं से संकेत मिलता है, कि गुजरात और आसपास के क्षेत्र उत्तर-पश्चिम भारत (101%) में सामान्य वर्षा हुई और केवल पूर्व और पूर्वोत्तर भारत (82%) में सामान्य से कम वर्षा हुई। हालाँकि, पूरे देश में 2023 मौसमी (दक्षिण-पश्चिम मानसून) वर्षा (दीर्घकालिक औसत का 94%) दीर्घकालिक औसत (88.0 सेमी) से कम थी।
- खरीफ और ग्रीष्म दोनों ऋतुओं में मूँगफली का उत्पादन सामान्य था, अतिवृष्टि के कारण कुछ हानिकारक प्रभाव

पड़े जिसके परिणामस्वरूप गुजरात और समीपवर्ती क्षेत्रों में बाढ़ (खरीफ के दौरान), रोगों (लीफ स्पॉट और स्टेम रॉट आदि) का प्रकोप हुआ।

- खरीफ 2022-23 (प्रथम वर्ष) के दौरान मूँगफली की प्राकृतिक खेती की प्रतिक्रिया प्राप्त हुआ, हालांकि यह पारंपरिक कृषि प्रथाओं (यहां ICM या एकीकृत फसल प्रबंधन अभ्यास के रूप में संदर्भित) की तुलना में उपज में 19% की कमी से जुड़ा था। प्राकृतिक खेती पारंपरिक कृषि रसायनों (उर्वरक और कीटनाशकों) से रहित है, जो गाय के गोबर, गोमूत्र, गुड़, दाल के आटे आदि का उपयोग करके बनाए गए प्राकृतिक मिश्रण, मल्चिंग प्रथाओं और सहजीवी इंटरक्रॉपिंग के उपयोग को प्रोत्साहित करता है। इसमें चार स्तंभ हैं, जो इसमें एकीकृत हैं जैसे कि जीवामृत और घंजीवामृत (गाय के गोबर पर आधारित फसल पोषण), बीजामृत (बीज उपचार), अच्छादन (मल्चिंग) और व्हापासा (कुशल और कम सिंचाई)। खरीफ 2023 के दौरान खरीफ मूँगफली में इसी तरह की उपज प्रतिक्रियाएं देखी गई |

- इसके अलावा, रसायनिक उर्वरक, गोबर की खाद, और कीटनाशक (बीएमपी) से युक्त एकीकृत फसल प्रबंधन के प्रयोग उच्च उत्पाद/लाभ को प्राप्त करने में अधिक सुगम रहा क्योंकि फसल की आवश्यकता के अनुसार पर्याप्त आपूर्ति के साथ संगत फसल की वृद्धि और विकास हुआ। इसके बावजूद प्राकृतिक खेती और पारम्परिक खेती प्रयोगों में एकीकृत फसल प्रबंधन की तुलना में रबी ऋतु में गेहूं का उत्पादन 40% कम और मूँगफली-गेहूं प्रणाली का उत्पादन में 30% कम प्राप्त किया गया (2022-23)। उल्लिखित दोनो प्रयोगों के बीच जैविक खेती को स्थान मिला।

- हालांकि, मूँगफली के बीज में तेल और प्रोटीन विभिन्न कृषि प्रथाओं (आईसीएमपी, ओएफ और एनएफ) से प्रभावित नहीं था, फिर भी, वर्जीनिया बंच जेजीजी 22 में 53.4 % की उच्चतम तेल की मात्रा का विश्लेषण किया गया था जबकि, स्पैनिश बंच टीजी-37ए में उच्चतम प्रोटीन की मात्रा (29.6 %) दर्ज की गई थी।

- समग्र उत्पादकता और आर्थिक प्रणाली का क्रम आईसीएमपी > ओएफ > एनएफ प्राप्त हुआ । जबकि, जैविक दृष्टिकोण में मूँगफली और गेहूं दोनों में क्रमशः यह अनुसरण किया गया: (मूँगफली के लिए) टीजी 37ए > जेजी 22 और (गेहूं के लिए) जीडब्ल्यू 451 > लोक-1

- उन्नत कृषि प्रौद्योगिकियों के माध्यम से उपज के अंतर को कम करने पर, स्पैनिश बंच 'TG 37A' में उन्नत प्रथा (या आईसीएम) के साथ उत्पादकता और इसके गुणांकों में उच्च मूल्य प्राप्त किया गया, जिसमें बीएनएफ के लिए राइजोबियम इनोक्यूलेशन,आईजीआर 6 या आईजीआर 40 को 1.25 kg/ha, पीजीपीआर 'नटबूस्ट' 1.25 kg/ha, खाद्य संश्लेषण मिट्टी को 5 t/ha, अनुशंसित एनपीके को 25:50:25 kg/ha, क्षारीय मिट्टियों के लिए जिप्सम (मिट्टी पर 500 kg/ha की दो बराबर भागों में डाला गया, जैसे कि मिट्टी में तथा मिट्टी के उपरी हिस्से में), पूर्ववर्ती और पश्चावर्ती हर्बिसाइड, और आवश्यक पौधा संरक्षण अभ्यास सहित मिट्टी पर ट्राइकोडर्मा विरिडे की 2.5 kg/ha की आवेदन, 500 kg खाद्य संश्लेषित शामिल है।

- ग्रीष्म एवं खरीफ मौसम में ऐसे ही वर्जिनिया बंच 'केडीजी के लिए होता है। इस प्रकार, इस अध्ययन से मूँगफली में उच्च और स्थिर पैदावार प्राप्त करने के लिए उन्नत प्रथा (आईसीएमपी) को अपनाने का सिफारिश करता है।

- दक्षिणी सौराष्ट्र क्षेत्र में प्रमुख खरपतवार प्रजातियाँ 1) सेज़, जैसे *Cyperus* spp.; 2) घास, जैसे *Dactyloctenium aegyptium, Echinochloa colonum* और *Diachanthium annulatum;* और 3) फैले पत्ते वाले खरपतवार, जैसे *Digera arvensis, Vernonia cinerea, Phyllanthus* spp., *Vigna* spp., *Eclipta alba, Alternanthera* spp., *Ammania bacifera, Euphorbia hirta, Tridax procumbens* और *Commelina benghalensis* शामिल हैं।

- एक कुशल खरपतवार नियंत्रण रणनीति को शोधने/पहचानने पर दो मौसमों के अध्ययनों ने गुजरात के दक्षिणी सौराष्ट्र क्षेत्र के तहत उच्च उपज और आर्थिक लाभ के कारण खरपतवार नियंत्रण के लिए "डिक्लोसुलम 2 6 ग्राम/हेक्टेयर बुवाई से पूर्व फेनोक्साप्रोप-पी-एथिल 78 ग्राम/हेक्टेयर अंकुरण के बाद" प्रभावकारी सिद्ध हुई। खरीफ 2023 के दौरान भी इसी तरह की प्रतिक्रिया प्राप्त हुई। इस सर्वोत्तम शाकनाशी उपचार संयोजन के बाद अगला सबसे अच्छा उपचार अर्थात डिक्लोसुलम 26 ग्राम/हेक्टेयर बुवाई से पूर्व क्लेथोडिम 180 ग्राम/हेक्टेयर अंकुरण के बाद (अंकुरण के 20-25 दिन बाद) प्राप्त किया गया।

- मूँगफली की गर्मियों में सिंचाई को अनुकूलित करने पर प्रकाशित अध्ययन में यह साबित हुआ कि IW/CPE अनुपात 0.8 (बोनाई सिंचाई को छोड़कर गर्मियों में लगभग 10 दिनों के अंतराल पर 10 सिंचाइयों) सर्वोत्तम है। स्प्रिंग-समर और खरीफ, 2023 दोनों में एक-साल के अध्ययन ने साबित किया कि दक्षिणी सौराष्ट्र क्षेत्र की मौजूदा कृषि पारिस्थितिकी में मूँगफली में उच्च उत्पादन और आर्थिकता को साकार करने के लिए सल्फर (S) का 15 किलोग्राम / हेक्टेयर बेसल एप्लिकेशन उपयुक्त है।
- ग्रीष्म मौसम के दौरान मूँगफली में सिंचाई के अनुकूलन पर यह पता चला कि आईडब्ल्यू/सीपीई अनुपात 0.8 (वसंत-ग्रीष्म के दौरान लगभग 10 दिनों के अंतराल पर 10 सिंचाई, बुवाई पूर्व सिंचाई को छोड़कर) अधिक था। स्प्रिंग-समर और खरीफ, 2023 दोनों मौसमों में एक-साल के अध्ययन से पता चला कि दक्षिणी सौराष्ट्र क्षेत्र की मौजूदा कृषि पारिस्थितिकी तंत्र के अंतर्गत मूंगफली में उच्च उत्पादन और आर्थिक लाभ की प्राप्ति के लिए सल्फर (S) का 15 किलोग्राम /हेक्टेयर बेसल एप्लिकेशन उपयुक्त है।
- एंडोफाइट SDEN35 (बीज का उपचार) + एपीफाइट 20S3 (पर्ण अनुप्रयोग) प्रक्रिया के साथ फली उत्पादन (2108 किलोग्राम/हेक्टेयर) में विशेष वृद्धि देखी गई, जो एंडोफाइट J31 (बीज का उपचार) और एपीफाइट 24E1 (पर्ण अनुप्रयोग) प्रक्रिया के साथ समान प्राप्त हुई।
- नियंत्रण के तुलना में केवल एंडोफाइट्स (J22N और REN51N) 3.9 dS/m की मिट्टी की लवणता के अंतर्गत पर फली की उपज को 243-377 किग्रा/हेक्टेयर तक बढ़ा सकते हैं।
- नियंत्रण के तुलना में एंडोफाइट्स के साथ मल्चिंग ने मूँगफली की उपज में 556-580 किग्रा/हेक्टेयर की वृद्धि की। मलचिंग ने कटाई के समय मिट्टी के लवणता को भी नियंत्रित करके 1 dS/m तक कम किया।
- मूँगफली की फली उपज, मूँगफली समतुल्य उपज (जीपीईवाई), बीज उपज और सरसों की डंठल उपज, चना और गेहूं की पुआल उपज पारंपरिक जुताई + अवशेष निगमन (खरीफ) -शून्य जुताई (रबी) के अंतर्गत अधिक थी, लेकिन बीज उपज और सरसों की डंठल उपज के लिए अंतर महत्वपूर्ण थे, जबकि गैर-महत्वपूर्ण अंतर के साथ पारंपरिक जुताई+अवशेष निगमन (खरीफ) - पारंपरिक जुताई (रबी) के तहत मूँगफली की भूसा उपज और गेहूं की अनाज उपज अधिक थी। चने की बीज उपज शून्य जुताई + अवशेष प्रतिधारण (खरीफ) - शून्य जुताई (रबी) के अंतर्गत अधिक थी, लेकिन अंतर गैर-महत्वपूर्ण थे। मूँगफली-गेहूं फसल प्रणाली से अन्य फसल प्रणालियों की तुलना में उच्च जीपीईवाई प्राप्त हुआ।
- मूँगफली की फली और भूसा उपज, बीज उपज और सरसों और मूँगफली की डंठल उपज (जीपीईवाई) टी4 (न्यूनतम जुताई + अवशेष प्रतिधारण (खरीफ मौसम) + दोनों फसलों के लिए 100% आरडीएफ के तहत अधिक थी, लेकिन सरसों के बीज की उपज के संबंध में मूँगफली की फली उपज के लिए अंतर गैर-महत्वपूर्ण था और जीपीईवाई टी4 टी2 (शून्य जुताई + अवशेष प्रतिधारण (खरीफ मौसम) + दोनों फसलों के लिए 100% आरडीएफ) और टी६ (पारंपरिक जुताई + अवशेष प्रतिधारण (खरीफ सीजन) + दोनों फसलों के लिए 100% आरडीएफ) के बराबर था सरसों के डंठल की उपज के संबंध में टी-4 टी-6 के बराबर था, जबकि टी-4 मूंगफली भूसा उपज के संबंध में टी-1 (किसान पद्धति) और टी-5 (न्यूनतम जुताई + अवशेष प्रतिधारण (खरीफ मौसम) + दोनों फसलों के लिए 100% आरडीएफ + डीजीआरसी कल्चर को छोड़कर शेष उपचारों के बराबर था।

फसल संरक्षण

- ब्रूचिड बीटल द्वारा इमली को पसंद किया गया।
- समानिया समन (*Samania saman*) को पहली बार ब्रुचिड बीटल के होस्ट के रूप में दर्ज किया गया।
- अधिकांश रासायनिक धब्बों को ब्रुचिड संक्रमण की पूर्व-जानकारी के लिए उपयुक्त नहीं पाया गया, क्योंकि मूँगफली की फली पर मिट्टी की उपस्थिति के कारण वे अंडों पर धब्बा लगाने में सक्षम नहीं थे।
- पोटेशियम परमैंगनेट के घोल से मूँगफली की फलियाँ और अंडों पर धब्बे साफ़ दिखाई दे रहे थे।

Executive Summary

Crop improvement

- Four crosses were effected to develop improved varieties resistant to collar rot in *kharif* 2023 and success rate of hybridization was 17%.
- Six crosses were effected targeting short duration (90 days), and fresh seed dormancy (3 weeks) during *Kharif*, 2023 and 1509 probable crossed pods were harvested.
- Total 117 genotypes were screened for cold and heat tolerance. Average pod yield per plant was highest in early sowing (7g) than normal (5g) and late sowing (2g).
- Total 719 progenies of 71 crosses were advanced to next filial generations (F2-F7) in *kharif* 2023.
- Developed 35 Spanish bunch and 14 Virginia bunch new advanced breeding lines in *kharif* 2023.
- Based on two-year evaluation, four superior Spanish bunch advanced breeding lines viz., PBS 12247, PBS 12230, PBS 12245 and PBS 12239 for pod & kernel yield over best check variety, TAG 24 were selected in *kharif* 2023. Entries were proposed for testing under AICRP-G trials.
- Based on two-year evaluation, two superior Virginia bunch advanced breeding lines viz., PBS 22156 and PBS 22157 for pod and kernel yield over best checks were selected in *kharif* 2023. Entries were proposed for testing under AICRP-G trials.
- Produced 36.0q TFL seed of Girnar-2 and 60.3q breeder seed of Girnar 4 at RRS, Bikaner.
- Supplied 2020 kg TFL seed of variety Girnar-2 to the farmers. Generated revenue of Rs 403050/- through sale of seed, fodder and general produce at RRS, Bikaner.
- A total 13 single plants were identified from cross K 1812 x PBS 14064.
- Sowed total 129 probable F_1s from 18 crosses to generate F_2 generation during *Kharif*, 2023.
- Total 2248 progenies of 93 crosses were advanced to next filial generations (F2-F8) based on male parent characters targeting early maturity, dormancy and quality traits during *kharif* 2023.
- 7 ABLs (PBS 16004, 16015, 16021, 16031, 16037, 16039, 16041) recorded 100% dormancy up to 21 days. Based on two samplings at CTT= 1580 °Cd and 1850 °Cd, and yield data, advanced breeding lines viz., PBS 16023, 16032, 16039 are identified as early maturing and higher pod yield (> 10 g/plant).
- In pooled data of summer 2022 and summer 2023, Spanish bunch lines *viz*., PBS 19040 (2892.66 kg/ha), PBS 19041 (2646.24 kg/ha), PBS 19050 (2874.9 kg/ha), and PBS 19052 (2719.5 kg/ha) lines found superior over best check TKG 19A (2335.4kg/ha) Similarly, Virginia lines *viz*., PBS 29236 (2786.1 kg/ha), PBS 29239 (2393 kg/ha) lines found superior over best check GJGHPS 2 (1931.4 kg/ha).
- Two genotypes *viz*., PBS 14085 and 14086 were supplied to AICRP-G testing in *rabi*-summer 2023-24. Two genotypes viz., PBS 29272 and PBS 29273 lines were given for AICRP-G testing during *Kharif* 2023.
- Two guide-RNA (gRNA) for FAD2B gene was designed and tested for Hairpin formation, 3' complimentary, self-annealing and off-targets. Cloned the gRNA-2, promoter and scaffold in the P201N vector.
- After verification, through sanger sequencing, the final vector was transformed into *Agrobacterium*.
- The de-embryonated cotyledons explants were co-cultivated with *A. tumefaciens* strain LBA4404 harbouring the CRISPR/Cas9 plasmid.

- 189 plants out of 190 transgenic groundnuts containing defensin gene were found positive after screening with gene specific primers.
- Identified two SSR marker (D-23 and D-98) for fresh seed dormancy.
- The root exudate study (in 10 groundnut cultivars) revealed that GJG 32 exuded maximum organic acids (particularly oxalic acid and oxaloacetic acid) in the rhizosphere during mid-season (50- 70 DAS) imposed water deficit stress and accumulated more Fe and Zn when compared to other cultivars.
- The transporters at root periplasmic membrane namely *IRT1*, *YSL3* and *ZIP 5* recorded a significant overexpression under Fe deficit condition when compared to susceptible check.
- Seed inoculation with three Mn-solubilising isolates, *Brevibacillus parabrevis* Mn-1, *Brevibacterium* sp. Mn12-1, and *Alcaligenes* sp. Mn12-2 resulted in significant increase in pod yield, the maximum was with Mn12-1 (13%) and was at par with Mn-1 and Mn12-2.
- Significantly higher pod yield of 2063 kg/ha was obtained with the application of 50 kg P_2O_5/ha + DGRC culture, which was at par with application of 25 kg P_2O_5/ha + DGRC culture and 25 kg P_2O_5/ha + DGRC culture + mulch.
- A 28% increase in labile-P pool is observed when DGRC culture is applied over control and 46% increase in labile-P pool is noted when DGRC culture is applied along with 25 kg P_2O_5/ha.

Crop Production

- Salient features of Monsoon 2023 in India indicated that it was normal rainfall over Northwest India (101%) covering Gujarat and adjoining region and below normal only over East & NE India (82%). However, the 2023 seasonal (SW monsoon) rainfall over the country as a whole *(94% of LPA)* was less than the long period average (LPA of 88.0 cm).
- Both *kharif* and summer groundnut production were normal except some detrimental effect caused by high rainfall events resulting in flooding (during *kharif*), occurrences of diseases (leaf spot and stem rot etc.) in some locations in Gujarat and adjoining regions.
- *Kharif* groundnut responded to Natural Farming (NF) during 2022-23 (1^{st} year) although it was associated with 19% reduction in yield compared to Conventional Farming practices (herein referred to as ICM or Integrated Crop Management Practice). NF is devoid of conventional agrochemicals (fertilizer and pesticides) that encourages the application of natural mixtures made using cow dung, cow urine, jaggery, pulse flour etc., mulching practices, and symbiotic intercropping. This has four pillars which are integrated into it such as *Jeevamrutha* and *Ghanjeevamrutha* (cowdung based crop nutrition), *Bijamrita* (seed treatment), *Acchadana* (mulching) and *Whapasa* (efficient and less irrigation). Similar yield responses were observed in *kharif* groundnut taken during *kharif* 2023 (with 8% lower yield under NF over ICMP).
- Moreover, ICM 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 other (NF and OF practices). The same was the trend during *rabi* wheat yield (40% lower) and the system (groundnut-wheat) as a whole (30% lower) obtained under NF compared to ICMP (2022-23). Organic farming occupied in between the above two practices.
- Although both oil and protein content in groundnut kernel (*kharif*, 2^{nd} year) were not influenced by different farming practices (ICMP, OF and NF) yet, significantly higher kernel-oil content (53.4 %) was analysed under Virginia bunch GJG 22 while, higher protein content (29.6 %) was recorded in Spanish bunch TG-37A.
- The overall productivity and economics followed the order: ICMP > *OF*> *NF*. While, on varietal front in both the groundnut and wheat, the trend followed were (for groundnut) *TG 37A*

> *GG 22 and* (for wheat) *GW 451> Lok-1,* respectively.

- On bridging the yield gap through improved agro-technologies, higher values of yield and its attributes including economics in Spanish bunch 'TG 37A' were obtained with the improved (or ICM) practice that consisted of *rhizobium* inoculation of IGR 6 or IGR 40 at 1.25 kg/ha for BNF, and PGPR 'NUTBOOST' at 1.25 kg/ha, FYM at 5 t/ha, recommended NPK at 25:50:25 kg/ha, Gypsum for alkaline soils (applied to soil at 500 kg/ha in two equal instalments, such as at basal and at earthing up), pre- & post-emergence herbicides, and required plant protection practices (including soil application of *Tricoderma viride* at 2.5 kg/ha amalgamated with 500 kg of FYM/ha).
- And so was the case for Viriginia bunch 'KDG 128' and for the seasons (spring-summer and *kharif*). Thus, the study concludes for adoption of improved practice (ICMP) for realization of higher and stable yields in groundnut (confirmed from across the seasons/varieties).
- The dominant weed species found in the Southern Saurashtra Region include 1) sedges, like *Cyperus spp.*; 2) grasses, like *Dactyloctenium aegyptium, Echinochloa colonum and Diachanthium annulatum.*; and 3) broad leaved weeds, like *Digera arvensis, Vernonia cinerea, Phyllanthus spp., Vigna spp., Eclipta alba, Alternanthera spp., Ammania bacifera, Euphorbia hirta, Tridax procumbens* and *Commelina benghalensis*.
- Two-seasons studies on refining/identifying an efficient weed control strategy confirmed the proven efficacy of "*Diclosulam 26 g/ha as PRE fb Fenoxaprop-p-ethyl 78 g/ha as PoE*" for season long weed control due to higher yield and economics under Southern Saurashtra Region of Gujarat. Similar was the response during *kharif* 2023 also. This best herbicide treatment combination was followed by the next best treatment *viz.,* Diclosulam 26 g/ha as PRE fb Clethodim 180 g/ha as PoE (20-25 Days after emergence).
- On optimization of irrigation scheduling in groundnut during spring-summer it showed that IW/CPE ratio 0.8 (10 irrigations at about 10 days' intervals during spring-summer leaving aside the pre-sowing irrigation) was optimum. One-year study indicated the efficacy of single basal application of S only at moderate doses (15 kg/ha) for realization of higher yield and economics in groundnut under the existing agroecosystem of Southern Saurashtra Region of Gujarat (Confirmed from both spring –summer and *kharif*, 2023).
- Significantly higher pod yield (2108 kg/ha) was observed with endophyte SDEN35 (Seed treatment) + epiphyte 20S3 (Foliar spray) treatment, which was at par with endophyte J31 (Seed treatment) treatment and epiphyte 24E1 (Foliar spray) treatment.
- Endophytes (J22N and REN51N) alone could increase the pod yield by 243 – 377 kg/ha over control (where no endophytes were applied) under the soil salinity of 3.9 dS/m.
- Mulching in combination with endophytes improved the groundnut yield by 556-580 kg/ha over un-inoculated control. Mulching also appreciably decreased the soil salinity at harvest by 1 dS/m over control.
- Pod yield of groundnut, groundnut pod equivalent yield (GPEY), seed yield and stalk yield of mustard, and straw yield of chickpea and wheat was higher under conventional tillage + residue incorporation (*kharif*) -zero tillage (*rabi*), but differences were significant for seed yield and stalk yield of mustard, while haulm yield of groundnut and grain yield of wheat was higher under conventional tillage + residue incorporation (*kharif*) - conventional tillage (*rabi*) with non-significant differences. Seed yield of chickpea was higher under zero tillage + residue retention (*kharif*) - zero tillage (*rabi*) but differences were non-significant. Groundnut-wheat cropping system gave higher GPEY than other cropping systems.
- Pod yield and haulm yield of groundnut, seed yield and stalk yield of mustard and groundnut pod equivalent yield (GPEY) was higher under T4 (minimum tillage + residue retention (*Kharif* season) + 100% RDF to both the crops), but differences were non-significant for pod yield of

groundnut, with respect to mustard seed yield and GPEY T4 was at par with T2 (zero tillage + residue retention (*Kharif* season) + 100% RDF to both the crops) and T6 (conventional tillage + residue retention (*Kharif* season) + 100% RDF to both the crops), regarding mustard stalk yield T4 was at par with T6, while T4 was at par with rest of the treatments except T1 (farmers practice) and T5 (minimum tillage + residue retention (*Kharif* season) + 100% RDF to both the crops + DGRC culture) regarding groundnut haulm yield.

Crop protection

- Tamarind was preferred host by bruchid.
- *Samania saman* was the new host recorded for the first time as host of bruchid beetle.
- Most of the chemical stains were not found suitable for early detection of bruchid infestation as they were not able to stain eggs due to presence of soil on groundnut pods.
- Potassium permanganate solution stained the groundnut pods and eggs were clearly visible.

1 Crop Improvement

Project 1: Development of groundnut production technologies for arid region of Rajasthan

PI: *Narendra Kumar*

Co-PI: *Rajaram Choudhary, BDS Nathawat*

1. Screening genotypes for low and high temperature tolerance

Seventeen genotypes were evaluated in a replicated field trial conducted on three different sowing dates: Early (20th January 2023), Normal (10th February 2023), and Late (1st March 2023) during the summer/spring season of 2023 at RRS, Bikaner. The results indicated that the genotypes NRCG 14367, OG 52-1, and Pratap Moongfali 3 had the earliest germination, occurring on the 23rd day. The cultivars TG 37A, TAG 24, and Dh 86 produced the highest yield per plant under the early (10-16g), normal (8-12g), and late (4-6g) sowing dates, respectively.

In another trial, 100 germplasm lines (50 Valencia and 50 Spanish bunch) were screened for tolerance to low and high temperatures under field conditions with an early sowing date of 20th January 2023. The days to field emergence ranged from 22 to 30 days across both habit groups. In the Valencia group, the germplasm lines NRCG 6402, 10889, 1028, 10966, and 10392 exhibited the earliest field emergence. In the Spanish bunch group, NRCG 16227 and 16815 showed the earliest emergence. The yield per plant ranged from 1-9 g across both groups. High-yielding lines in the Valencia group included NRCG 11495, 11349, 10889, and 1286, while in the Spanish bunch group, the top yielders were NRCG 16849, 13967, 10390, 13955, 7076, and 11567, each producing 7-9 g per plant.

2. Hybridization

Four crosses were made to develop improved groundnut varieties resistant to collar rot during the *Kharif* season of 2023. The number of harvested crossed pods ranged from 11 (Girnar 2 × OG 52-1) to 110 (RG 638 × VG 19535). The mean success rate of the hybridization program was 17%, with individual success rates ranging from 10% to 27%.

3. Identification of hybrids

Thirteen different crosses were raised in summer 2023 to identify F_1s. A total 51 hybrids were identified from seven crosses through DNA markers.

4. Advancement of different filial generations

A total 719 progenies of 71 high yielding crosses with resistance to collar rot, stem rot and FDR were advanced during *kharif* 2023 at RRS, Bikaner to different filial generations (F_2:13, F_3:9, F_4:14, F_5:5, F_6:22, F_7:8). Among them 36 crosses were in early generations (up to F_4) and rest 35 crosses were in advanced generations. During selection, 329 progenies and seven crosses were rejected at the time of harvesting due to large proportion of poor recombinants and absence of desirable trait in the recombinants. Only 390 progenies were advanced to next filial generation.

Image 1.1: Selections in breeding materials at RRS, Bikaner during *kharif* 2023

Single plant progenies of 30 crosses were raised in advanced generations (F_6 & F_7), from which 49 new advanced breeding lines of Spanish bunch (35) and Virginia bunch (14) were identified.

5. Yield evaluation of advanced breeding lines

A total seventeen Spanish bunch advanced breeding lines with two checks (TG-37A, TAG 24) were evaluated in RBD with three replications for yield and its component traits during *kharif* 2022 and 2023. Based on the two-year testing, advanced breeding lines *viz*., PBS 12247 followed by PBS-12230, PBS 12245 and PBS 12239 were found significantly superior over the best check variety TAG 24 for pod and kernel yield. This breeding line may be proposed for testing under AICRP-G trials for *kharif* season.

A total twenty-four Virginia bunch advanced breeding lines with two checks (Girnar 2 and HNG 69) were evaluated in RBD with three replications for yield and its component traits during *kharif* 2022 and 2023. Based on the two-year testing, only two advanced breeding lines *viz*., PBS 22156 and PBS 22157 were found at par with best check variety HNG 69 for pod yield and Girnar 2 for kernel yield. These breeding lines had 8% yield superiority over the best check. Hence these breeding lines will be proposed for testing under AICRP-G trials for *kharif* season.

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

I. Development of new advanced breeding lines

A total 49 new high yielding advanced breeding lines (SB-35, VB-14) were developed from advanced generations during *kharif* 2023.

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

The breeding material of 44 different crosses from five segregating generations (F_3 to F_6 generation) were selected during *kharif* 2023 and to be supplied to different AICRP-G centres for location specific selections for high yield and collar rot resistance.

III. Multiplication and status of AICRP-G lines

During *kharif* 2023, seeds of ten elite breeding lines (PBS 12200, PBS 12217, PBS 12218, PBS 12221, PBS 12223, PBS 12228, PBS 12231, PBS 12232, PBS 12239 and PBS 12247) were multiplied to get sufficient seed required for testing under AICRP-G trials.

7. Screening of genotypes for resistance of collar rot

Screening for resistance to collar rot was done in sick plot wherein 100 groundnut breeding lines, cultivars and interspecific derivatives were screened in replicated trial at SKRAU, Bikaner during *kharif*

2023. Data were recorded on plant mortality (%) up to 45 DAS. Collar rot incidence ranged from 18 to 52%. Under high and uniform disease pressure of sick plot, 22 genotypes exhibited seedling mortality of 25% or less, which may be tested for at least two more years to ascertain their resistance to collar rot. Based on two-year screening under sick plot condition, 18 genotypes out of 72 exhibited less than 25% plant mortality during 2022-23. These genotypes will be screened for another two 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 of groundnut under natural condition during *kharif* 2022 & 2023 at Bikaner. Data were recorded on plant mortality up to 45 DAS. Seedling mortality per cent ranged 0 to 67% and 0 to 86% during 2022 and 2023, respectively. Highest disease incidence was observed in Virginia runner germplasm NRCG 13839 (86%). Susceptible cultivar RG 638 recorded 54% seedling mortality while resistant genotypes OG52-1 and PBS 22092 recorded 6% plant mortality under natural condition. A total of 79 germplasm had less than 5% seedling mortality while 33 germplasm had no disease mortality during both the years. These germplasms will be screened for 2 more years to ascertain their resistance level under field condition.

Besides, 48 advanced breeding lines were also screened for collar rot under natural condition during *kharif* 2023 at Bikaner. Seedling mortality per cent ranged from 9- 80%. Five breeding lines viz., PBS 22151, 12231, 12232, 12249, 12250 showed less than 15% seedling mortality. Highest disease incidence was observed in Virginia bunch breeding line PBS 22160 (80%). These breeding lines will be screened for 2 more years to ascertain their resistance level.

8. Screening of genotypes for resistance of fusarium blight

A total 150 groundnut advanced breeding lines and cultivars were screened in replicated trial under disease affected identified area for resistance to fusarium leaf blight at Bikaner during *kharif* 2022 and 2023. Data were recorded on plant mortality from 50 DAS to till harvesting. Based on the pooled year data, maximum disease mortality was 33% and 80% in 2022 and 2023, respectively. A total 24 genotypes recorded <20% plant mortality during both the years. These genotypes need to be tested for two more years to ascertain the resistance of fusarium leaf blight.

Image 1.2: Breeder seed production of Girnar 4

Image 1.3: TFL seed production of Girnar 2

9. Seed production of groundnut varieties

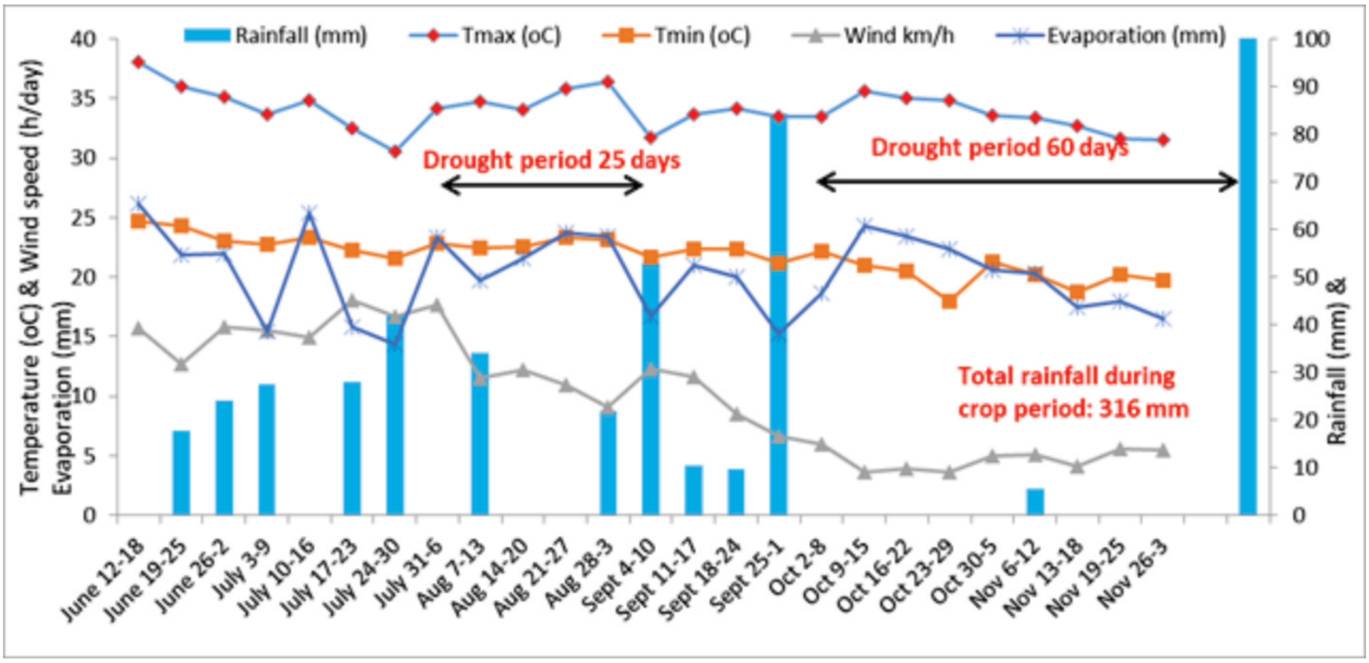
During *Kharif* 2023, seed production at ICAR-DGR-RRS, Bikaner, covered 3 hectares for TFL seed of the Girnar-2 variety and 6.4 hectares for breeder seed of Girnar-4. This effort resulted in the production of 36.0 quintals of TFL seed of Girnar-2 and 60.3 quintals of breeder seed of Girnar-4. Groundnut yield in 2023 was adversely affected by late sowing on July 15th and low soil organic carbon content, leading to poor pod filling. Despite these challenges, 2,020 kg of TFL seed of Girnar-2 were supplied, generating revenue of ₹17,35,490 from the sale of seed, fodder, and general produce. Additionally, in collaboration with an ICAR institute, 136 quintals of groundnut fodder were provided gratis to ICAR-CSWRI-ARC, Bikaner, in exchange for free canal water support for groundnut seed production.

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

PI: *Ajay BC*

Co-PI: *Praveen Kona, Rajanna GA, KK Reddy, Sushmita Singh*

Weather conditions



Hybridization, selection and generation of advancement in segregating generations

Generation advancement during summer 2023

A set of 20 breeding lines were multiplied for yield evaluation. Also, three crosses in F2 and four crosses in F4 generation were advanced to next filial generation in a bulk method during summer season (1st week of March 2023) at Anantapur for rapid generation advancement.

Generation advancement during *Kharif* 2023

Four fresh crosses were attempted in *kharif* 2023 to enhance yield under drought stress and more than 200 hybrid pods were harvested with 20% crossing success. Eight crosses in F1 generation were raised and true hybrids were identified which were later bulked after harvest for advancing to next generation. Four crosses in F2 and F3 were advanced to their next filial generations. A set of 320 narrow leaf segregants in F6 generation were advanced to next filial generation.

Generation advancement during *Rabi* 22-23

A set of 313 SPPs were multiplied during post-rainy season (3rd week of October 2022) at Anantapur for further yield evaluation. Also, three crosses in F1 and four crosses in F2 were advanced to their next filial generations.

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 (27 DAS).

Preliminary yield evaluation trial

A set of 193 Spanish advanced breeding lines were evaluated for yield related traits under natural drought prone conditions of Anantapur following augmented design during rainy season of 2023 with K 1812 and Dh 256 as check varieties. Around 36 advanced breeding lines recorded higher pod yield whereas 86 advanced breeding lines had higher fodder yield in comparison to check variety Dh 256.

A set of 148 Virginia advanced breeding lines were evaluated for yield related traits under natural drought prone conditions of Anantapur following augmented design during rainy season of 2023 with

KDG 128 as check variety. Around 32 advanced breeding lines recorded higher pod yield whereas 14 advanced breeding lines had higher fodder yield in comparison to check variety KDG 128.

Advanced yield evaluation trial

A set of 42 Spanish advanced breeding lines were evaluated for yield related traits under natural drought prone conditions of Anantapur following RCB design during rainy season of 2023 with K 1812 and Dh 256 as check varieties. Around eight advanced breeding lines recorded higher pod yield whereas 12 advanced breeding lines had higher fodder yield in comparison to check variety Dh 256.

A set of 49 Virginia advanced breeding lines were evaluated for yield related traits under natural drought prone conditions of Anantapur following RCB design during rainy season of 2023 with KDG 128 as check varieties. Around 13 advanced breeding lines recorded higher pod yield whereas 11 advanced breeding lines had higher fodder yield in comparison to check variety KDG 128.

Evaluation of germplasm accessions shortlisted for pod yield

After screening 2,500 Spanish germplasm accessions from 2020 to 2022, 162 germplasm accessions were shortlisted. These selected accessions were evaluated in a replicated design under rainfed conditions in Anantapur. Several accessions, namely NRCG 11452, 10678, 11427, 16747, 11574, 11730, 10477, 11577, 14674, 10675, and 10539, recorded higher pod yield per plant compared to the best check, Dh 256, which had a yield of 11.07 g/plant. Additionally, accessions NRCG 11414, 11730, 7660, 11102, 10991, 13410, 16477, 12958, 12819, 11624, 12184, 13518, 16508, 10753, 8550, 11574, 13592, 11332, and 14329 recorded high fodder yields. Notably, accessions NRCG 11452, 11427, 10678, 10539, 11577, 16747, 11574, 10477, and 10675 showed both higher pod yields and higher harvest indices than the best check, Dh 256, which had a pod yield of 11.07 g/plant and a harvest index of 33%.

Evaluation of germplasm accessions shortlisted for high protein

A set of 371 Spanish set of germplasm accessions were evaluated for oil and protein content during *Kharif* 2022 at RRS DGR Anantapur and DGR Junagadh and 58 accessions were shortlisted with high protein at both/either of the locations. Of these 58, 39 accessions were further evaluated during summer 2023 at RRS DGR Anantapur. Performance of these accessions under three environments are presented in the Table 1. Accessions, NRCG 13293, NRCG 14705, NRCG 14039, NRCG 14732, NRCG 15471, NRCG 14552, NRCG 13938, NRCG 10413, NRCG 3491, NRCG 8202, NRCG 203 recorded high average protein content over three seasons.

Table 2.1: Oil and protein content of 39 accessions.

SN	Accession	Oil			Protein		
		ATP sum23	**JND kh22**	ATP kh22	ATP sum23	**JND kh22**	ATP kh22
1	NRCG 80	45.92	43.78	45.07	31.92	29.62	36.10
2	NRCG 137	47.42	45.80	47.50	29.86	32.68	35.29
3	NRCG 145	45.55	49.25	45.82	32.47	27.64	35.61
4	NRCG 203	45.31	43.35	43.73	32.32	35.24	33.90
5	NRCG 1329	53.01	44.24	47.72	24.8	30.29	36.10
6	NRCG 3491	42.83	46.30	43.51	34.03	32.50	35.28
7	NRCG 6098	48.43	48.35	44.88	29.7	36.76	33.50
8	NRCG 6105	46.53	45.03	44.10	31.27	36.99	32.80
9	NRCG 8202	44.16	47.12	42.94	33.05	34.33	34.11
10	NRCG 8230	47.78	42.91	45.26	29.85	35.79	31.67

11	NRCG 9334	41.91	42.91	44.49	35.14	35.24	33.40
12	NRCG 10391	45.63	48.20	43.12	32.23	30.80	35.96
13	NRCG 10413	42.15	44.39	43.37	34.38	34.26	33.97
14	NRCG 10520	43.44	45.85	46.63	33.52	33.92	34.32
15	NRCG 11496	47.32	48.36	42.73	30.29	30.85	35.26
16	NRCG 11649	43.16	43.15	46.47	33.81	35.57	32.93
17	NRCG 12493	46.61	49.00	46.51	31.66	30.20	35.46
18	NRCG 12516	46.68	48.20	45.33	31.53	31.40	35.04
19	NRCG 13293	40.83	42.57	45.49	35.75	35.16	34.07
20	NRCG 13348	46.26	45.08	45.00	31.49	31.10	35.04
21	NRCG 13894	46.1	43.90	42.11	32.02	31.44	35.11
22	NRCG 13938	41.74	44.35	44.95	34.54	33.10	35.30
23	NRCG 14039	42.8	43.16	43.96	34.02	35.19	34.23
24	NRCG 14047	48.19	44.20	46.10	29.86	31.29	35.96
25	NRCG 14100	46.4	44.46	44.67	31.53	35.12	32.56
26	NRCG 14363	44.8	47.37	44.08	32.79	36.99	31.43
27	NRCG 14535	48.16	43.66	45.09	29.91	36.67	32.09
28	NRCG 14552	42.97	45.36	43.57	33.99	34.64	34.38
29	NRCG 14565	46.34	45.98	43.06	31.93	33.92	34.17
30	NRCG 14570	46.59	44.80	45.50	31.04	35.21	31.35
31	NRCG 14572	43.53	44.68	43.70	34.16	35.41	33.56
32	NRCG 14603	44.6	45.65	42.67	33.06	34.26	33.92
33	NRCG 14605	43.29	45.76	45.28	33.52	34.14	33.90
34	NRCG 14705	42.05	45.47	43.44	34.54	34.71	34.27
35	NRCG 14728	45.25	45.35	43.24	32.49	34.39	34.26
36	NRCG 14730	48.37	45.72	43.43	29.64	34.15	33.91
37	NRCG 14732	42.94	45.81	42.39	34.36	33.84	35.15
38	NRCG 15471	42.68	41.62	43.76	34.18	34.29	34.76
39	NRCG 16491	46.44	47.58	42.12	31.32	34.52	34.38

Project 3: Breeding groundnut for earliness, fresh seed dormancy and confectionary types

PI: *Dr. Praveen Kona*

Co-PI: *Dr. Narendra Kumar, Dr. Chandramohan S.*

***Summer*, 2023:**

1. **Identification and advancement of F_1s from 16 crosses for early maturity, quality traits (large seed, low oil and high protein) effected during *Kharif*, 2022**

In the summer of 2023, approximately 751 probable hybrid pods from 16 crosses were sown to identify true F1 plants and advance the generation, targeting early maturity (90 days) and quality traits such as seed size, oil and protein content, blanchability, and sucrose content. A total of 116 true F1 plants were selected from these 16 crosses based on molecular marker confirmation and male parent characteristics. Details related to the crosses and their purposes are illustrated in Table 3.1.

Table 3.1. Identification and advancement of F_1s from 16 crosses

S. No.	Name of the cross	Purpose	Seed Number	Selected SPP
1	K 1812 × PBS 29079B	Large seed size with high yield	75	2
2	J 95 × GJG HPS 2	Large seed size with high yield	84	6
3	K 1812 × RG 638	Large seed size with high yield	32	4
4	PBS 29079B × KDG 128	Large seed size with high yield	2	0
5	Dh 256 × PBS 29146	Large seed, high protein and low oil	37	8
6	K 1812 × PBS 29146	Large seed, high protein and low oil	55	10
7	Dh 257 × PBS 29213	Large seed, high protein and low oil	140	34
8	RG 638 × GJG HPS 2	Large seed size with high yield	121	8
9	KDG 128 × PBS 29079B	Large seed size with high yield	78	0
10	PBS 29146 × K 1812	Large seed, high protein and low oil	45	4
11	K 1812 × VRI 4	High yield, high blanching, sucrose	78	10
12	KDG 128 × R 2001-2	Mapping population for blanchability	62	0
13	TAG 24 × SG 99	Early maturity, high yield	48	0
14	VRI 3 × K 1812	Early maturity, high yield	75	11
15	ICGV 92206 × GJG 32	Early maturity, high yield	15	1
16	PBS 15044 × K 1812	High yield with fresh seed dormancy	80	18

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

In Spanish trial, 14 ABLs were evaluated with two checks, TPG41, TKG 19A in three replications under RBD design during summer 2023. 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, PBS19040, PBs 19041, and PBS 19050 recorded >66g of hundred kernel weight and found superior over best check TPG 41 (65.67 g). Genotype, PBS 19036 recorded highest SP as 68.05 % and found superior over best check TPG 41 (67.72 %). Total 04 genotypes recorded >29 % of protein of which PBS 19044 recorded highest protein content (31.15 %). PBS 19035, 19036, 19038, 19040, PBS 19050, and PBS 19052 lines found superior over best check TKG 19A (10.52g) in terms of pod yield/plant recording yield of >12gm/plant and having good combination of quality characters. In pooled data of summer 2022 and summer 2023, PBS 19040 (2892.66 kg/ha), PBS 19041 (2646.24 kg/ha), PBS 19050 (2874.9 kg/ha), and PBS 19052 (2719.5 kg/ha) lines were found superior over best check TKG 19A (2335.4 kg/ha).

In a Virginia trial, 17 ABLs along with five checks—Mallika, Girnar 2, Raj Mungphali 3, GJG HPS 2, and BAU 13—were evaluated using an RBD design with three replications. All traits, including HKW, HPW, SP, KL, pod yield per plant, oil percentage, and protein percentage, showed significant variation compared to the checks. The genotype PBS 29249 recorded the highest SP at 67.76%, and the line PBS 29239 recorded an HKW of over 60g. The lines PBS 29236, PBS 29239, and PBS 29244 outperformed the best check, GJG HPS 2 (7.16g), in terms of pod yield per plant, each recording yields of over 10 g/plant with a good combination of quality traits. In pooled data from summer 2022 and summer 2023, lines PBS 29236 (2786.1 kg/ha) and PBS 29239 (2393 kg/ha) were found to be superior to the best check, GJG HPS 2 (1931.4 kg/ha).

In preliminary large seed yield 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, PBS 29255, PBS 29256, PBS 29257 and PBS 29258 showed good combination of confectionery traits. In pooled data of summer 2022 and summer 2023, PBS 29267, PBS 29263, PBS 29261 recorded >3500 kg/ha yield and found superior over best check GJGHPS 2 (2275.5 kg/ha).

Table 3.2: Pooled mean data of top best lines during summer 2022 and 2023

Genotypes	HKW(g)	PY (kg/ha)
PBS 29254	90.27	3063.60
PBS 29258	93.10	3487.62
PBS 29260	79.13	3119.10
PBS 29261	81.20	3645.24
PBS 29262	84.73	3585.30
PBS 29263	83.47	3805.08
PBS 29267	88.80	3614.16
PBS 29269	96.87	3294.48
GJG HPS 2 (Best check)	67.70	2275.50
CV (%)	7.7	8.9

HKW = Hundred Kernel Weight, PY = Pod Yield

3. Evaluation of 37 stable advanced breeding lines for early maturity and fresh seed dormancy.

Table 3.3: Intensity of dormancy in advanced breeding lines 21 days after sowing during summer 2023

Genotypes	Laboratory test	Field test	*In-situ* test
Dh 86	45	70	present
Girnar 3	90	35	absent
PBS 16004	100	100	absent
PBS 16013	100	100	absent
PBS 16015	100	100	absent
PBS 16021	100	100	absent
PBS 16022	100	95	absent
PBS 16026	100	99	absent
PBS 16031	100	100	absent
PBS 16035	100	100	present
PBS 16037	100	100	present
PBS 16038	100	100	absent
PBS 16041	100	100	absent
PBS 16045	97	100	absent

Total 37 ABLs along with three checks were screened for fresh seed dormancy both *ex-situ* germination on field and *in situ* germination through petri plate method. In both the methods, total 7 ABLs (PBS 16004, 16015, 16021, 16031, 16037, 16039, 16041) recorded 100% dormancy up to 21 days in comparison to checks (Dh86, Girnar 3 and TPG 41). Based on two samplings at CTT= 1580 °Cd and 1850 °Cd, and yield data, advanced breeding lines viz., PBS 16023, 16032, 16039 are identified as early maturing and higher pod yield (> 10 g/plant). These lines were identified to mature at CTT 1580 °Cd which is equivalent to 85-87 calendar days.

4. Evaluation of 22 advanced breeding lines for yield traits at Anantapur (*rabi* 2022-23) and Junagadh (summer 2023).

At Anantapur and Junagadh, 22 ABLs were evaluated along with three checks, Mallika, GJG HPS-2 and Raj Mungphali-3 in three replications under RBD design. All the traits *viz*., HKW, HPW, SP, KL and pod yield per plant showed significant variation when compared to checks. Genotypes, PBS 29069, 29212 and 29213 recorded >80 g of hundred kernel weight and found superior over best check GJGHPS 2 (63.80 g). Genotype, PBS 29191 recorded highest SP (63.23 %) and found superior over best check Raj Mungphali-3 (58.42 %). PBS 29067, 29212 and 29213 lines found superior over best check GJGHPS 2 (9.63 g) in terms of pod yield/plant (>12 g/plant).

Seed multiplication of 13 new advanced breeding lines (PBS 14085, 14086, 14087, 14088, 14089, 19050, 19052, 11094, 11095, 29256, 29267, 29269, 29271) of groundnut (about 2-5 kg each) was done.

Single cross (K 1812 x PBS 14064) was effected targeting the fresh seed dormancy and 200 crossed pods were harvested.

Generation advancement of F_3 (459 single plants are selected from 26 crosses), and F_4 (56 single plants selected in 1 cross) for early maturity and/or fresh seed dormancy and F_3 (9 crosses- 418 single plants selected), F_6 (one cross-100 single plants), F_8 (19 SPP 1 row bulk selected from 6 crosses) of quality traits (large seed, high protein, low oil) was done.

Image 3.1: Selected promising lines in segregating generations of groundnut

***Kharif* 2023:**

1. Hybridization Programme:

Total 06 crosses targeting to early maturity (90 days) and fresh seed dormancy (>3weeks) with high yield were effected during *Kharif*, 2023. Total 1,189 matured crossed pods were harvested from 06 crosses.

Table 3.4. List of crosses undertaken in groundnut during *Kharif* 2023

S. No.	Name of Cross	Purpose	Bud pollinated	No. crossed pods
1	Dh 86 x GG 35	Early maturity, High yield	501	351
2	VG 19721 x PBS 14064	High yield with fresh seed dormancy	366	199
3	K 1812 x PBS 14108	Early maturity, High yield	168	142
4	TAG 24 x PBS 14108	Early maturity, High yield	1065	551
5	GJG 32 x VG 34	Early maturity, High yield	236	143
6	TAG 73 x PBS 15044	High yield with fresh seed dormancy	266	123

2. Advancement of segregating generations

From a single cross (K 1812 x PBS 14064), 200 harvested pods were sown to identify true F_1 plants, resulting in the selection of 13 single plants. In the summer of 2023, a total of 129 probable F_1 plants from 18 crosses (16 from the quality project and 2 from the salinity project) were sown to generate the F_2 generation during *Kharif* 2023. Subsequently, 133 single plants from 18 crosses in the F_2 generation, 1,192 single plants from 46 crosses in the F_4 generation, 802 single plants from 19 crosses in the F_5 generation, 112 single plants and 39 line bulks from eight crosses in the F_6 generation, and 4 single line bulks from one cross in the F_7 generation, along with 5 line bulks and 5 single plant progenies (SPP) from one cross in the F_8 generation were selected and advanced based on male parent characteristics targeting early maturity, dormancy, and quality traits. Using the single pod descent method, the cross Girnar 5 x PBS 29148 was advanced from the F_6 generation (200 lines) to the next generation to develop the RIL population.

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

A yield evaluation trial involving 17 ABLs and three checks was conducted at Junagadh using an RBD design with three replications. All the traits *viz*., HKW, HPW, SP, KL and pod yield per plant showed significant variation when compared to checks. In the pooled analysis of three seasons (*Kharif* 2021, *Kharif* 2022 and *Kharif* 2023), genotypes viz., PBS 29256, PBS 29267 and PBS 29269 recorded >85g of Hundred Kernel Weight and found superior over the best check GJGHPS 2 (67.7g). PBS 29267, PBS 29263 and PBS 29261 recorded >3500 kg/ha yield and were found superior over best check GJGHPS 2 (2500 kg/ha).

At Junagadh and Bikaner, a Spanish trial with 14 ABLs along with two checks, TPG41, TKG 19A and a Virginia trial having 17 ABLs along with five checks Mallika, Girnar 2, Raj Mungphali 3, GJG HPS2 and BAU13 were undertaken under RBD design with three replications. Due to heavy rainfall/storm at Junagadh the data has not shown significant results for both the trials. At Bikaner, in Spanish trial, PBS 19040, PBS 19050, and PBS 19052 genotypes found at par with best check TPG 41 (9.5g) in terms of pod yield/plant recording 11g/plant in Spanish trial. In Virginia trial, no genotype was found superior in yield to best check Raj Munfali 3 at Bikaner but genotypes PBS 29245, PBS 29252, PBS 29238, and PBS 29241 were at par with best check Raj Munfali 3.

4. Evaluation of advanced breeding lines for fresh seed dormancy

Total 37 ABLs were evaluated for fresh seed dormancy during *kharif* 2023 in RBD using three checks, Dh86, Girnar 3 and TPG 41 using field and laboratory methods. Total 3 ABLs (PBS 16015, and PBS 16041) recorded 100% dormancy up to 21 days in both the methods.

Image 3.2: Advanced breeding lines evaluation for fresh seed dormancy using petri plate germination test

5. New advanced breeding lines seed multiplication:

Total 23 newly selected advanced breeding lines *viz*., PBS 14064, PBS 16015, PBS 16023, PBS 16021, PBS 16041, PBS 15014, PBS 15022, PBS 16023, PBS 15028, PBS 15056, PBS 15027, PBS 16033, PBS 16044, PBS 14085, PBS 14087, PBS 14086, PBS 14088, PBS 29256, PBS 29267, PBS 29269, PBS 29271, PBS 29272 and PBS 29273 were multiplied to get sufficient seed.

6. New genotypes supplied to AICRP-G Trials:

Two genotypes *viz*., PBS 14085 and 14086 were supplied to AICRP-G testing for evaluation in rabi-summer 2023-24. Two genotypes viz., PBS 29272 and PBS 29273 lines were given for AICRP-G testing during *Kharif* 2023.

Identification of SSR markers for fresh seed dormancy

The plant material consisted of 40 advanced breeding lines (ABLs) exhibiting fresh seed dormancy (FSD) generated from hybridization programs at the Plant Breeding Section (PBS) of ICAR-DGR, and nine non-dormant Spanish bunch genotypes lacking FSD, used for marker identification.

A total of 110 SSR markers from both the B05 and A09 genomic regions were screened in panels of genotypes differing in the presence or absence of fresh seed dormancy (FSD). Out of the 110 SSR markers tested, 15 (13.63%) were found to be polymorphic. Based on their banding patterns, the ability of these polymorphic markers to distinguish between non-dormant and dormant genotypes was determined. Among the 15 polymorphic SSR markers, three markers—D23, D98, and D21—were able to differentiate all 9 non-dormant genotypes from 31, 28, and 25 dormant genotypes (out of 40), respectively, by producing 315 bp, 352 bp, and 282 bp bands in non-dormant genotypes and 290 bp, 309 bp, and 367 bp bands in dormant genotypes. The remaining polymorphic markers were unable to clearly distinguish between the two groups of genotypes.

Table 3.5: Summary of polymorphic SSR markers differentiating number of dormant and non-dormant genotypes.

Sr. No.	SSR marker	No. of non-dormant genotypes (out of 9 non-dormant genotypes)	Band size (bp)	No. of dormant genotypes (out of 40 ABLs for Fresh seed dormancy)	Band size (bp)
1	D-23	9	315	31	290
2	D-98	9	352	28	309
3	D-21	9	382	25	367
4	D-32	9	273	17	293
5	D-42	9	385	4	452
6	D-68	8	312	27	295
7	D-69	8	201	23	213
8	D-82	8	225	17	207
9	D-40	8	685	8	452
10	D-45	7	388	28	376
11	D-55	7	290	18	325
12	D-12	7	359	3	328
13	D-22	6	192	28	213
14	D-62	6	267	24	286
15	D-108	5	521	7	475

Finally, 9 dormant (PBS 14064, PBS 16004, PBS 16015, PBS 16021, PBS 16031, PBS 16037, PBS 16039, PBS 16023, PBS 16041) and 9 non-dormant (TG 37A, TAG 24, JL 24, TMV 2, Narayani, TMV 7, JL 501, GPBD 4, Prasuna) genotypes were selected for further analysis

Sequence analysis:

Primers that could distinguish the highest number of dormant ABLs were selected for sequencing analysis. Two primers, D23 and D98, were able to differentiate the maximum number of dormant ABLs from non-dormant genotypes. Of these, primer D23 was chosen for further analysis. The PCR product obtained with primer D23 was sequenced, and the resulting sequences were trimmed for low-quality regions and assembled into a contig to produce consensus sequences. These sequences were then subjected to BLAST analysis using the megaBLAST tool to identify homologous sequences. The results yielded a total of 10 sequences for *Arachis* spp. These sequences were subsequently used to construct a phylogenetic tree to identify the nearest homolog to the sequence of interest. The phylogenetic analysis indicated that the homolog for the query sequence is an uncharacterized ncRNA, LOC130969811, from *Arachis stenosperma*, located on chromosome 1. This ncRNA gene consists of 3 exons spanning 1429 bases.

Description	Scientific Name	Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
Arachis hypogaea cultivar Shitouqi chromosome A02	Arachis hypogaea	157	23533	24%	5e-36	93.27%	99791824	CP030984.1
Arachis hypogaea cultivar Shitouqi chromosome A07	Arachis hypogaea	143	17380	26%	3e-32	91.59%	83117376	CP030989.1
Arachis hypogaea cultivar Shitouqi chromosome A08	Arachis hypogaea	141	4183	24%	1e-31	92.00%	51955169	CP030990.1
PREDICTED: Arachis stenosperma 28S ribosomal RNA (LOC130942767), rRNA	Arachis stenosp...	129	129	23%	6e-28	79.52%	3348	XR_009071319.1
PREDICTED: Arachis duranensis heavy metal-associated isoprenylated plant protein 25 (LOC10748351...	Arachis durane...	128	128	14%	2e-27	87.38%	924	XM_052261142.1
PREDICTED: Arachis duranensis heavy metal-associated isoprenylated plant protein 25 (LOC10748351...	Arachis durane...	128	128	14%	2e-27	87.38%	925	XM_021140139.2
PREDICTED: Arachis hypogaea heavy metal-associated isoprenylated plant protein 25-like (LOC112794...	Arachis hypogaea	81.5	81.5	10%	3e-13	84.72%	987	XM_025836332.2
PREDICTED: Arachis stenosperma uncharacterized LOC130969811 (LOC130969811), ncRNA	Arachis stenosp...	76.1	76.1	6%	1e-11	97.73%	1022	XR_009081931.1
PREDICTED: Arachis duranensis uncharacterized LOC107493456 (LOC107493456), transcript variant ...	Arachis durane...	73.4	73.4	6%	4e-11	95.56%	355	XR_008010409.1
PREDICTED: Arachis hypogaea uncharacterized LOC112785056 (LOC112785056), ncRNA	Arachis hypogaea	67.1	67.1	7%	6e-09	87.04%	1177	XR_003194227.1

Figure 3.1: Blast results for primer D23 in *Arachis* spp.

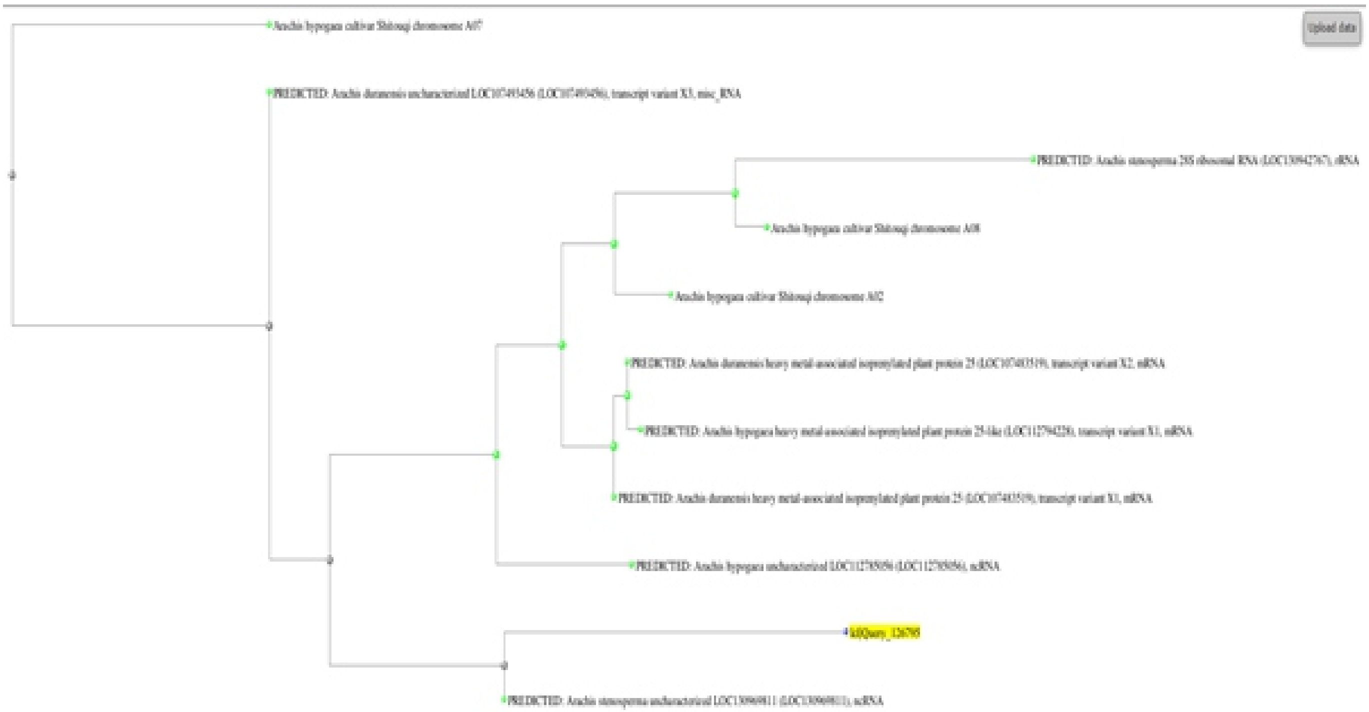


Figure 3.2: Phylogenetic tree based on the BLAST results for primer D23 in *Arachis* spp.

Management of groundnut genetic resources and trait specific characterization

(*Praveen Kona*)

1. Multiplication of 120 spanish germplasm lines in 5m each was completed during summer 2023.
2. Evaluated 195 germplam lines for early maturity in augmented design during summer 2023 and three times sampling at 90, 100,110 days was taken. Data was recorded on harvest index, shelling percent, number of mature kernel, number of immature kernel in three samples. Identified NRCG 10290, 10559,12291 having maturity of 90 days. These lines were identified to mature at CTT 1580 °Cd which is equivalent to 85-87 calendar days.
3. 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.
4. A total of about seven thousand five hundred (7500) groundnut accessions have been maintained in the medium cold storage module (4-5^{0}C and 30 % RH) as working collection; and also, a set is separately maintained through long term storage (10-12 years).
5. Seed multiplication of 2800 Spanish germplasm lines was undertaken at AICRP-G center, JAU, Junagadh during *Kharif* 2023.
6. Supplied 236 released varieties and 450 germplasm lines to different indenters or researchers during 2023.

Project 4: Genetic enhancement of groundnut through genome editing and molecular approaches

PI: *Sangh Chandramohan*

Co-PI: *SK Bera*

Targeted gene editing using CRISPR/Cas9 for high oleate trait (FAD2 gene).

Sequences of *Arachis hypogaea* FAD2 genes were downloaded from the Genbank. To target and modify the ahFAD2 genes, two sgRNAs, sgRNA1 (5′- AAACACTTCGTCGCGGTCGA-3′) and sgRNA2 (5′-CAAACACTTCGTCGCGGTCG-3′), were designed based on the sequence of coding region using software CRISPR RGenTool. We started with gRNA2 for preparing the vector.

Table 4.1: Properties of guide RNA designed for CRISPR cas9

Name	Location	Direction	Hairpin, 3' complimentary and self annealing	Chr No.	Number of Found Targets Cas of finder
gRNA1: AAACACTTCGTCGCGGTCGA**GGG**	437	-	None	19	1
gRNA2: CAAACACTTCGTCGCGGTCG**AGG**	438	-	None	19	1

Initially we took gRNA2 for cloning in the vector. For cloning, p201N-Cas9 (Addgene#59175) was sequentially digested with SwaI followed by SpeI. MtU6 (377 bp) and scaffold (106 bp) fragments were amplified using their respective primers employing high-fidelity DNA polymerase, using pUC gRNA shuttle vector as template. Four DNAs were mixed together; U6 promoter fragment, gRNA ssDNA, scaffold fragment and Linearized p201N vector using NEBuilder assembly Kit. Confirmed construct were mobilized in *Agrobacterium tumefaciens* for attempting genetic transformation experiments **(Figure 4.1-4.4)**.

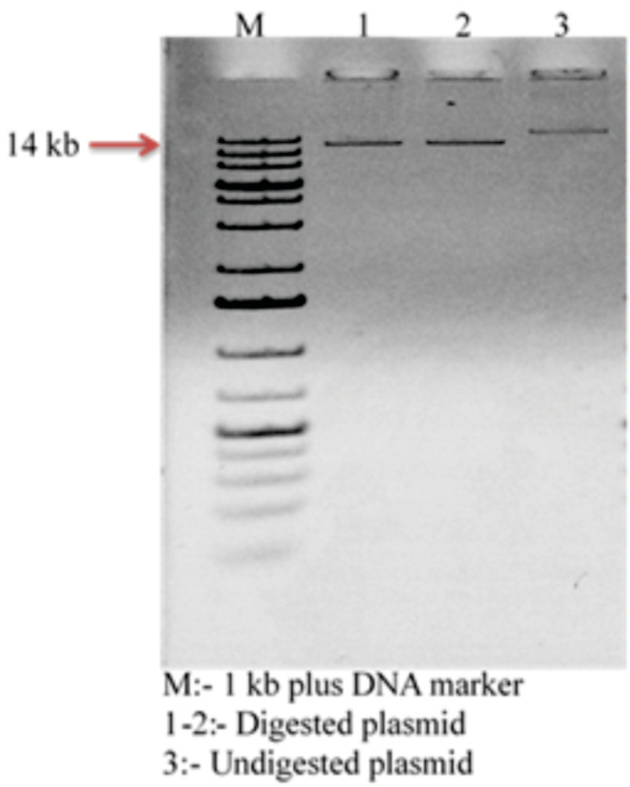


Figure 4.1: Restriction digestion visualized on 1 % agarose gel.

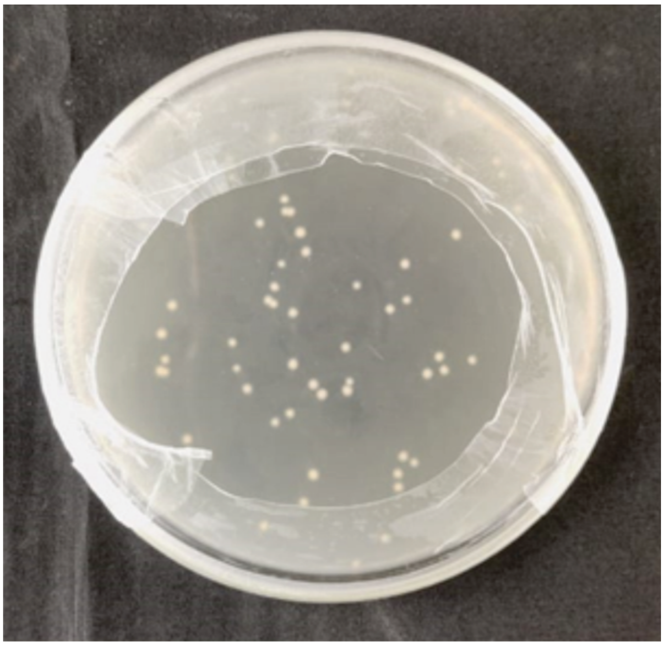


Figure 4.2: Transformed colonies on LB media

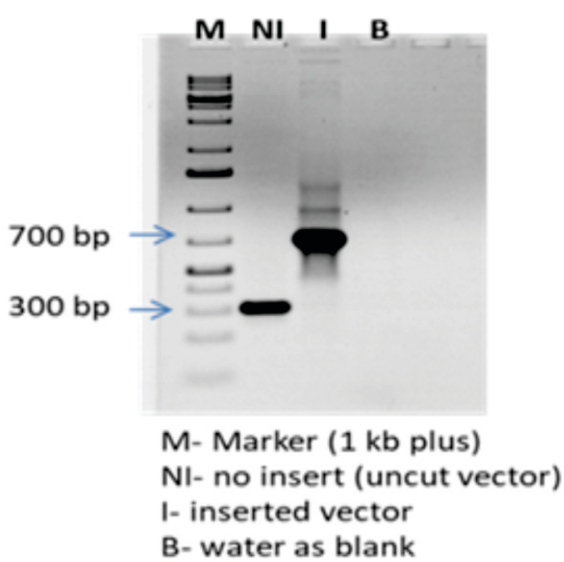


Figure 4.3: PCR amplification of insert

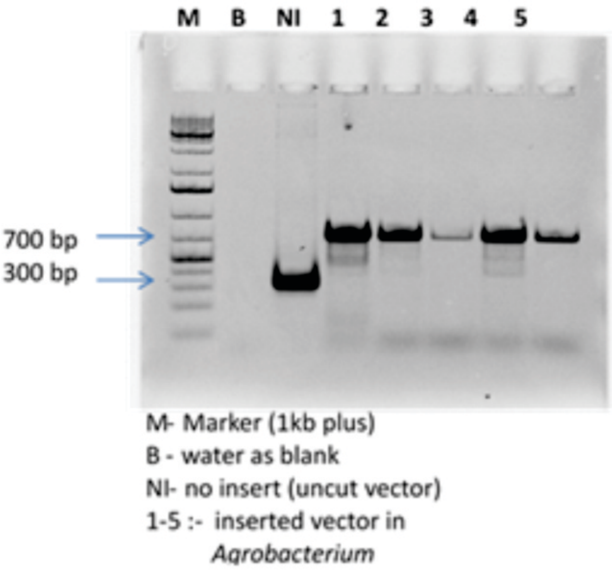


Figure 4.4: PCR amplification of the insert

Agrobacterium mediated transformation:

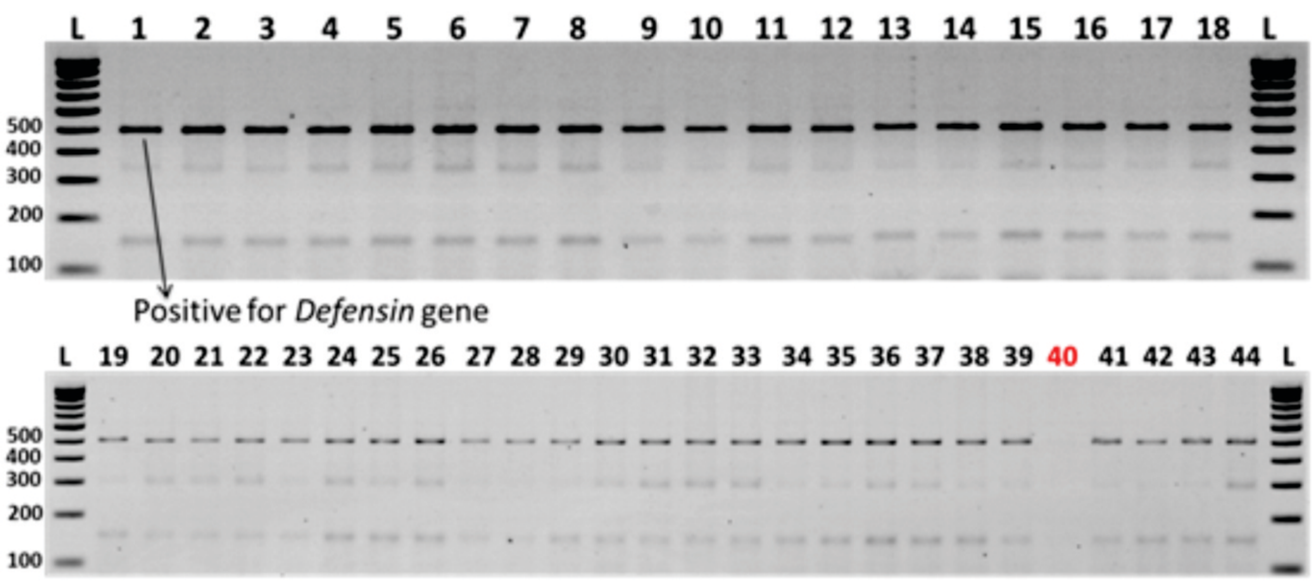
The mature seeds of the variety GG 20 were used in the study (Oleic acid-63.93%, Linoleic acid-19.68% and Mutation in FAD2A is present). The de-embryonated cotyledons explants from mature pre-soaked seeds were co-cultivated with *A. tumefaciens* strain LBA4404 harbouring the CRISPR/Cas9 plasmid. The total number of cotyledons used in the study is summarized in the table 4.2.

Table 4.2: Summary of explants used for transformation

No of cotyledons	Media	Remarks
120	MS + BAP	Agrobacterium infection
57	MS + BAP + Cefotoxin	Transfer from agrobacterium to culture media
30	MS + BAP + Cefotoxin	
30	MS + BAP + GA3 + Cefotoxin	

Screening of transgenic groundnut (T_5) expressing defensin gene for Aflatoxin resistance.

Thirteen lines derived from six distinct events were used for genotyping. A total of 195 seeds, comprising 15 seeds from each line were sown in separate pots within a controlled PII glasshouse environment. Subsequent to seedling growth, DNA extraction was performed, and PCR testing was done by utilizing defensin gene-specific primers (SynDEF1). Out of 190 plants screened, 189 found positive (Figure 4.5) and 171 lines were harvested for further analysis.



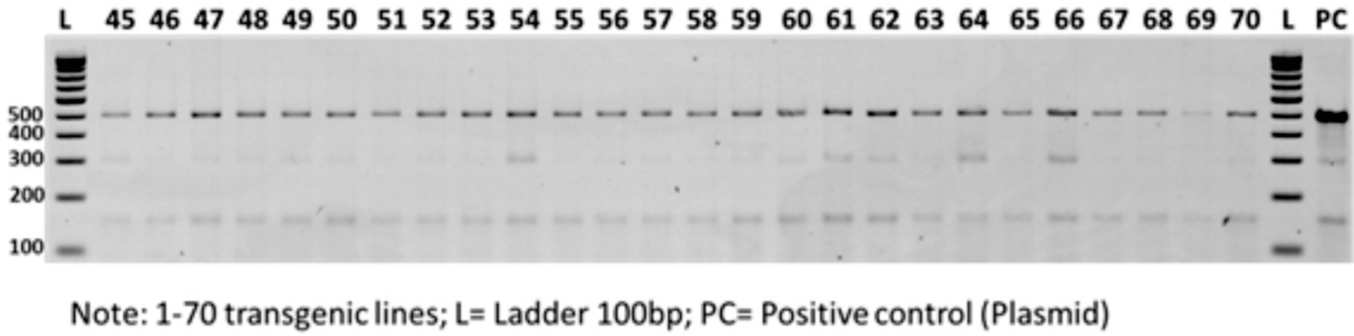


Figure 4.5: PCR amplification using gene specific primer

Project 5: Optimization of mineral nutrition in groundnut for better human and soil health

PI: *Sushmita Singh*

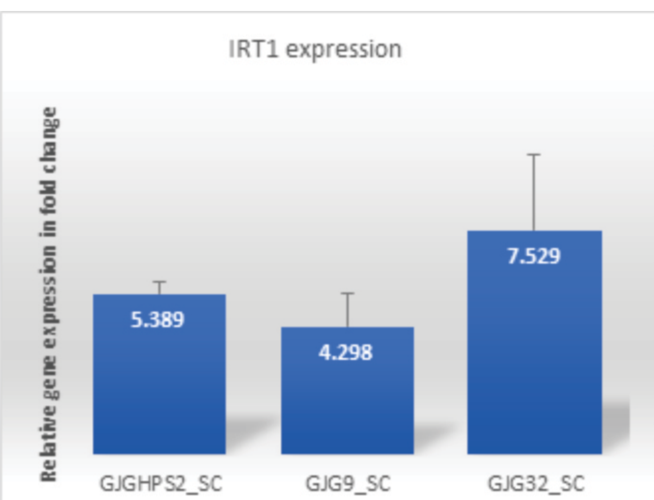
Co-PI: *Rinku Dey, Rajanna GA, Rajaram Choudhary & Kiran K Reddy*

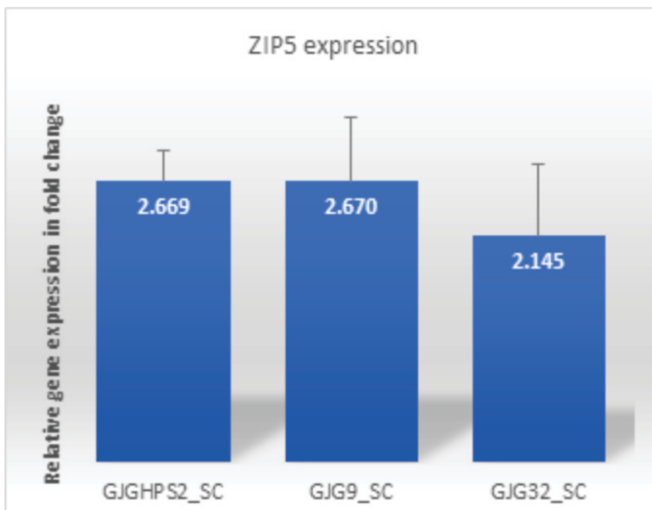
1. The root exudates mediating Zn and Fe uptake in plants

Ten groundnut cultivars were evaluated under a field trial during Summer 2023 to study the organic acids exuded from plants regulating the Fe and/or Zn uptake under variable moisture conditions, with and without external Zn application. Among the five organic acids (namely oxalic acid, oxaloacetic acid, malic acid, ascorbic acid and citric acid) the most predominant were oxaloacetic acid (203- 628 ppm), oxalic acid (75-130 ppm); followed by citric acid (5.05- 15.7 ppm). The Zn treated cultivars recorded reduced exudation of organic acids (17.33% - 56.62%) with respect to control.

2. Specific roles of different transporters in Fe uptake and accumulation in groundnut

In a study to examine the overexpression of different transporters at the root PM of different genotypes during Fe deficit soil conditions, a RT-PCR study revealed that the cultivars GJG 32, GJG9 and GJGHPS2 exhibited an overexpression of transporters *IRT1* (4.30 to 7.53 folds), *YSL3* (3.20-3.52 folds) and *ZIP5* (2.14- 2.67 folds) in the periplasmic membrane of roots over the susceptible check NRCG 7472.





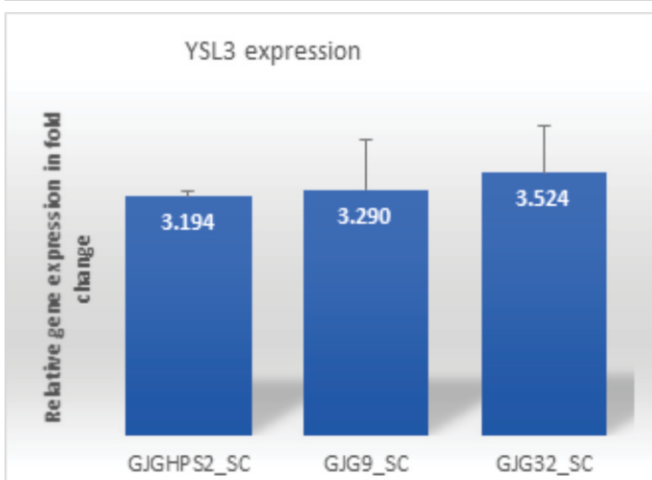


Figure 5.1: Relative gene expression of *IRT1*, ZIP5 and *YSL3*

3. Mn-solubilizing microbial inoculants

Five efficient Mn-solubilising bacterial cultures were evaluated in a field trial during summer 2023 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, the maximum with Mn12-1 (13%), at par with Mn-1 and Mn12-2.

4. Development of consortia of Zn, K and Mn-solubilising isolates and evaluation in field

Four different consortia of zinc, potassium, and manganese solubilizing bacterial isolates were developed from the previously identified efficient bacterial isolates for Zn, K, and Mn-solubilization. These four consortia were evaluated in a field trial during summer 2023, along with NutMagic bacterial formulation. Seed inoculation with the consortia *Acinetobacter oleivorans* ZM-12 + *Pseudomonas taiwanensis* KM-9 + *Alcaligenes* sp Mn12-2; *Enterobacter cloacae* subsp. *dissolvens* ZM-9+ *Acinetobacter lactucae* KM5-2 + *Brevundimonas diminuta* Mn11-2, and NutMagic resulted in increase in pod yield of groundnut, cultivar TG37A during summer 2023, maximum with ZM-12 + KM-9 + Mn12-2 (18%). This was at par with the consortia ZM-9+ KM5-2 + Mn11-2, and NutMagic formulation.

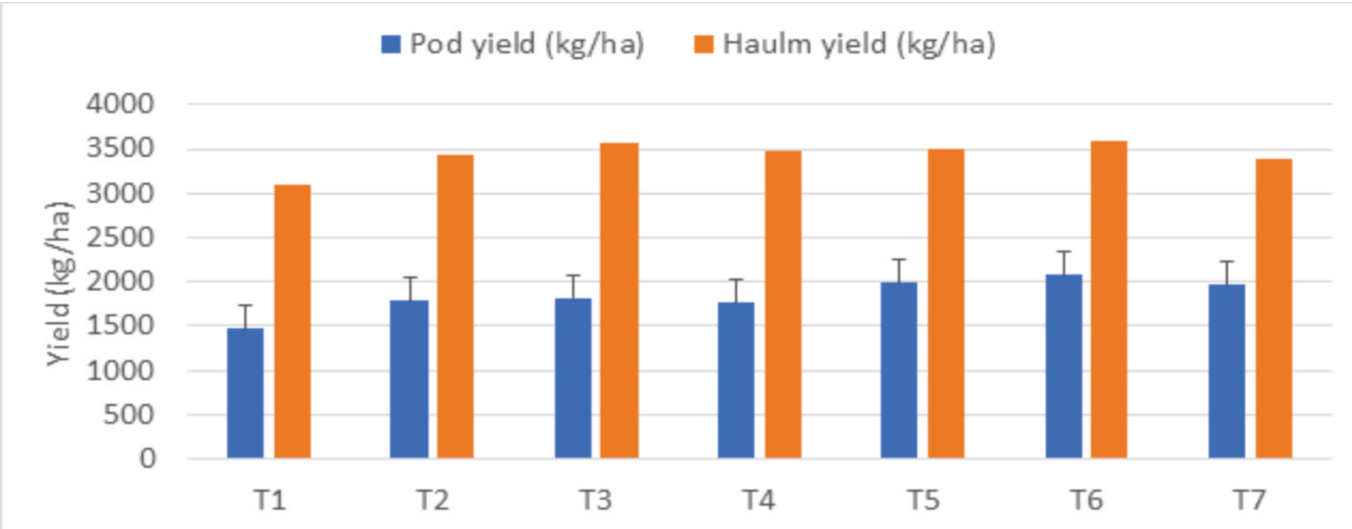
Sub-Project: Improving P use efficiency in groundnut-based cropping systems

(**PI:** *Kiran Reddy*)

Effect of PSB (NutMagic) and different levels of P on groundnut yield and soil P fractions (Pooled data)

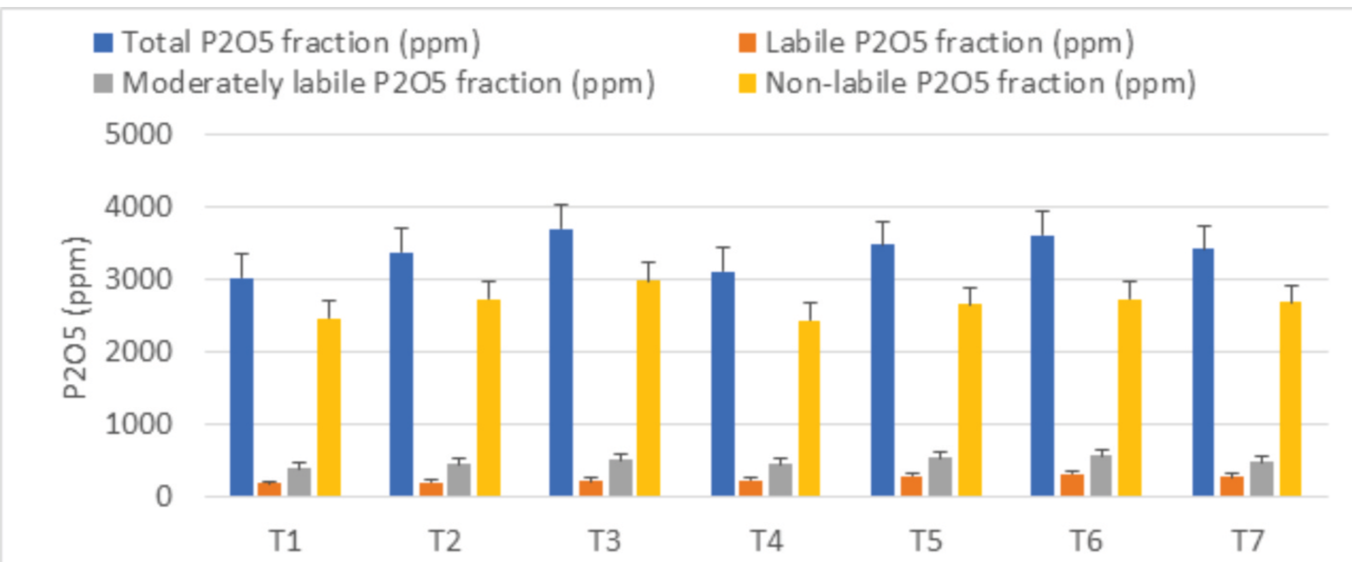
The experiment was conducted in summer season of 2021, 2022 and 2023 with seven treatments [T1-0 kg P_2O_5/ha; T2-25 kg P_2O_5/ha; T3-50 kg P_2O_5/ha; T4-0 kg P_2O_5/ha + NutMagic; T5-25 kg P_2O_5/ha + NutMagic; T6-50 kg P_2O_5/ha + NutMagic; T7-25 kg P_2O_5/ha+ NutMagic + Wheat straw Mulch @ 5 t/ha] and 3 replications in RBD design. 25 kg N through Urea, P_2O_5 as per treatment through DAP and 30 kg K_2O/ha through MOP were supplied. TG 37A variety was used for sowing. Phosphate solubilizing bacterial (PSB) formulation NutMagic was used as seed treatment. Pooled data of three year showed that the significantly higher pod yield (2077 kg/ha) was obtained with T6 – 50 kg P_2O_5/ha + NutMagic which was at par with T5 – 25kg P_2O_5/ha + NutMagic, T7 and T3. There is noticeable increase of pod yield by 290 kg/ha when NutMagic with no phosphorus was applied to soil (T4 vs T1). There was a potential saving of 25 kg P_2O_5/ha with application of NutMagic+25 kg P_2O_5/ha, which gave at par pod yield when 50 kg P_2O_5/ha alone was applied to soil. Haulm yield was observed to be non-significant among the treatments. Available P (kg/ha) at harvest ranged from 7.70 kg P/ha to 12.03 kg P/ha, with the least in T1, where no P was applied and maximum was observed in T6, where 50 kg P_2O_5/ha + NutMagic was applied

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 was 3345 mg P_2O_5/kg, labile-P pool was 169 mg P_2O_5/kg soil, moderately labile P pool was 341 mg P_2O_5/kg soil and non-labile-P pool was 2876mg P_2O_5/kg soil. Pooled data revealed that at harvest, in different treatments, total-P pool in soil ranged from 3023-3707 mg P_2O_5/kg, labile-P pool ranged from 177-315 mg P_2O_5/kg soil, moderately labile P pool ranged from 386-572 mg P_2O_5/kg soil and non-labile P-pool ranged from 2460-2984 mg P_2O_5/kg soil. A 29 % increase in labile-P pool is noted when NutMagic is applied over control (T3 vs T1) and 64 % increase in labile-P pool is noticed when NutMagic + 25 kg P_2O_5/ha is applied over control (T5 vs T1)



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 + NutMagic; T5-25 kg P_2O_5/ha+ NutMagic; T6-50 kg P_2O_5/ha + NutMagic; T7-25 kg P_2O_5/ha+ NutMagic + Wheat straw Mulch @ 5 t/ha

Figure 5.2: Effect of different treatments on Pod and Haulm Yield



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 + NutMagic; T5-25 kg P_2O_5/ha + NutMagic; T6-50 kg P_2O_5/ha + NutMagic; T7-25 kg P_2O_5/ha+ NutMagic + Wheat straw Mulch @ 5 t/ha

Figure 5.3: Effect of different treatments on soil P fractions at harvest

Project 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*

Objective:

Development of pre-breeding lines for biotic, abiotic stresses and quality traits

Progress of Work:

Interspecific breeding lines advanced:

A total of 326 interspecific breeding lines from 20 crosses were further advanced during *kharif* 2023.

Generation advancement of high oleic breeding lines:

A total of 822 progenies ($F_{5\text{-}6}$) from eight crosses were selected for further advancement during summer 2023.

Genotyping for ahFAD2 alleles:

Single plants of F_1 generation from 15 high oleic crosses were genotyped for presence of *ahFAD2* alleles during summer 2023. A total of 654 single plants were genotyped from which 30 plants were found positive for both ahFAD2a and ahFAD2b alleles.

Evaluation of Spanish bunch high oleic advanced breeding lines:

Hundred and eleven high oleic Spanish bunch breeding lines were evaluated along with five checks during summer 2023 for second time. The check, GJG 32 recorded maximum pod yield/20 plants among checks based on pooled analysis over two seasons. Five breeding lines (223, 3704, 305, 3089 & 4394) recorded significantly high pod yield than best check.

Characterization of germplasm for 3-seeded pods:

Valencia groundnut germplasm were characterized for 3-seeded pods/plant over three seasons. Sixteen germplasm recorded more than 40% 3-seeded pods/plant and observed superior over check variety.

Seed multiplication of advanced breeding lines:

Thirteen high oleic lines and two high yielding lines were multiplied during *kharif* 2023 for further testing under AICRP.

Besides, about 4000q of Nucleolus and Breeder seeds of Girnar 4 and Girnar 5 varieties were produced at Junagadh, Bikaner and Ananthpur during both summer and *kharif* 2023.

Screening of interspecific derivatives for resistance to collar rot

A total 113 interspecific derivatives of three crosses {21-(J11 X A. *pusilla*) × TG37A; 78-(J 11X A. *diogoi*) × TG 37A; 14-(J 11X A. *duranensis*) × TG 37A} were screened under natural condition and sick plot for resistance to collar rot at DGR-RRS & SKRAU, Bikaner respectively during *kharif* 2023. Data were recorded on plant mortality up to 45 DAS. Collar rot disease incidence ranged from 0-41% under natural condition while 18-52% under sick plot condition. Susceptible cultivar RG 638 recorded 54% seedling mortality while resistant genotypes OG52-1 recorded 30% plant mortality. Interspecific derivatives having less than 20% plant mortality need to be screened under sick plot for two more years to ascertain their resistance stability level.

Image 6.1: Wild breeding lines

Project 9: Microbial management of major foliar fungal diseases of groundnut and variability analysis in pathogens

PI: *Rinku Dey*

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

1. Generation advancement of segregating materials to different filial generations

A total 50 single plant progenies of 8 crosses in F_6 generation of *Alternaria* leaf blight resistance were advanced to next filial generation in summer 2023 at DGR, Junagadh. Among them total 57 single plants were selected for generation advancement at the time of harvesting based on good recombinants and presence of desirable trait in the recombinants.

2. Develop new advanced breeding lines

A total 57 single plant progenies of eight cross were raised in F_7 generation and advanced to next filial generation during *Kharif* 2023 at RRS, Bikaner and identified 16 new advanced breeding lines of Spanish bunch (13) and Virginia bunch (3).

3. Evaluation of antifungal endophytes and epiphytes for management of Fusarium wilt and blight of groundnut

An experiment was conducted in *Kharif* 2023 at Bikaner with 15 treatments and 3 replications in RBD. Two Endophytes J31 and SDEN 35 were used for seed treatment and 4 epiphytes 19S3, 49S2, 24E1 and 20 S3 were used as foliar spray at 45, 60, 75, 90 and 105 DAS. Significantly higher pod yield (2108 kg/ha) was observed with SDEN35 (Seed treatment) + 20S3(Foliar spray) treatment which was at par with J31 (Seed treatment) + 24E1(Foliar spray), J31 (Seed treatment) + 19S3 (Foliar spray) and J31 (Seed treatment).

Image 9.1: Experimental view

2 Crop Production

Meteorological situation (2023)

The monsoon, the lifeline of the country's $ 3.732 trillion economy (5th largest in world as per 2023), 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. The realized 2023 southwest monsoon seasonal (June to September) rainfall over the country as a whole and four broad geographical regions are given herein in figure along with the respective long period average (LPA) values.

The 2023 season rainfall over the country as a whole (94% of LPA) was less than the long period average (LPA of 88.0 cm). The 2023 season rainfalls over two of the four geographical regions of the country (except NW India and central India) were also less than the respective LPAs. The highest rainfall (101% of LPA) was received in NW India and the lowest rainfall (82% of LPA) was received in East & NE India. Central India and East & South India received season rainfalls of 100% of LPA and 91% of LPA, respectively. The monthly rainfall over the country as a whole were less than LPA during two months of the season (91% of LPA in June, 64 % of LPA in August) and were more than LPA during the months of the July (113% of LPA in July) & and September (113% of LPA).

The Country as a whole received higher rainfall (of 105% of LPA) during the first half (91% of LPA in June and 113% of LPA in July), which was more than that during the second half (with 83% of LPA) segregated to 64% of LPA in August and 113% of LPA in September. Thus, among the four months, rainfall deficiency was highest during August and rainfall was excess during July and September. The Fig 7.1 also shows the subdivision-wise seasonal rainfall during June to September. Under the existing situation, the sowing of groundnut crop was thus, delayed under Gujarat condition.

Out of the total 36 meteorological subdivisions, 3 subdivisions constituting 9% of the total area of the country received excess, 26 subdivisions received normal rainfall (73% of the total area) and 7 subdivisions (18% of the total area) received deficient season rainfall. These seven meteorological subdivisions with deficient rainfall were Nagaland, Manipur, Mizoram and Tripura (NMMT), Gangetic West Bengal, Jharkhand, Bihar, East UP, South Karnataka and Kerala.

The state of Gujarat can be divided into five zones: Kutch, North Gujarat, East Central, Saurashtra, and South Gujarat. The average rainfall over these zones during the period (1992-2021) is 456 mm, 720 mm, 806 mm, 717 mm, and 1476 mm, respectively. The frequency of rainy days is given in Fig 7.2. In Junagadh spring summer crop of groundnut received a meagre rainfall of only 13.3 mm while the its *Kharif* crop received 1729.6 mm of rainfall due to an extended monsoon (associated with a very heavy rainfall during June and July 2023; Fig 7.3 & 7.4). During spring-summer 2023 it is pertinent to note that the Saurashtra region of Gujarat (Junagadh and adjoining region) received only 13.3 mm rainfall during mid to end of March 2023.

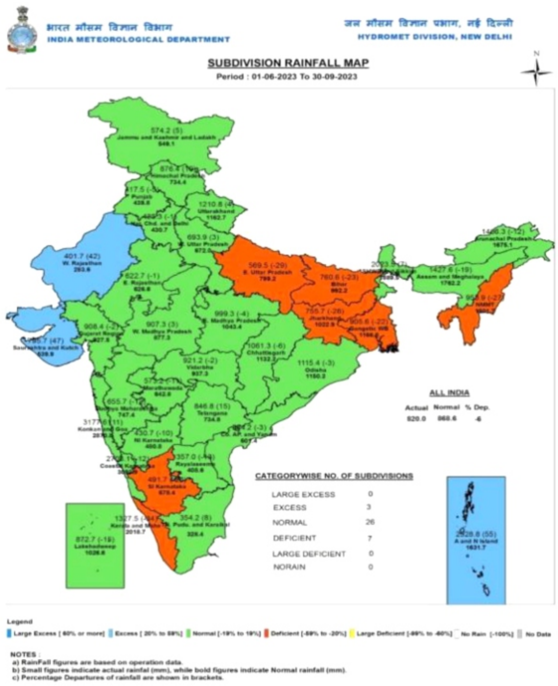


Fig 7.1: Sub-division wise rainfall distribution over India during SW (June-Sept, 2023 -IMD, India)

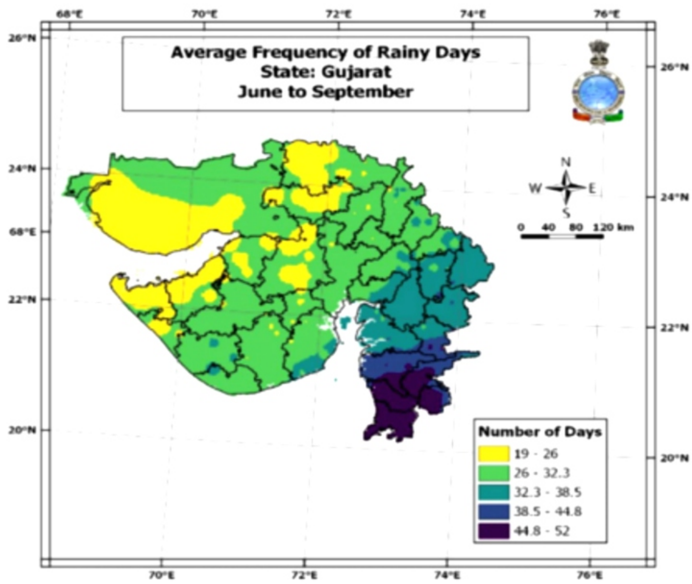


Fig 7.2: Average frequency of rainy days over Gujarat during entire Summer Monsoon (1998-2018)

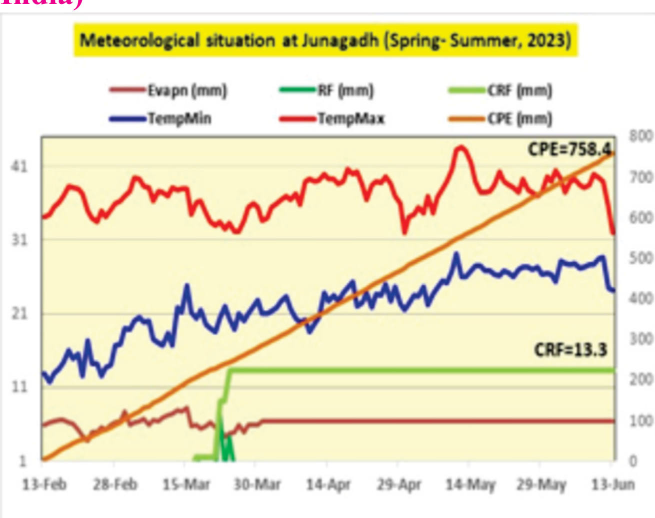


Fig 7.3: Weather situation at ICAR-DGR, Junagadh (Gujarat) during Spring-Summer 2023

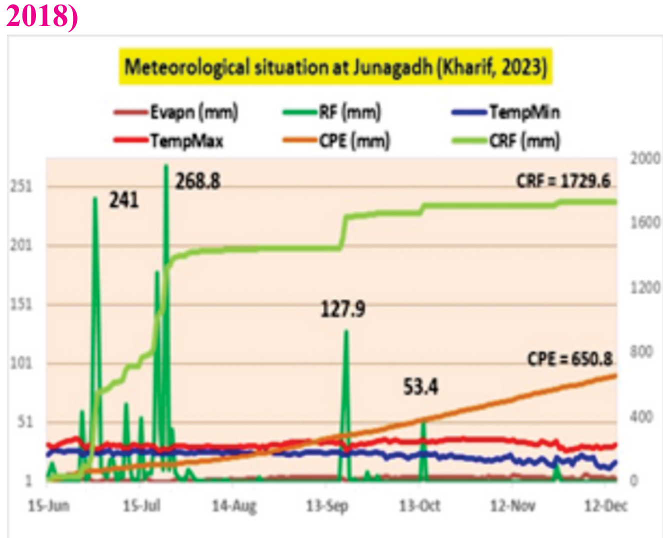


Fig 7.4: Weather situation at ICAR-DGR, Junagadh (Gujarat) during *Kharif* 2023

Project 7: Climate resilient sustainable agriculture through low- cost natural farming in groundnut- based cropping system

PI: *C.S. Praharaj*

Co-PI: *Kiran Reddy, KK Pal (till 30.06.2023), Sushmita Singh*

1. Natural Farming as an Alternative to Conventional Farming

Natural Farming or Zero Budget Natural Farming (ZBNF) is considered as an alternative to chemical fertilizer-based agriculture and high input-cost agriculture. 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 cow dung, cow urine, jaggery, pulse flour etc., mulching practices, and symbiotic intercropping. ZBNF has four pillars such as 1) *Jeevamrutha* and *Ghanjeevamrutha* (cowdung based crop nutrition), 2) *Bijamrita* (seed treatment), 3) *Acchadana* (mulching), and 4) *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.

Natural Farming (ZBNF)

Keeping in view of importance of ZBNF as a natural farming (*vis-à-vis* conventional and organic farming), an experiment was initiated in order to confirm its viability and productivity sustenance. The site was the main campus of ICAR-DGR, Junagadh and the season was spring/summer 2022 during which sowing of an exhaustive fodder crop of pearl millet was undertaken 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 an exhaustive crop of pearl millet (before groundnut-wheat cropping system to continue during *Kharif* 2022 and *rabi* 2022-23). Thus, soil homogeneity is maintained through exhaustive crop of pearl millet. After this, both the groundnut and wheat crops were grown during *Kharif* season following onset of monsoon (mostly during July to October under Gujarat condition) and the following *rabi* season (November to March) during 2022-23 (in a year). During the current year (2022-23), the complete data set recorded/ analysed/reported included groundnut-wheat during *Kharif* 2022 and *Rabi* 2022-23, respectively. Further, the second *Kharif* crop of groundnut was delayed and harvested only by the mid-November 2023. The subsequent rabi wheat crop (2023-24) is standing in the field (following its planting by the end of November) when this report (January 2024) is written.

The Methodology

Following completion of an exhaustive crop of pearl millet during spring/summer 2021-22, groundnut-wheat cropping system was initiated from groundnut crop during *Kharif* 2022. The crop was grown with three treatments of farming system, viz., 1) Integrated Crop Management (ICM Practice), 2) Zero Budget Natural Farming (NF, Seed treatment with Beejamrutha/Bijamrita + application of Jeevamrutha & Ghanjeevamrutha at fortnightly intervals + mulching with organic residues +plant protection with natural pesticides /fungicides like Neemastra, Agniastra etc.), and 3) Organic Farming (OF, Use of FYM, Vermicompost, Biofertilizer and plant protection with organic products etc.). The varieties of both groundnut habit groups such as Spanish bunch 'TG 37A' (2004 released) and Virginia bunch 'GJG 22' (2013 released) are grown (in sub plots) amalgamated with above three Farming Systems (in main plot) for assessing the varietal performance (under the different farming systems) with the adopted methodologies (Table 7.1). This experiment was carried out in prevailing agro-ecosystem involving medium black calcareous soil under Southern Saurashtra Agro-climatic Zone of Gujarat.

Table 7.1 The details of methodology of Natural Farming adopted under field condition

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.

Ghan Jeevamrita	It is composed of the dry cowdung (200 kg) and Jeevamrita (mixed withdry cow-dung), left 48 hours for shade-drying, and is applied as a basal dose with 800 kg/acre in 1st year, 500 kg/acre in 2nd year and 200 kg/acre in subsequent years.	It is a solid form of Jeevamrita. It is used to increase soil fertility by microbial consortia. It can be added to the soil for healthy soil, and more often in malnutrition soil.
Bijamrita	It is basically made up of water (20 L), cow dung (5 kg), urine (5 L), lime (50 g) and just a handful of soil (Seed treatment).	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 is done by soil mulch, straw mulch or live mulch.	It conserves soil moisture, by reducing evaporation.
Whapasa – moisture	The irrigation should be reduced as per need only; and the same should be practiced with efficiency, in alternate furrows.	It is based on the idea that plant roots does not need a lot of water, in-fact, what roots need is water vapour, and therefore, Whapasa is the condition where there coexist both air molecules and water molecules present in the soil.

Table 7.2: Nutrient content in input-formulations used in natural farming (ZBNF) *versus* others

Nutrient	Bijamrita	Jivamrita	FYM	Vermicompost
N (%)	**2.380**	1.96	0.50	1.60
P (%)	0.127	0.173	0.20	0.70
K (%)	0.485	0.280	0.50	0.80
Fe (ppm)	**282**	15.35	146.5	175
Mn(ppm)	10.7	3.32	69.0	96.5
Zn (ppm)	4.29	2.95	14.5	24.5

This permanent field experiment, was carried out in a low soil fertility high *p*H soil in large plots (~100 m^2) at ICAR-DGR, Junagadh during *Kharif* 2022-23. The prevailing agro-ecosystem involves an irrigated tract of alkali soil (with *p*H of 8.24, low available N, P, K, medium SOC of 0.63%) falling under Southern Saurashtra Agro-climatic Zone of Gujarat, and Gujarat Plain and hill region of India. This experiment was laid out in 8-times replicated split plot. Further, all these permanent plots of three farming practices (ICMP, NF, and OF) were followed with wheat (two cultivars of wheat *viz*., GW 451 and Lok-1) in rotation during *rabi* (winter season) of 2022-23. Macro- and micronutrient analysis indicated higher content of N and Fe were analyzed in Bijamrita compared to FYM and Vermicomposting (Table 7.2). The findings are explained herein as under:

Groundnut

The study revealed that pod yield to the tune of 1316-1630 kg/ha (with a mean minimum of 1473 kg/ha) was realized with low-cost Natural Farming practice (NF) depending on the varieties (higher yields with Spanish bunch) vis-à-vis 1448-1779 kg/ha (with a mean yield of 1613 kg/ha) under Organic Farming practice. On the contrary, higher pod yield of 1679-1965 kg/ha (with a mean maximum yield of 1822 kg/ha) was realized with the ICM practice employing the latest improved crop production technologies. Higher (20.9%) yield of groundnut was also realized under Spanish bunch (TG 37A with 1791 kg/ha) compared to Virginia bunch (GJG 22 with 1481 kg/ha). Similar trend was observed in case of economics in different farming practices (higher net return of INR 67267 in ICMP followed by INR 56301 in OF and INR 53348 in NF) and varieties (better net return of INR 67667 in TG 37A followed by INR 50276 in GJG 22). Thus, significant yet similar trend in terms of productivity and economics were observed in case of farming practices.

Wheat

Various farming practices/modules exerted significant influence on the succeeding wheat crop especially in productivity (yield and yield attributes) realization. A critical perusal of the data clearly showed that grain yield to the tune of a mean value of 3156 kg/ha (the lowest yield) was realized with low-cost Natural Farming practice vis-à-vis 3947 kg/ha under Organic Farming practice. However, a mean yield of 5300 kg/ha (the highest yield) was realized with ICMP employing improved production technologies as per recommended practice (Table 7.3). Similar was the trend observed for other growth and yield attributes, *viz*., straw yield (6439 kg/ha), biological yield (11.7 t/ha), dry weight of plants at harvest (215 g meter row length, number of panicles per meter row length (90.1) and seed index (58.2 g) under the treatment (with ICMP compared to OF and NF) although higher values in respect of harvest indices (47.4%) were observed under NF practices (Table 7.3). As a result, economics was in favour of ICMP. On wheat varietal effect, higher grain yield (4464 kg/ha) and straw yield (5429 kg/ha) were realized (along with favourable economics) with wheat 'GW 451' compared to Lok-1 (with grain yield of 3805 kg/ha and straw yield of 4519 kg/ha). Similar was the trend in other attributes (Table 7.3 & 7.4). Interaction effect on growth parameters was mostly not significant except for yield and economics (Higher with the treatment, ICMP+GW 451).

Groundnut - wheat

On cropping (groundnut-wheat) system perspectives, various farming practices/modules and varieties again exerted significant influence on yield and yield attributes similar to either crop as in above. The data indicated that the lowest total grain yield (to the tune of mean value of 2681 kg/ha only in terms of Groundnut Equivalent Yield, GEY) was realized with low cost Natural Farming (NF) practice vis-à-vis 3125 kg/ha with Organic Farming (OF) practice (Table 7.4; Fig 7.5). However, a mean maximum yield of 3851 kg/ha was realized with ICMP employing improved production technologies as per recommended practice. Similar was the case for other growth/yield attributes, *viz*., total biomass productivity (16.3 t/ha), productivity per day (72.8 kg/ha/day) and other parameters including that of economics (NR of INR 154888 and BCR of 3.03) under ICM practice (compared to all others). Thus, the effect of main plot (farming practice) was in the following order: ICMP >OF >NF (on yield, its attributes and economics front); while on sub plot front, significantly greater productivity was recorded under wheat GW 451 compared to Lok-1. The values of all the growth and developmental parameters were also higher under the above treatments (GW 451). Interaction effect on growth parameters was mostly significant, thereby indicating higher crop response in combination of ICMP and GW 451.

Oil and Protein content

The quality parameters i.e., both oil and protein content in groundnut kernel were not influenced by different farming practices/modules (Table 7.5).

Table 7.3: Agro-economic attributes of wheat as influenced by farming practices and varieties

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (t/ha)	HI (%)	Dry wt. (g/m row length)	Panicles/ m row length	Seed Index (g/1000 -seed)	GR (INR/	NR (INR/ ha)	BCR	Groundnut (*kharif*-2022)	
											Pod Yield (kg/ha)	Haulm Yield (kg/ha)
Farming Practices												
ICM	5300	6439	11.7	45.1	215	90.1	58.2	119062	87621	3.79	1822	2740
NF	3156	3503	6.66	47.4	138	68.1	53.2	70561	45836	2.85	1473	2014
OF	3947	4979	8.93	44.2	184	74.5	56.6	88855	57532	2.84	1613	2564
SEm(±)	104	113	0.21	0.41	7.45	3.67	0.76	2291	2291	0.08	24.3	14.3
C.D.(0.05)	317	347	0.63	1.26	22.8	11.3	2.34	7015	7015	0.26	74.3	43.7
Varieties												
GW 451#	4464	5429	9.89	45.3	186	80.1	54.0	100285	71123	3.40	1791	2458
Lok 1$	3805	4519	8.32	45.9	173	75.1	58.0	85366	56204	2.92	1481	2420
SEm(±)	70.4	56.6	0.10	0.44	4.02	2.09	0.42	1514	1514	0.05	21.9	13.3
C.D.(0.05)	208	168	0.31	NS	11.9	NS	1.24	4484	4484	0.15	65.1	NS
Interaction	*	*	*	NS	NS	NS	NS	*	*	*	NS	*

Pod/haulm yield of TG 37A and $ pod/haulm yield of GJG 22 for the last two columns (all others are related to wheat)

However, the habit groups had. In fact, significantly higher oil content (53.4 %) was analyzed in the kernel of Virginia bunch GJG 22 while, that of protein content (29.6 %) was recorded under Spanish bunch TG-37A.

To sum up (two seasons in one year i.e., *Kharif* and *rabi* during 2022-23), it was inferred from the above that groundnut crop responded to low cost ZBNF or Natural farming (although with 19% lower yield compared to ICMP). Yet, the later (farming practice) based on integrated crop management comprising of chemical fertilizers, FYM and pesticides was advantageous for realizing higher yield/return as it was evident from both the component crops of groundnut-wheat and the cropping system as a whole. Confirmation of the results obtained so far was further experimented through repetition of the same for 2nd year (2023-24) and the results are awaited. On the cropping system/cultivar modes, the following trend was apparent (based on crop productivity and economics.

Table 7.4 Productivity & economics of the cropping system (groundnut-wheat) under different treatments

Treatment	Total yield# (kg/ha)	Total Biomass productivity (t/ha)	Productivity/day* (kg/ha)	GR (INR/ha)	NR (INR/ha)	BCR
Farming Practices						
ICM	3851	16.3	72.8	231143	154888	3.03
NF	2681	10.1	45.3	160334	99185	2.62
OF	3125	13.1	58.5	188656	113833	2.52
SEm(±)	45.6	0.20	0.91	2604	2604	0.04
C.D.(0.05)	140	0.62	2.78	7976	7976	0.12
Varieties						
TG 37A- GW 451	3500	14.1	63.1	209533	138790	2.95
GJG 22 - Lok 1	2937	12.2	54.6	177223	106480	2.50
SEm(±)	35.2	0.11	0.50	1999	1999	0.03
C.D.(0.05)	104	0.33	1.49	5919	5919	0.08
Interaction	*	*	*	*	*	*

Total yield in terms of Groundnut Equivalent yield (GEY)

1) Integrated Crop Management Practice > Organic Farming > Natural Farming
2) Groundnut: Spanish Bunch (TG 37A) > Virginia Bunch (GJG 22);
3) Wheat: GW 451 > Lok-1 (Wheat)
4) Groundnut-wheat: ICMP >OF>NF

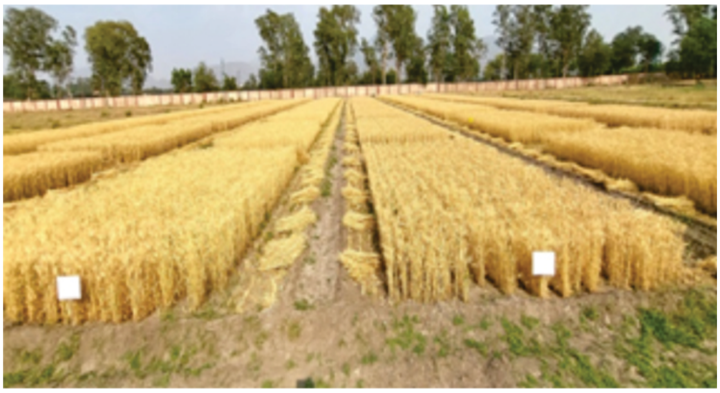


Fig 7.5: View of the long-term experiment on different farming showing both the crops in rotation

Table 7.5: Quality parameters of groundnut as influenced by farming practices and varieties

Treatments	Kernel moisture (%)	Oil content (%)	Protein content (%)
Farming Practices (F)			
Conventional	5.64	50.8	27.6
Farming	5.75	51.2	27.2
Natural			
Farming			
Organic Farming	5.67	51.7	26.6
SEm (±)	0.14	0.34	0.30
CD (P=0.05)	NA	NA	NA
Varieties (V)			
TG-37 A	5.74	49.1	29.6
GJG-22	5.63	53.4	24.7
Sem (±)	0.09	0.25	0.29
CD (P=0.05)	NA	0.75	0.85
Interaction (F x V)			
SEm(±)	0.19	0.47	0.42
CD (P=0.05)	NA	NA	NA
Interaction (V x F)			
SEm(±)	0.18	0.46	0.46
CD (P=0.05)	NA	NA	NA
CV(%)	3.39	0.92	1.70

1. Groundnut during *Kharif* 2023

The above experiment was repeated further for 2nd year during 2023-24 (as in 2022-23) with all its components/treatments in-tact involving groundnut-wheat cropping system. The wheat crop (Lok 1 and GW 451) was in the field when this report was last written. The groundnut crop showed prolonged growth and its harvest was delayed by around 2-3 weeks depending on variety (more with Virginia bunch GJG 22 and less with TG 37A due to continuous rainfall and flooding condition prevailed in the field (at DGR Campus) during June-July 2023 (with rainfall peaks at 241 and 269 mm). The data on yield and yield traits obtained in groundnut (Table 7.6) revealed there was again yield reduction to the extent of 22.7% following low cost ZBNF or Natural farming compared to ICMP. However, Organic farming practice could yield 8.0% lower than that of ICMP. Both the above farming practices had significantly lower values of observed parameters (in terms of yield and its attributes) compared to ICMP as evident from Table 7.6. On the contrary, organic farming had significant higher values of certain specific attributes viz., shelling percentage and seed index due to improved & balanced nutrition at the later stages of the crop as a result of higher quantity of FYM application to it (OF). Nevertheless, ICMP based on integrated crop management comprising of chemical fertilizers, FYM and pesticides had resulted in realization of higher pod, kernel and biological yield.

On cultivars of groundnut, the observed trend was similar to previous year with statistically significant higher pod yield and HI realized under TG 37A compared to GJG 22 (Table 7.6) although some of yield attributes (haulm yield, biological yield, shelling per cent and seed index) are favoured by the later (GJG 22).

Table 7.6: Yield and its attributes of groundnut as influenced by farming practices and varieties (*Kharif* 2023)

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological yield (kg/ha)	HI (%)	Kernel yield (kg/ha)	Shelling (%)	Seed Index (g)
Farming Practices							
CF	1702	2710	4413	38.61	1202	70.7	41.0
NF	1314	2575	3889	33.87	901	68.7	38.9
OF	1566	2620	4186	37.46	1133	72.4	42.7
Sem(±)	15.85	41.33	41.33	0.46	14.93	0.49	0.51
C.D.(0.05)	48.53	NA	126.59	1.41	45.71	1.49	1.55
Varieties							
TG 37 A	1591	2532	4123	38.52	1102	69.1	35.5
GJG 22	1464	2738	4202	34.77	1056	72.0	46.2
Sem(±)	26.30	36.38	44.18	0.50	20.58	0.54	0.40
C.D.(0.05)	77.87	107.71	NA	1.47	NA	1.60	1.19
Interaction	NA	NA	NA	NA	NA	NA	NA
C.V. %	2.35	2.31	1.64	2.1	2.7	1.2	1.7

2. Bridging the Productivity Gap

Increased pressure on food production continuously demands for enhancement in the agricultural yields that has inevitably led to the indiscriminate use of chemical fertilizers/ agrochemicals along with conventional practice. Thus, crop yields have become stagnant and soil quality has deteriorated. The optimization of the mineral nutrition in crops through inclusion of biological agents in the improved nutrient management (Improved Crop Management Practice) is fast emerging as a suitable alternative to counteract the adverse environmental impacts exerted by synthetic agrochemicals as they facilitate the overall growth and yield of crops in an eco-friendly manner. Groundnut, being a very high nutrient requiring crop, also needs serious attention into the mineral nutrition aspects to attain higher yield with stability.

Therefore, an experiment involving yield maximization in groundnut was taken up during both summer- spring 2023 and *Kharif* 2023 at ICAR-DGR, Junagadh. Here, three distinct treatments such as (1) Control (Small & marginal Farmers' practice, FP,), (2) Practice adopted by the progressive farmers (PF), and (3) Improved Crop Management practice adopted by Research Institutes (ICMP). The last treatment involved technologies amalgamation by the Research Institute (ICAR-DGR and AICRP on Groundnut) with the objective of yield improvement with economic perspectives. These three treatments were tried in large plots (~100 m^2 as a DEMO) for yield maximization at the main campus of ICAR-Directorate of Groundnut Research, Junagadh (Gujarat state of India) during both spring-summer 2023 and *Kharif* 2023 in a RBD layout with four replications. Varieties belonging to both Spanish bunch (TG 37A, 2004 released) and Virginia bunch (KDG 128, 2016 released) habit groups were taken up for the study. The crop was sown during February 2023 and harvested in May 2023.

The Improved Practice (ICMP) consisted of *Rhizobium* inoculation of IGR 6 or IGR 40 at 1.25 kg/ha for BNF, and PGPR 'NUTBOOST' at 1.25 kg/ha, FYM at 5 t/ha, recommended NPK at 25:50:25 kg/ha, gypsum for alkaline soils (applied to soil at 500 kg/ha in two equal instalments such as at basal and at earthing up with 50% each), pre- & post-emergence herbicides, and required plant protection practices (including soil application of *Tricoderma viride* at 2.5 kg/ha amalgamated with 500 kg of FYM/ha). The 'Control plot' (FP) was applied with no FYM and seed treatment with only fungicide i.e. carbendazim + mancozeb, plant protection measures as per trader advise, 10-12 no.

of irrigations without biocontrol agents. The 'Practice adopted by Progressive Farmers' (PF) included “FYM at 7-8 t/ha, NPK at 25-50-50 kg/ha, foliar spray with micronutrint mixture Grade-(30-35 g per 15 liter water) at flowering & pod formation, pre-emergence herbicide pendimethalin (stomp) accompanied with two hand weedings/interculture at 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 number of irrigations and *Tricoderma* at 2.5 Kg/ha with 500 kg FYM as soil application.

The study revealed that higher observed values in yield and its attributes in Spanish bunch cultivar 'TG 37A' such as pod yield (3185 kg/ha), shelling per cent (72.6 %), seed index (45 g), harvest index (45.9%) along with favorable economics (higher net return of INR 150716 and BCR of 3.88) were realized with ICMP (Improved practices) adopted during spring-summer 2023 seasons (Groundnut harvested during May 2023). This higher crop performance under ICMP or Improved Practices was again followed by that in progressive farmers' practices and control (farmers' practices) in that order (ICMP > PF > FP). Similar trend was also observed in case of other variety (Virginia bunch cultivar, KDG 128). In fact, still higher values in respect of above growth and yield parameters *viz.*, pod yield of 3923 kg/ha, shelling per cent of 73.3 %, seed index of 45.8g, net return of 197079 INR, and BCR of 4.68 during the seasons were observed under KDG 128 during spring-summer 2023 (Table 7.7 and 7.8). It was apparent that due to appropriate input(s) supply and their utilization especially under improved practice (ICMP). Higher productivity and economic output were also realized during spring-summer season due to lesser (biotic and abiotic) stresses.

KDG 128, a Virginia bunch outperformed over the Spanish bunch variety (TG 37A) due to higher yield realization and favorable economics across the season and cultivation practice (higher with ICMP). On soil (categorized under low to medium fertility and normal EC) parameters, almost similar soil nutrient availability with little variations under different plots both at the start and end of the experiment was observed. However, NPK uptake and economics were favoured with ICMP. In fact, different farming practices exerted significant influence on nutrient (NPK) content and uptake in both the groundnut cultivars during spring-summer. It clearly showed that NPK content and uptake in seed and haulm, and total nutrient (NPK) uptake were significantly higher in improved practices over those in farmers' practices/ progressive farmers' practices. Keeping in view of higher productivity, the total uptake for NPK, inclusive of both kernel and haulm, in respect of improved practices were to the tune of 176 21.5 and 73.6 kg/ha in cultivar TG-37A and 165, 17.3 and 56.9 kg/ha in cultivar KDG-128, respectively (Table 7.9 & 7.10). Thus, based on the content and uptake of nutrient(s), the treatments were in the following order: *ICM Practices >progressive farmers' practices >farmers' practices.* The study concluded for adoption of improved practice for realization of higher and stable yields in groundnut as confirmed from varieties of both the habit groups (Fig 7.7).

Table 7.7: Groundnut (TG -37A & KDG - 128) yield & its attributes during Spring-Summer 2023

Treatment	Pod yield (kg/ha)		Biological yield (kg/ha)		Haulm yield (kg/ha)		HI (%)		Shelling%		Kernel yield (kg/ha)		Pods/plant		Seed Index (g)	
	TG 37A	KDG 128	TG A 37	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	2539	3220	5656	7152	3118	3932	44.9	45.0	68.9	68.5	1754	2207	14.1	18.9	40.5	39.5
Progressive Farmers' Practice	2978	3668	6489	7929	3511	4261	45.9	46.3	70.5	71.1	2102	2609	17.3	22.4	43.0	42.3
ICM Practice	**3185**	**3923**	**6937**	**8626**	**3752**	**4703**	**45.9**	**45.5**	**72.6**	**73.3**	**2315**	**2872**	**20.4**	**25.3**	**45.0**	**45.8**
SEm ((±)	45.2	69.2	93.8	93.3	54.1	46.0	0.27	0.52	1.40	0.97	52.6	63.0	0.73	0.96	0.94	1.20
C.D. (0.05)	159.3	244.3	331.0	329.0	190.9	162.15	NS	NS	NS	3.43	185.5	222.2	2.94	3.85	3.35	4.30

Significant at p<0.05; NS: Not significant.

Table 7.8 Yield attributes & economics of Groundnut (TG -37A and KDG - 128) during Spring-Summer 2023

Treatment	Nodule count (#/pl)		Nodule Wt. (mg/pl)		Plant height (cm)		No. of Branches (#/pl)		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
Farmers' Practice	87.0	160	28.9	50.1	29.2	40.6	2.90	5.89	114502	156716	3.38	4.17
Progressive Farmers' Practice	105.3	174	31.31	51.9	31.7	41.0	3.11	6.10	138604	180865	3.71	4.44
ICM Practice	**118.9**	**188**	**33.30**	**54.8**	**32.6**	**41.5**	**3.21**	**6.00**	**150716**	**197079**	**3.88**	**4.68**
SEm(+/-)	1.49	0.16	0.51	0.52	0.54	1.79	0.06	0.22	2810	3946	0.06	0.08
C.D. (0.05)	6.00	0.66	2.07	2.08	2.16	NS	0.23	NS	9913	13920	0.20	0.27

Significant at $p<0.05$; NS: Not significant; NR: Net return, BCR: Benefit Cost Ratio.

Table 7.9 Nutrient (NPK) content (%) and uptake (kg/ha) by Groundnut (TG -37A & KDG - 128) during Spring-Summer 2023

Treatment	N content in kernel		P content in kernel		K content in kernel		N content in halum		P content in halum		K content in halum		N uptake in kernel		P uptake in kernel	
	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	4.00	3.54	0.44	0.35	1.50	1.33	1.49	0.91	0.16	0.31	0.58	0.31	69.8	78.3	7.75	7.60
Progressive Farmers' Practice	4.33	3.74	0.52	0.37	1.73	1.35	1.67	1.06	0.20	0.30	0.69	0.30	90.8	97.6	10.81	9.65
ICM Practice	**4.69**	**3.83**	**0.56**	**0.41**	**1.95**	**1.42**	**1.81**	**1.17**	**0.23**	**0.34**	**0.76**	**0.34**	**67.9**	**110.0**	**12.91**	**11.7**
SEm(+/-)	0.09	0.06	0.01	0.01	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.01	1.97	3.60	0.26	0.19
C.D. (0.05)	0.32	0.20	0.02	0.02	0.12	0.06	0.08	0.07	0.02	0.03	0.06	0.03	6.93	12.7	0.92	0.65

Table 7.10 Nutrient (NPK) uptake (kg/ha) by Groundnut (TG -37A and KDG - 128) during Spring-Summer 2023

Treatment	K uptake in kernel		N uptake in halum		P uptake in halum		K uptake in halum		N total uptake		P total uptake		K total uptake	
	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	26.3	29.4	46.4	35.9	5.07	3.34	18.1	12.1	116	114	12.8	10.9	44.4	41.5
Progressive Farmers' Practice	36.3	35.2	58.6	45.1	6.93	4.61	24.1	12.8	149	143	17.7	14.3	60.4	48.1
ICM Practice	**45.1**	**40.8**	**67.9**	**54.9**	**8.53**	**5.59**	**28.5**	**16.1**	**176**	**165**	**21.5**	**17.3**	**73.6**	**56.9**
SEm(+/-)	1.01	1.03	0.81	1.19	0.23	0.17	0.70	0.46	2.0	3.8	0.47	0.35	1.39	1.21
C.D. (0.05)	3.57	3.63	2.87	4.21	0.79	0.59	2.60	1.61	7.2	13.5	1.66	1.23	4.89	4.26

Fig 7.6 Demonstration showing higher crop performance under ICM Practice

Therefore, adoption of improved crop management (ICM) practice was required for realization of higher and stable yields of improved groundnut variety resulting in higher availability of plant nutrients, better growth of plants and higher output/economic returns. In addition, keeping in view of the negative impact of excessive use of chemical fertilizers on environment and high costs involved in the production of N and P fertilizers and their use as critical inputs, ICM practice involving use of PGPR-NUTBOOST as seed treatment tested in our study proved to be a promising alternative. This is required for profitable crop production and recovery of poor quality (degraded) soils in a sustainable manner (as in the existing condition).

Groundnut yield maximization (*Kharif* 2023)

The above experiment was repeated further for 2nd year (4th *Kharif* season) with all the three treatments involving two groundnut cultivars (TG 37A and KDG 128) during 2023-24 (as in 2022-23) in large plots. The sowing of groundnut crop was delayed by around 6 weeks due to continuous rainfall and flooding condition prevailed in the open field (at DGR Campus) during June-July 2023. So were also the dates of harvesting. The data on yield and yield traits obtained in groundnut (Table 7.11) confirmed the earlier results. In fact, adoption of improved crop management (ICM) practice was required for realization of higher and stable yields of improved groundnut variety. Among the varieties, KDG 128 out-yielded compared to TG 37A under the existing condition of South Saurashtra region (Table 7.11). Other yield and its attributes followed the same trend.

Table 7.11: Yield and Yield attributes of Groundnut cultivars (TG -37A and KDG - 128) during *Kharif* 2023

Treatment	Pod yield (kg/ha)		Haulm yield (kg/ha)		Biological yield (kg/ha)		HI (%)		Kernel yield (kg/ha)		Shelling (%)		Seed Index	
	TG 37 A	KDG 128	TG 37 A	KDG 128	TG 37 A	KDG 128	TG 37 A	KDG 128	TG 37 A	KDG 128	TG 37 A	KDG 128	TG 37 A	KDG 128
Farmers' Practice	1714	2219	2579	2979	4292	5198	39.9	42.7	1179	1589	68.8	71.6	38.5	35.8
Progressive Farmers' Practice	1854	2356	2770	3152	4623	5508	40.1	42.8	1309	1720	70.6	73.0	40.0	38.1
ICM Practice	**2010**	**2601**	**2996**	**3437**	**5006**	**6039**	**40.2**	**43.1**	**1474**	**1929**	**73.3**	**74.1**	**43.0**	**40.2**
SEm(+/-)	49.7	40.1	80.38	46.0	105.5	68.1	0.76	0.46	46.3	26.2	0.75	0.38	0.61	0.60
C.D. (0.05)	175.2	141.3	283.5	162.2	372.1	240.3	NA	NA	163.2	91.78	2.63	1.33	2.17	2.10
C.V. %	5.3	3.4	5.78	2.9	4.55	2.4	3.81	2.13	7.0	2.98	2.10	1.04	3.04	3.14

The above study confirmed that adoption ICM practice (optimized through refinement in technologies) was required for realization of higher and stable yields in groundnut under existing agro-ecology. This is confirmed from the experiments carried out so far across the seasons (Spring/summer 2023 and *Kharif* 2022 &2023) and varieties (Spanish TG 37A and Virginia KDH 128) of both the habit groups.

3) Season-long 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 Spanish bunch groundnut 'TG 37A' (2004 released) was carried out during spring-summer 2023 at the main campus of ICAR-DGR, Junagadh. Nine treatment combinations involving weed control through combination of pre- and post-emergence herbicides and hand weeding were taken up in four times replicated RCBD. These treatments included (T_1) Weedy Check, (T_2) HW twice at 20-25 and 40-45 days of emergence followed by interculture operation, (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, (T_8) Oxyflourfen 200 g/ha as PRE *fb* Quizalofop ethyl 50 g/ha as PoE, and (T_9) Weed Free. The experiment was sown during 1st week of February with pre-sowing irrigation, followed by other GAP, and harvested during 1st week of June 2023. The crop was raised following standard recommended practice. Post emergence herbicides were applied at 20-25 days after crop emergence. The observations pertaining to growth and yield attributes including those related to weeds, and production economics were also recorded during the season.

The above study revealed that there was a dominance of sedges (*Cyperus rotandus, and Cyperus Esculentus)* in the experiment. Few grasses including (*Eluropus villosus, Dactyloctenium aegyptium, Cyperus rotandus, Echinochloa colonum and Diachanthium annulatum.*, 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, Tridax procumbens* and *Commelina benghalensis*) were also present.

The study revealed 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 improved yield attributes and better weed control characteristics. As a result, certain combination of herbicides 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 13.06% was recorded under this (T_4 with 3245 kg/ha) compared to manual weed control followed by intercultural operation (T_2 with 2870 kg/ha). Consequently, there was increase in net return (14.66%) and BCR (8.74%) recorded under the treatment involving Diclosulam 26 g/ha as PRE *fb* Fenoxaprop-p-ethyl 78 g/ha as PoE (T_4) compared to manual weed control (T_2). This was followed by the next best treatment where both diclosulam 26 g/ha as PRE (and) *fb* Clethodim 180 g/ha as PoE (T_3) were applied to the crop (with yield of 3126 kg/ha). Other crop and weed growth pattern followed the same trend as that of pod yield (Table 7.12 & 7.14 and Fig 7.7).

Table 7.12 Pod yield, its attributes and nodulation in groundnut under weed control treatments during Spring-Summer 2023

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological yield (kg/ha)	HI (%)	Pods/ Plant (#/pl)	Nodule count (#/pl)	Nodule dry wt. (mg/pl)	Shelling (%)	Seed index (g)	Kernal yield (kg/ha)
Weedy Ck	1102	1709	2810	39.2	6.2	63.9	24.0	71.5	44.8	788
HW+IC	2870	3685	6555	43.8	12.3	89.9	30.8	77.0	49.5	2210
Diclo+Cleth	3126	3797	6923	45.1	15.1	100.2	31.3	771	49.3	2114
Diclo+Feno	**3245**	**3821**	**7067**	**45.9**	**16.2**	**105.4**	**31.6**	**78.3**	**51.0**	**2538**
Oxy+Cleth	2006	2614	4621	43.4	10.2	80.2	27.6	73.5	46.3	1475
Oxy+Feno	2149	2852	5001	43.0	8.0	82.6	28.8	75.4	48.5	1620
Pendi+Imaz)	2830	3632	6462	43.8	12.6	89.3	29.2	76.6	47.3	2169
Oxy+Quiz	1810	2531	4342	41.7	10.7	77.3	26.7	72.1	46.5	1307
Weed Free	**3375**	**4009**	**7385**	**45.7**	**16.7**	**109.7**	**33.1**	**79.1**	**52.8**	**2671**
SEm(±)	58.7	70.3	120	0.57	1.57	3.29	0.83	0.63	1.32	147.0
C.D.(0.05)	172.5	206	351	1.67	4.76	9.96	2.51	1.84	3.88	50.06

Table 7.13: Nutrient (NPK) content (%) and uptake (kg/ha) by groundnut under weed control treatments during Spring-Summer 2022-23

Treatment	N/ P/ K content in kernal	Uptake (kernel) N	P	K	N/ P/ K content (halum)	N uptake (halum)	P uptake (halum)	K uptake (halum)	N uptake (Total)	P uptake (Total)	K uptake (Total)
Weedy Ck	2.17/ 0.21/ 0.40	16.7	1.61	3.06	1.28/0.10/0.51	21.8	1.73	8.69	38.5	3.35	11.75
HW+IC	2.45/ 0.22/ 0.48	54.4	5.04	10.8	1.63/0.11/0.56	61.1	4.43	21.1	115.5	9.47	31.92
Diclo+Cleth	2.50/ 0.25/ 0.47	61.3	6.35	11.6	1.75/0.14/0.54	67.4	5.47	20.9	128.7	11.8	32.45
Diclo+Feno	**2.69/ 0.24/ 0.50**	**67.7**	**6.04**	**12.6**	**1.83/0.13/0.58**	**69.7**	**5.26**	**22.3**	**137.3**	**11.3**	**34.83**
Oxy+Cleth	2.25/ 0.22/ 0.40	33.4	3.27	5.99	1.45/0.10/0.52	37.9	2.78	13.7	71.3	6.05	19.64
Oxy+Feno	2.30/ 0.21/ 0.44	36.7	3.41	7.07	1.42/0.11/0.53	39.7	3.22	15.0	76.4	6.63	22.07
Pendi+Imaz)	2.40/ 0.23/ 0.41	51.3	4.97	8.87	1.56/0.12/0.55	57.0	4.55	20.4	108.2	9.52	29.22
Oxy+Quiz	2.18/ 0.21/ 0.40	28.0	2.78	5.18	1.39/0.11/0.51	34.9	2.77	12.9	62.9	5.56	18.04
Weed Free	**2.71/ 0.27/ 0.53**	**72.6**	**7.41**	**14.4**	**1.88/0.15/0.60**	**75.4**	**6.21**	**24.2**	**148.0**	**13.6**	**38.56**
SEm(±)	0.04/0.008/0.008	1.99	0.21	0.32	0.03/0.004/0.011	1.32	0.16	0.51	2.90	0.28	0.62
C.D.(0.05)	0.13/0.024/0.026	6.00	0.64	0.09	0.09/0.01/0.033	3.98	0.49	1.53	8.76	0.84	1.84

Further, an appraisal of data indicated that total uptake of NPK were significantly influenced by different weed management treatments in spring-summer 2023. Significantly higher total uptake of NPK (148.0, 13.6 and 38.6 kg/ha) was analysed under the weed free check (T_9) respectively, followed by Diclosulam 26 g/ha as PRE *fb* Fenoxaprop-p-ethyl 78 g/ha as PoE (T_4) and Diclosulam 26 g/ha as PRE *fb* Clethodim 180 g/ha as PoE (T_3). In contrast, the lowest total uptake of NPK (38.46, 3.35 and 11.75 kg/ha) was noticed under the unweeded control (T_1) in spring-summer 2023 (Table 7.13).

Table 7.14: Weed attributes and economics of Groundnut under different weed control treatments during spring-summer 2023

Treatment	Weed count (#/m^2) 45 DAS	60 DAS	90 DAS	Weed dry wt. (g/m^2) 45 DAS	60 DAS	90 DAS	NR (INR/ha)	BCR
Weedy Ck	80.0	101.0	108.0	50.1	101.0	122.6	31,140	1.74
HW+IC	33.3	34.0	38.3	47.8	47.6	65.2	1,40,115	4.12
Diclo+Cleth	12.7	20.7	24.3	39.3	53.5	45.2	1,51,802	4.15
Diclo+Feno	10.0	16.0	19.3	22.2	25.0	21.1	**1,60,655**	**4.48**
Oxy+Cleth	50.0	62.7	64.7	39.2	46.3	37.1	81,501	2.69
Oxy+Feno	45.7	52.3	56.0	30.7	31.0	41.8	93,163	3.02
Pendi+Imaz)	39.0	39.7	45.7	46.3	81.2	98.1	1,36,715	3.99
Oxy+Quiz	52.3	63.0	69.7	29.3	38.4	41.1	71,681	2.54
Weed Free	**2.0**	**2.0**	**1.7**	**1.66**	**2.33**	**2.33**	**1,65,939**	**4.36**
SEm(±)	2.48	2.03	2.69	1.78	1.14	1.65	3,628	0.08
C.D.(0.05)	7.49	6.15	8.16	5.38	3.44	5.03	10,652	0.23

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

Fig 7.7: Performance of weed control treatments (T_1, T_4 & T_3) in groundnut at 90 days after sowing

Herbicide efficacy during *Kharif* 2023

The above experiment was repeated during *Kharif* 2023 at a different location in ICAR-DGR Junagadh. The study revealed 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 improved yield attributes and yield also (Table 13). An increase in the pod yield to the extent of 21.65% was recorded under this (T_4 with 2601 kg/ha) compared to manual weed control followed by intercultural operation (T_2 with 2138 kg/ha) during *Kharif* 2023. This was followed by the next best treatment where both diclosulam 26 g/ha as PRE (and) *fb* Clethodim 180 g/ha as PoE (T_3) were applied to the crop (with yield of 2542 kg/ha). Nevertheless, continuous or season long manual weed control method (under weed free treatment, T_9) could not help in realizing significantly higher yield compared to above chemical control treatment wherein both pre+post emergence herbicides were applied. Other crop and weed growth pattern followed the same trend as that of pod yield (Table 7.15).

Therefore, effective weed control practice involving application of an efficient herbicide or their appropriate combination through both pre- and post-emergence could be a boon as it was useful for season-long weed control. It further favoured higher crop growth and development leading to scaling crop productivity and monetary returns. This result also confirmed earlier study during *Kharif* 2022 at the same location. Thus, our three seasons (spring-summer 2023, *Kharif* 2022 & 2023) 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. This could help in saving cost of production compared to both manual weed control through two hand weeding followed by interculture (up to 45 DAS) and absolute weed free situation.

Table 7.15: Pod yield and its attributes in groundnut under various weed control treatments during *Kharif* 2023

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological yield (kg/ha)	HI (%)	Kernal yield (kg/ha)	Shelling (%)	Seed index
Weedy Ck	1,014	1,678	2,691	37.8	661	65.2	33.5
HW+IC	2,138	3,102	5,240	40.8	1497	70.0	36.2
Diclo+Cleth	2,542	3,480	6,022	42.2	1802	70.9	38.7
Diclo+Feno	**2,601**	**3,586**	**6,187**	**42.1**	**1829**	**70.3**	**37.7**
Oxy+Cleth	2,098	2,881	4,979	42.2	1427	68.1	35.2
Oxy+Feno	2,103	3,032	5,136	41.0	1430	68.0	35.7
Pendi+Imaz)	2,258	3,254	5,512	41.0	1563	69.3	37.0
Oxy+Quiz	2,070	2,661	4,731	43.8	1392	67.2	34.3
Weed Free	2,696	3,617	6,313	42.7	1930	71.6	40.1
SEm(±)	72.1	337.3	458.1	1.04	50.9	0.75	0.34
C.D.(0.05)	211.8	114.9	156.0	3.05	149.4	2.21	1.00
C.V. %	6.7	7.6	6.0	5.0	6.8	2.18	1.86

4. Irrigation and Sulphur needs of spring-summer Groundnut

An experiment with the objective of assessing and refining both irrigation schedules (on IW/CPE basis *i.e.*, irrigation water/Cumulative Pan Evaporation) and sulphur fertilization requirements of groundnut crop was carried out during Spring-Summer 2023 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 Spanish bunch 'TG 37A' (2004 released). Irrigation levels included (I_0) Flood Irrigation (as a Control mainly based on at critical stages), (I_1) Irrigation at IW/CPE 0.6 (Irrigation at 83.3 mm cumulative pan evaporation), (I_2) Irrigation at IW/CPE ratio 0.8 (Irrigation at 62.5 mm cumulative pan evaporation), and (I_3) Irrigation at IW/CPE ratio 1.0 (Irrigation at 50 mm cumulative pan evaporation); while Sulphur levels included (S_0) control or no sulphur, (S_1) 15 kg

S/ha, (S_2) 30 kg S/ha, and (S_3) 45 kg S/ha. During spring-summer 2023, the groundnut crop was irrigated six times under I_0, eight times for I_1, ten times for I_2, and twelve times for I_3 in order to optimize number of irrigations required for higher yield under irrigated spring-summer condition of South Gujarat (this excluded the sowing-time irrigation). Sulphur was applied as a single dose during sowing in elemental form. The observation included growth attributes, pod yield & yield attributes, and economics of groundnut. The experiment was sown during first week of February with pre-sowing irrigation and harvested during 1st week of June 2023. The crop (Fig 7.8 and 7.9) was raised following standard recommended practices.

The study showed that irrigation scheduling at 0.8 IW/CPE (I_2) at an interval of about 10-days was optimum as both the yield and economics were favourably influenced in respect of the above as observed during spring-summer season. Less than ten irrigation caused significant yield reduction (compared with that at either six or eight irrigations at I_0 and I_1, respectively during the season). 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) had low crop-needs. It was confirmed that its requirements for its application at very lower doses (up to 15 kg S/ha). Although yield was not significantly influenced by S application in spring-summer (not in *Kharif*), yet significantly higher branches, pods per plant and total N uptake were evident at 15 kg/ha (Elemental S). 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 (to either 30 or 45 kg/ha) could not result in additional advantages in terms of crop productivity and returns (and BCR). Similar studies conducted during *Kharif* 2022 season also confirmed the low requirement of S (15 kg/ha). Thus, two season studies 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 (Table 7.16, 7.17 & 7.18).

Table 7.16: Pod yield and its attributes in groundnut under different irrigation and sulphur treatments

Treatment (No. of Irrigation given)	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological yield	Pods/plant (#.pl)	100 kernel wt. (g)	Kernal yield (kg/ha)	Shelling (%)	HI (%)
Irrigation Levels (IW/CPE ratio)								
I_0 (Control) 6	2704	3482	6186	12.92	38.98	1857	68.68	43.7
I_1 (0.6) 8	3195	3892	7087	14.42	42.28	2255	70.60	45.1
I_2 (0.8) 10	3356	4116	7473	18.42	45.68	2455	73.10	45.1
I_3 (1.0) 12	3280	4476	7756	15.81	44.06	2360	71.94	42.3
Sem(±)	125	183	256	0.685	0.521	97.6	0.721	1.19
C.D.(0.05)	441	647	903	2.418	1.839	344	2.543	NS
Sulphur levels (kg/ha)								
S_0 (Control)	3080	3860	6948	14.42	42.72	2170	70.45	44.3
S_1 (15)	3129	4050	7186	15.83	42.72	2229	71.10	43.6
S_2 (30)	3107	4031	7138	15.03	42.52	2213	71.04	43.5
S_3 (45)	3219	4010	7229	16.28	43.04	2315	71.73	44.7
Sem(±)	74.6	91.4	148	0.457	0.85	57.7	0.562	0.56
C.D.(0.05)	NS	NS	NS	1.342	NS	NS	NS	NS
Interaction					NS			

Table 7.17: Growth, nodulation and economics in groundnut under different irrigation and Sulphur levels

Treatment	Plant height (cm)	No. of branches (#/pl)	Nodule count (#/pl)	Nodule dry wt. (mg/pl)	NR (INR/ha)	BCR
Irrigation Levels (IW/CPE ratio)						
I0 (Control)	24.6	4.00	46.4	25.1	123198	3.41
I1 (0.6)	29.6	3.89	58.2	29.6	152324	3.92
I2 (0.8)	33.4	3.94	70.1	33.4	161871	4.04
I3 (1.0)	32.5	4.03	63.6	32.5	159842	3.94
SEm(±)	0.65	0.045	5.194	1.86	7493.2	0.14
C.D.(0.05)	2.28	NS	NS	NS	26434	NS
Sulphur levels (kg/ha)						
S0 (Control)	29.8	3.81	57.1	29.5	147312	3.90
S1 (15)	31.1	4.22	59.5	31.0	149998	3.88
S2 (30)	29.6	3.92	62.4	30.7	147249	3.75
S3 (45)	30.6	3.92	59.3	29.5	151976	3.77
SEm(±)	0.44	0.07	1.856	1.72	4549	0.087
C.D.(0.05)	NS	0.206	NS	NS	NS	NS
Interaction			NS			

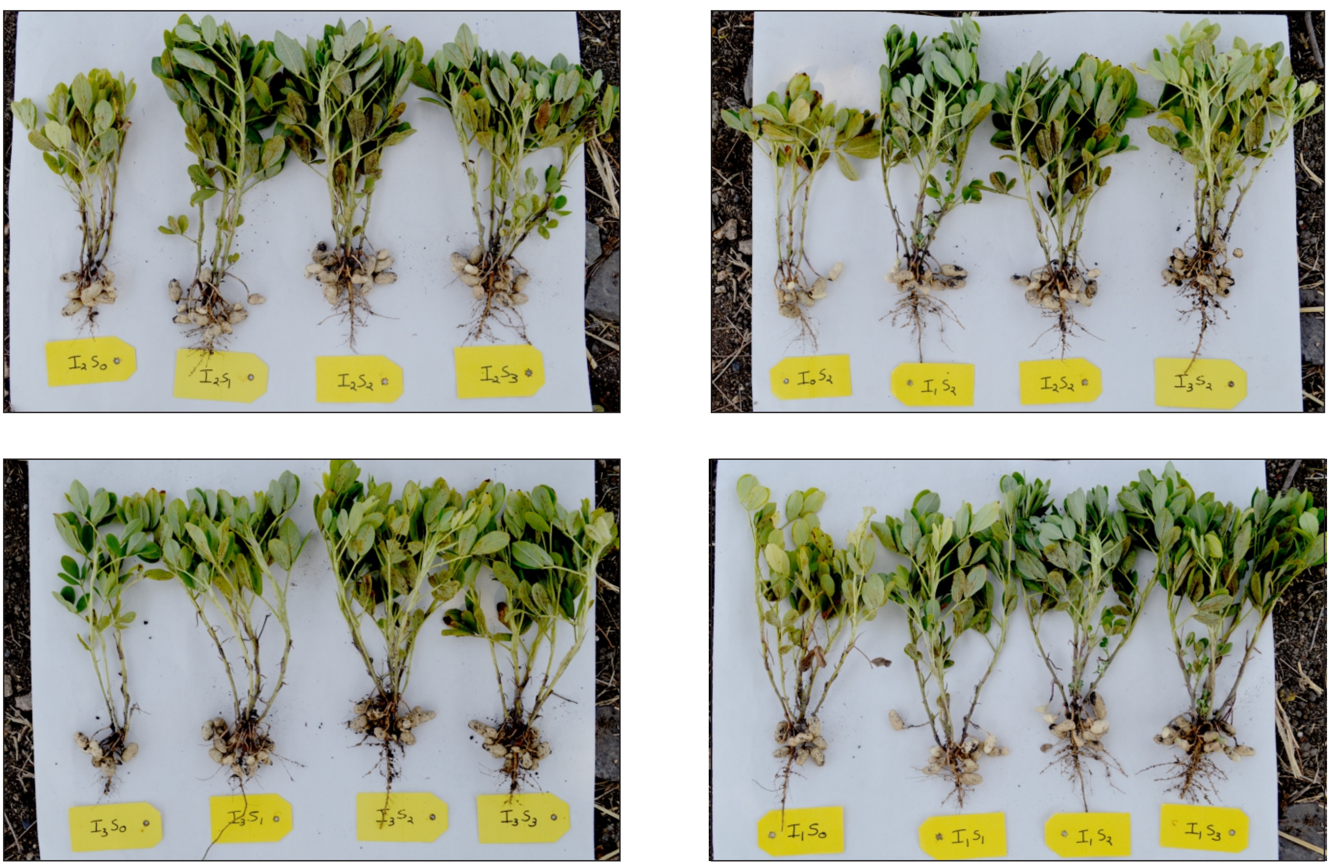


Fig 7.8: comparison among treatments in groundnut during spring-summer 2023

Fig 7.9: Field view of the experiment with irrigation levels and S application during spring-summer 2023

Table 7.18 Nutrient (NPK) content (%) and uptake (kg/ha) by groundnut under irrigation and Sulphur levels

Treatment	N/ P/ K content in kernel	N/ P/ K content in halum	Uptake in kernel			Uptake in halum			Total uptake		
			N	P	K	N	P	K	N	P	K
Irrigation Levels (IW/CPE ratio)											
I0 (Control)	2.75/0.27/0.90	1.42 /0.12/ 0.50	51.2	4.96	16.7	49.4	4.13	17.4	101	9.1	34.1
I1 (0.6)	2.98/0.33/0.94	1.54/ 0.16/ 0.54	67.6	7.50	21.2	60.0	6.13	21.3	128	13.6	42.5
I2 (0.8)	3.20/0.36/1.05	1.72/0.19/0.60	78.5	8.92	25.8	70.5	7.73	24.5	149	16.7	50.3
I3 (1.0)	3.10/0.35/0.98	1.60/0.16/0.57	73.3	8.30	23.1	71.4	7.32	25.3	145	15.6	48.4
SEm(±)	0.08/0.01/0.06	0.03/0.01/ 0.02	4.41	0.56	0.75	3.36	0.492	1.30	6.8	0.96	1.77
C.D.(0.05)	0.27/0.04/0.02	0.12/ 0.04/ 0.05	15.5	1.98	2.69	11.85	1.734	4.57	24.1	3.39	6.25
Sulphur levels (kg/ha)											
S0 (Control)	2.91/0.31/0.95	1.53/0.15/0.54	63.5	6.78	20.7	59.5	5.78	20.8	123	12.6	41.5
S1 (15)	3.09/0.33/0.98	1.59/0.16/0.56	69.3	7.52	22.0	64.8	22.72	22.7	134	14.1	44.7
S2 (30)	2.97/0.32/0.96	1.53/0.15/0.55	66.3	7.34	21.4	62.0	22.35	22.4	128	13.5	43.8
S3 (45)	3.07/0.35/0.98	1.62/0.17/0.56	71.5	8.04	22.7	65.1	22.65	22.7	137	14.9	45.4
SEm(±)	0.07/0.02/0.02	0.04/0.01/0.01	2.24	0.44	0.70	1.99	0.383	0.77	3.0	0.64	1.12
C.D.(0.05)	NS/NS/NS	NS/NS/NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction					NS						

Sulphur requirement of groundnut (*Kharif* 2023)

A large plot demonstration was carried out at ICAR-DGR, Junagadh during *Kharif* 2023. The data revealed that the efficacy of soil application of sulphur only at 15 kg/ha (moderate doses through pure elemental S) for realization of higher yield and its attributes under the existing situation/region of Gujarat as around 12.3% additional yield along with similar increases in other yield traits was realized with this alone (Table 7.19).

Table 7.19: Pod yield and its attributes in groundnut under different S-levels during *Kharif* 2023

Treatment (S Levels, (kg/ha)	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological yield (kg/ha)	HI (%)	Kernel yield (kg/ha)	Shelling (%)	Seed index (g)
No Sulphur(Control)	1,789	2,581	4,371	40.9	1,184	66.1	34.1
15	2,010	2,907	4,917	40.9	1,397	69.5	37.7
30	1,960	2,701	4,661	42.0	1,348	68.8	36.0
45	1,976	2,836	4,811	41.1	1,378	69.8	37.7
SEm(±)	31.0	32.0	54.0	0.37	25.7	0.46	0.78
C.D.(0.05)	100	103	175	NS	83.2	1.48	2.52
CV(%)	3.2	2.3	2.3	1.8	3.9	1.3	4.3

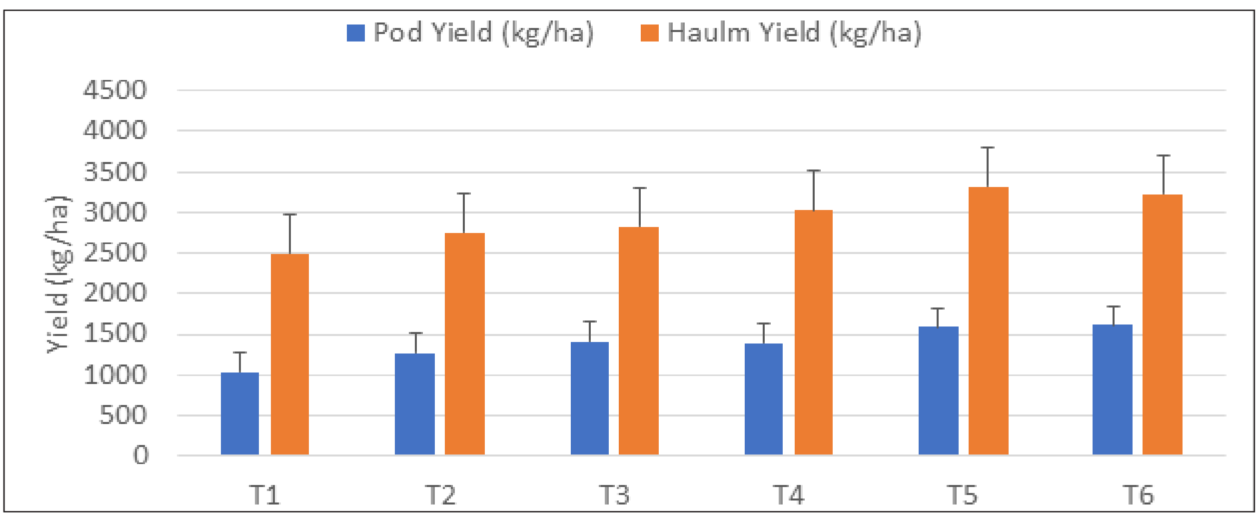
Project 8: Salinity and heat stress in groundnut: basis of tolerance and mechanism

PI: *KK Pal* (Left on 30.06.2023)

Co-PI: *Rinku Dey* (Left on 22.12.2023), *Sushmita Singh, Kiran K Reddy, Praveen Kona, and Raja Ram Choudhary*

Effect of endophytes and mulching on yield parameters under salinity

The experiment was conducted from summer 2021 to 2023, with six treatments [T1-Control; T2-J22N Endophyte (seed treatment+ furrow application at 45 DAS); T3-REN51N Endophyte (seed treatment+ furrow application at 45 DAS); T4-mulch @ 10 t/ha; T5-J22N Endophyte (seed treatment+ furrow application at 45 DAS) + mulch @ 10 t/ha; T6-REN51N Endophyte (seed treatment+ furrow application at 45 DAS) + Mulch @ 10 t/ha] and 3 replications in RBD design. 25 kg N through Urea, 50 kg P_2O_5 through DAP and 30 kg K_2O/ha through MOP was supplied. Wheat straw mulch @ 10 t/ha was used. Initial soil EC was 0.5 dS/m. Irrigation water salinity of 4 dS/m was imposed on the treatments. Two endophytes *Bacillus firmus* J22N and *Bacillus subtilis* REN51 were used in the treatments. TG37A variety was used for sowing. Pooled data of three years revealed that significantly higher pod yield (1613 kg/ha) was obtained with T6-REN51N Endophyte (seed treatment+ furrow application at 45 DAS) + Mulch @ 10 t/ha, which was at par with T3-REN51N Endophyte (seed treatment+ furrow application at 45 DAS), T4 and T5. Endophytes alone could increase the pod yield by 23.5-36.4% over control. Application of mulch has decreased the soil salinity by 1 dS/m compared to control. Mulching in combination with endophytes has increased the pod yield by 54-56 % over control. Haulm yield was found to be significantly high in T5, which was at par with T4 and T6. Lowest EC at harvest was observed in T5 and T6 (2.9 dS/m).



T1-Control; T2-J22N Endophyte T3-REN51N Endophyte; T4- mulch @ 10 t/ha; T5-J22N Endophyte + mulch @ 10 t/ha; T6-REN51N Endophyte + Mulch @ 10 t/ha

Fig 8.1: Effect of different treatments on pod and haulm yield under salinity

Project 1: Development of Groundnut Production technologies for arid region of Rajasthan

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 consisted of 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 by 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* 2022. For residue application, residues of mustard, wheat and chickpea crops were taken from other fields during *kharif* 2022. Sowing of groundnut (var. Girnar-2) was done on 11th July 2022 45 X10 cm spacing with recommended dose of fertilizers (20:40:00 kg N: P_2O_5: K_2O/ha). Harvesting of groundnut was done on 16th November 2022. During *rabi* season 2022-23, mustard (var. Giriraj), chickpea (var. CSJ-515) and wheat (var. DBW 187) were sown on 22nd, 24th and 25th November 2022, respectively. Mustard, chickpea and wheat were sown at the spacing of 45 x10 cm, 30 x 10 cm and 20 x 10 cm, respectively with 100% recommended dose of fertilizers each for mustard (90:40:40 kg N: P_2O_5: S/ha), chickpea (20:32 kg N: P_2O_5/ha) and wheat (120: 40:20 kg N: P_2O_5: K_2O/ha). Crops were harvested on 24th and 25th March 2023.


Image 1.4: Experimental field view

Pod yield and haulm yield of groundnut was obtained higher under conventional tillage + residue incorporation (*kharif*) - zero tillage (*rabi*), and conventional tillage + residue incorporation (*kharif*) - conventional tillage (*rabi*), respectively, but differences were non-significant. Seed yield and stalk yield of mustard was significantly higher under conventional tillage + residue incorporation (*kharif*) - zero tillage (*rabi*), and lowest was under conventional tillage (*kharif*) - conventional tillage (*rabi*). Seed yield and straw yield of chickpea was found higher with zero tillage + residue retention (*kharif*) - zero tillage (*rabi*), and conventional tillage + residue incorporation (*kharif*) - zero tillage (*rabi*), respectively but differences were non-significant. Moreover, grain yield and straw yield of wheat was higher under conventional tillage + residue incorporation (*kharif*) - conventional tillage (*rabi*), and conventional tillage + residue incorporation (*kharif*) - zero tillage (*rabi*), respectively, with non-significant differences.

Groundnut pod equivalent yield (GPEY) was higher under conventional tillage + residue incorporation (*kharif*) - zero tillage (*rabi*) with non-significant differences. Among cropping systems, groundnut-wheat cropping system gave higher GPEY than other cropping systems.

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 (T1), zero tillage + residue retention (*kharif* season) + 100% RDF to both the crops (T2), zero tillage + residue retention (*kharif* season) + 75% RDF to both the crops + NutMagic in groundnut (T3), minimum tillage + residue incorporation (*kharif* season) + 100% RDF to both the crops (T4), minimum tillage + residue incorporation (*kharif* season) + 75% RDF to both the crops + NutMagic in groundnut (T5), conventional tillage + residue incorporation (*kharif* season) +100% RDF to both the crops (T6), and conventional tillage + residue incorporation (*kharif* season) + 75% RDF to both the crops + NutMagic in groundnut (T7). The experiment was laid out in RBD pattern with three replications. All experimental plots were prepared by 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 during *kharif* 2022. In farmers' practice treatment, tillage was similar to conventional tillage and fertilizers were applied as 20:30 kg N: P_2O_5/ha for groundnut. Other treatments were based on 100% recommended dose of fertilizers for groundnut (20:40 kg N: P_2O_5/ha). Sowing of groundnut, var. Girnar-2, was done on 13th July 2022 at the spacing of 30x10 cm. 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 21st November 2022 with 100% recommended dose of fertilizers for mustard as 90:40:40 kg N : P_2O_5 : S/ha, while in farmers' practice fertilizers dose applied was 80:30:20 kg N : P_2O_5: S/ha.


Image 1.5: Experimental field view

Pod yield of groundnut was higher under T4 while lowest under T1, but differences were non-significant. However, haulm yield was found significantly higher under T2, being at par with rest of the treatments except T1 and T5. Significantly higher seed yield of mustard was under T4, being at par with T2 and T6, and stalk yield of mustard was also higher under T4, being at par with T6. Both seed yield and stalk yield of mustard were found lowest with T1. Similarly, groundnut pod equivalent yield (GPEY) was higher under T4, being at par with T2 and T6.

3 Crop Protection



Project 10: Management of White grubs, Bruchid beetle, Spodoptera and Helicoverpa in groundnut

(Formerly: Studies on white grub and bruchid beetle and their management in groundnut)

PI: Harish G.

Co-PI: Rinku Dey, Nataraja MV

1. 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.

2. Assessment of carry over population of Bruchids from fields

Choice and No choice test were conducted to evaluate the host preference of bruchid in field condition. Tamarind was preferred host by bruchid. *Samania saman* was the new host recorded for the first time as host of bruchid beetle.

3. Early detection of eggs using chemical stains

Most of the chemical stains were not found suitable for early detection of bruchid infestation as they were not able to stain eggs due to presence of soil on groundnut pods. However, DGR Stain 1 solution stained the groundnut pods and eggs were clearly visible. Hence DGR Stain 1 may be used for early detection of eggs in field itself.

4. Assessment of field level infection by Aspergillus

Around 60 samples were tested for Aflatoxin (inhouse) by ELISA method and all were tested positive for aflatoxin contamination. 110 samples were sent for Aflatoxin estimation by HPLC method and 5 samples were contaminated and rest were below detectable limit.

Project 11: Transcriptomics and metabolomics of *GBNV*-resistant and –susceptible groundnut genetic resources for identification of *GBNV*-resistant gene(s) and mechanism(s)

(Formerly: Development of rapid detection techniques of Peanut Bud Necrosis and Tobacco Streak Viruses in groundnut)

PI: *Nataraja V Maheshala;*

Co-PIs: *Harish G, Ananth Kurella**

*On Study leave w.e.f. 02.04.2023

1. Rabi-summer 2022-23

Groundnut Bud Necrosis Virus was maintained in susceptible genotype, Kadiri-6 in the net house and *Thrips palmi* population was cultured on white cabbage in the laboratory.

2. Kharif 2023

As per the recommendations of 24th RAC (2023), work on thrips and virus were discontinued and a new project is formulated on "Bio-intensive management of *Spodoptera* in groundnut". However, field evaluation of Entomopathogenic fungal strains could not be carried out due to Biparjoy cyclone followed by continuous rains leading to delayed establishment of crop and very low level of *Spodoptera* infestation in the field. *Spodoptera* infestation was below the ETL (20-25% damage at 40 days of crop age) hence, trial was vitiated.

4 Highlights of AICRP on Groundnut

Inputs: Nataraja Maheshala, Nodal Officer, AICRP-G

I. Crop Improvement

1.1. Maintenance of groundnut germplasm

A total of 2535 germplasm accessions were being maintained at eight centres.

1.2. 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 8 and 21 AICRP-G centres. Altogether, 6537 and 10062 single plant selections and 315 and 366 bulk selections were made during *rabi*-summer 2021-22 and *Kharif* 2022, respectively.

1.3. 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. Progenies of 404 and 642 crosses were advanced to their respective next filial generation during *rabi*-summer 2021-22 and *Kharif* 2022, respectively.

1.4. 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 Argo Ecological Zones of groundnut. However, a modified three-tier system of evaluation of groundnut entries under the nomenclature of Initial Varietal Trial; and Advanced Varietal Trial, Stage I (AVT I) and Advanced Varietal Trial, Stage II (AVT II) will be adopted from *Kharif* 2023 onwards.

During *rabi*-summer 2021-22, under IVT-I (Spanish), 16 entries were tested at 20 centres along with check varieties and trial will be repeated as such in *rabi*-summer 2022-23. IVT-II was conducted and pooled analysis was done for IVT -I and IVT-II and the test entry, VG 17008 is promoted for AVT testing in zone-IV. Salinity Tolerance Varietal trial was conducted for second year at four locations in Gujarat, Karnataka and West Bengal. However, the trial is repeated as such for third year as experiment failed in three centres.

During *Kharif* 2022, under IVT-I (Spanish), 12 entries were tested at 29 centers along with check varieties in all the five zones. Two entries (TCGS 1798 and J 111) were promoted to AVT-I in zone-I, seven entries (J 116, Dh 293, J 111, VG 20001, TCGS 1798 and ICDh 181030) were promoted to AVT-I in zone-II and seven entries (ICDh 181030, J 116, Dh 293, VG 20001, ICRG 20-113, TCGS 1798 and VG 20002) were promoted to AVT-I in zone-IV. Similarly, in IVT-I (Virginia), 8 entries were tested at 23 centers along with check varieties in all four zones. Two entries (RG 628 and RG 624) were promoted to AVT-I in zone-I. Drought tolerance screening trial and early maturity screening trial were conducted in four and five centers, respectively, and will be repeated in Kharif 2023. Under IVT-II (Spanish), the pooled analysis of IVT-I and IVT-II, one entry (VG 17008) was promoted to AVT in zone-IV and two entries (TVG 17204 and JL 1291) were promoted to AVT in zone-II. In case of IVT-II (Virginia), the pooled analysis of IVT-I and IVT-II, three entries (RG 648, RG 575 and NRCGCS 637) were promoted to AVT in zone-I. Under special trials like Large Seed Varietal Trial-II, one entry (CGL-23) was promoted to AVT; High-Oleic Varietal Trial-II (Spanish), two entries (ICGV 171025 and ICGV 181023) were promoted to AVT; and High-Oleic Varietal Trial-II (Virginia), one entry (ICGV 181035) was promoted to AVT. From AVT (Spanish) trial, two entries each were recommended for identification in zone-II (VG 19721 and J 108) and zone-IV (VG 19721 and TCGS 1707). Similarly, from AVT (Virginia) trial, one entry (VG 19535) was recommended for identification in zone-I.

1.5. Status of Groundnut Breeder Seed Production 2022-23

A total breeder seed production target of 8732.40q was assigned for 60 groundnut varieties to 23 centres. During *Kharif* 2022, a total quantity of 3048.44q breeder seed was produced. To mitigate the short fall, a compensatory programme was undertaken during *rabi*-summer 2022-23 and the anticipated production is about 6964.70q.

II. Crop Production

A. Agronomy

a. *Rabi*-summer 2021-22

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

Application of 40 Kg P_2O_5/ha + DGRC recorded higher pod yield of 2609 Kg/ha at Vriddhachalam.

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

Sowing of Phule Unnati in summer on 15th February produced significantly higher pod yield (3499.7 Kg/ha) at Rahuri. While, sowing of Kadiri Chitravathi on 5th May produced significantly higher pod yield (2560 Kg/ha) at Kadiri.

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

The higher pod yield of (2476 Kg/ha) was recorded by incorporating sunhemp 45 days before sowing groundnut along with 75% RDF application at Tindivanam.

b. *Kharif* 2022

1. Identification of groundnut + millet intercropping system for southern zone of Andhra Pradesh

Both at Tirupati and Kadiri, intercropping of groundnut+foxtail millet in 5:3 ratio was found to be superior in attaining higher yield and economics over sole or intercrop cultivation of little millet, fox tail millet and brown top millet.

2. Effects of potash solubilising bacteria and levels of potash on growth, yield, and quality of groundnut

At Durgapura, seed inoculation of potassium solubilizing bacteria (KSB) had significant effect on groundnut yields and monetary returns over control. While at Tirupati, seed inoculation with KSB along with 50%, 75% and 100% RDK had non-significant effect on groundnut yield compared to control.

3. Intensification of rain-fed groundnut production

Better system yields and economics were observed with skipping one row after every two rows of groundnut (30×10 cm^2) and planting with coriander (for vegetable purpose) and harvesting coriander at 30 DAS at Dharwad, Gwalior and Hiriyur. However, at Kadiri, sole crop of groundnut (30×10 cm^2) performed better than other treatments.

B. Front Line Demonstrations (FLDs)

1. *Rabi*-summer 2021-22

- 66 FLDs were allotted in 6 states having 6 groundnut research FLD centers. The states in which FLDs conducted were Gujarat, Karnataka, Maharashtra, Odisha, Puducherry, and Telangana. Five new varieties were demonstrated in improved technologies against nine old ruling varieties under farmers' practice.
- Under Whole Package of practices, pod yield achieved in improved technology is 2708 Kg/ha, while with farmers' practices is 2223 Kg/ha. Yield under improved practice increased by 22% over farmers' practice. Pod yield under improved practices ranged from 12-34 %.

- The average Cost of Cultivation and Gross Marginal Returns (GMR) with Whole Package (WP) in improved practices was Rs.56430/ha and Rs. 157061/ha, respectively, whereas, in farmers practice it was Rs. 55541/ha and Rs. 130619/ha, respectively. There is an increase of 20% in GMR in improved practices over farmers' practices.
- Net returns in improved practice are Rs. 100637/ha compared to Rs. 75077/ha in farmers' practice. There is an increase in Net returns of 34% in improved practices over farmers' practice and additional net returns obtained over farmers' practice is Rs. 25559/ha. BCR in improved practice is 2.85 and in farmers' practice is 2.40.

2. *Kharif* 2022

- 643 FLDs were allotted in 10 states having 23 groundnut research FLD Centers. The FLDs were conducted in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Manipur, Uttar Pradesh, Tamil Nadu and West Bengal. FLDs were conducted in 8 components.

I. Component: Whole package

- A total of 415 FLDs were allotted in 10 states having 15 groundnut research FLD Centers. 15 new varieties were demonstrated in improved technologies against 20 old ruling varieties under farmers' practice.
- Under Whole Package of practices (WP), pod yield achieved in improved technology is 2332 Kg/ha, while with farmers' practices it is 1867 Kg/ha. Yield under improved practice increased by 25% over farmers' practice. Pod yield under improved practices ranged from 6-111%.
- The average Cost of Cultivation and Gross Marginal Returns (GMR) with Whole Package (WP) in improved practices was Rs.51228/ha and Rs. 131936/ha, respectively, whereas, in farmers' practice it was Rs. 47075/ha and Rs. 107045/ha, respectively. There is an increase of 23% in GMR in improved practices over farmers' practices.
- Net returns in improved practice are Rs. 80708/ha compared to Rs. 59970/ha in farmers' practice. There is an increase in Net returns of 35% in improved practices over farmers practice and additional net returns obtained over farmers practice is Rs. 20738/ha. BCR in improved practice is 2.56 and in farmers practice it is 2.24.

ii. Component: Improved variety (IV)

- A total of 118 FLDs were allotted in 4 states having 4 groundnut research FLD centers and implemented 118 FLDs from 4 centers (100 % implementation). 5 new varieties were demonstrated in improved technologies against 4 old ruling varieties under farmers' practice.
- With improved varieties under improved practices, average Pod Yield achieved was 1817 Kg/ha, while under farmers' traditional practices it is 1525 Kg/ha. Yield under improved practice increased by 19 % over farmers' practice. Pod yield under improved practices ranged from 11-38 %.
- The average Cost of Cultivation and Gross Marginal Returns with improved practices was Rs.48083/ha and Rs. 115531/ha, respectively, whereas, in farmers practice it was Rs. 45823/ha and Rs. 97078/ha respectively. There is an increase of 19% in GMR in improved practices over farmers' practices.
- Net returns in improved practice are Rs. 67448/ha compared to Rs. 51256/ha in farmers' practice. There is an Increase in Net returns of 32% in improved practices over farmers' practice and additional net returns obtained over farmers practice is Rs. 16193/ha. BCR in improved practice is 2.40 and in farmers practice it is 2.09.

iii. Component: Improved variety + Gypsum application

- A total of 10 FLDs were allotted to Udaipur center for component demonstration (Improved variety GJG 9 + Gypsum application) and all 10 FLDs have been implemented.
- With improved variety and gypsum application under improved practices, average pod yield achieved was 1720 Kg/ha, while under farmers' traditional practices it is 1365 Kg/ha. Yield under improved practice increased by 26 % over farmers' practice.
- The average Cost of Cultivation and Gross Marginal Returns with improved practices was Rs.51182/ha and Rs. 111477/ha, respectively, whereas, in farmers' practice it was Rs.

40136/ha and Rs. 76317/ha, respectively. There is an increase of 46% in GMR in improved practices over farmers' practices.

- Net returns in improved practice are Rs. 60295/ha compared to Rs. 36181/ha in farmers' practice. There is an increase in Net returns by 70% in improved practices over farmers practice and additional net returns obtained over farmers practice is Rs. 24114/ha. BCR in Improved practice is 2.17 and in farmers practice is 1.92.

iv. Component: Improved variety + calcium and Boron application

- A total of 15 FLDs were allotted to Sultanpur center for component demonstration (improved variety Divya + calcium and boron application) and all 15 FLDs have been implemented.
- With improved variety + calcium and boron application under improved practices, average Pod Yield achieved was 2364 Kg/ha, while under farmers' traditional practices it is 1743 Kg/ha. Yield under improved practice increased by 37 % over farmers' practice
- The average Cost of Cultivation and Gross Marginal Returns with improved practices was Rs.72518/ha and Rs. 141414/ha respectively whereas, in farmers practice it was Rs. 64518/ha and Rs. 105122/ha respectively. There is an increase of 36% in GMR in improved practices over farmer's practices.
- Net returns in improved practice are Rs. 68896/ha compared to Rs. 40604/ha in farmers' practice. There is an Increase in Net returns by 86% in improved practices over farmers practice and additional net returns obtained over farmers practice is Rs. 28292/ha. BCR in Improved practice is 1.95 and in farmers practice is 1.64.

v. Component: Improved variety + seed treatment

- A total of 30 FLDs were allotted to Gorakhpur center for component demonstration (Improved variety Dh 86/ RG 578/ GG 2 + seed treatment) and all 30 FLDs have been implemented.
- With improved variety + seed treatment under improved practices, average Pod Yield achieved was 2391 Kg/ha, while under farmers' traditional practices it is 2022 Kg/ha . Yield under improved practice increased by 18% over farmers' practice. Pod yield under improved practices ranged from 1-27%.
- The average Cost of Cultivation and Gross Marginal Returns with improved practices was Rs.40850/ha and Rs. 154538/ha respectively whereas, in farmers practice it was Rs. 38600/ha and Rs. 131486/ha, respectively. There is an increase of 17% in GMR in improved practices over farmer's practices.
- Net returns in improved practice are Rs. 113688/ha compared to Rs. 92886/ha in farmers' practice. There is an increase in Net returns by 22% in improved practices over farmers practice and additional net returns obtained over farmers' practice is Rs. 20802/ha. BCR in Improved practice is 3.78 and in farmers practice is 3.41.

vi. Component: Improved variety + Integrated weed management (IWM)

- A total of 11 FLDs were allotted to Jhargram center for component demonstration (improved variety TG 51+ IWM) and all 11 FLDs have been implemented.
- With improved variety + IWM under improved practices, average Pod Yield achieved was 2204 Kg/ha, while under farmers' traditional practices it is 1810 Kg/ha. Yield under improved practice increased by 22 % over farmers' practice.
- The average Cost of Cultivation and Gross Marginal Returns with improved practices was Rs.38733/ha and Rs. 99160/ha, respectively, whereas, in farmers practice it was Rs. 34400/ha and Rs. 81454/ha, respectively. There is an increase of 22% in GMR in improved practices over farmers' practices.
- Net returns in improved practice are Rs. 60427/ha compared to Rs. 47054/ha in farmers' practice. There is an increase in net returns by 29% in improved practices over farmers' practice and additional net returns obtained over farmers practice is Rs. 13373/ha. BCR in improved practice is 2.56 and in farmers practice is 2.37.

vii. Component: Integrated Nutrient Management (INM)

- A total of 11 FLDs were allotted to Jhargram center for component demonstration (INM) and all 11 FLDs have been implemented.

- With INM under improved practices, average Pod Yield achieved was 1953 Kg/ha, while under farmers' traditional practices it is 1635 Kg/ha. Yield under improved practice increased by 19 % over farmers' practice.
- The average Cost of Cultivation and Gross Marginal Returns with improved practices was Rs.51319/ha and Rs. 117025/ha, respectively, whereas, in farmers practice it was Rs. 49450/ha and Rs. 98732/ha, respectively. There is an increase of 22% in GMR in improved practices over farmers' practices.
- Net returns in improved practice are Rs. 65707/ha compared to Rs. 49282/ha in farmers' practice. There is an increase in net returns by 33% in improved practices over farmers' practice and additional net returns obtained over farmers practice is Rs. 16424/ha. BCR in improved practice is 2.24 and in farmers practice is 1.98.

viii. Component: Intercropping system (Groundnut: Pigeon pea in 3:1 ratio)

- A total of 9 FLDs were allotted to Junagadh center for component demonstration (Intercropping) and all 9 FLDs have been implemented.
- With intercropping under improved practices, average pod equivalent yield achieved was 3105 Kg/ha, while under farmers' traditional practices (sole groundnut crop) it is 1953 Kg/ha. Yield under improved practice increased by 61 % over farmers' practice.
- The average Cost of Cultivation and Gross Marginal Returns with improved practices was Rs.103017/ha and Rs. 203207/ha, respectively, whereas, in farmers practice it was Rs. 72090/ha and Rs. 130456/ha, respectively. There is an increase of 56% in GMR in improved practices over farmer's practices.
- System net returns in improved practice is Rs. 100190/ha compared to Rs. 58366/ha in farmers' practice. There is an increase in system net returns of 72% in improved practices over farmers practice and additional system net returns obtained over farmers' practice is Rs. 41824/ha. BCR in improved practice is 1.97 and in farmers practice is 1.81.

III. Crop Protection

A. Entomology

1. *Rabi*-summer 2021-22

- The highest incidence of leafhopper (9.0/top 3 leaves), thrips (12.0/terminal bud) and highest per cent leaf damage due to Spodoptera litura (23%) and leaf miner (13.0%) was recorded at Dharwad.
- In recording incidence of natural enemies, highest number of coccinelid (2 /plant) was recorded at Dharwad and Raichur followed by Vriddhachalam (1/plant). Maximum spiders (3/plant) were observed at Dharwad followed by Raichur (2/plant). Parasitisation per cent recorded was highest in Raichur (9%) followed by Dharwad (3%). Natural control by entamopathogenic fungi (5%) and NPV (1%) was recorded only from Dharwad.
- In monitoring of pests using traps, highest Spodoptera moth catch per trap (54 moths per trap) was recorded in 9th Standard meteorological week (SMW) at Dharwad followed by Vriddhachalam (3.0 moths per trap). But, at Raichur, highest moth catch (73.0 moths per trap) was reordered during 5th SMW.
- Highest moth catch for Helicoverpa was recorded during 9th SMW at Dharwad (22 moths per trap). But, at Raichur, highest moth catch recorded during 1st SMW (36 moths per trap).
- Sucking pest incidence was maximum during 7th SMW (Thrips 150 adults per trap) and 10th SMW (Leaf hoppers 42 adults per trap), respectively, at Dharwad.
- Among 33 (stage I) and 62 (Stage II) genotypes screened under natural condition against insects, four genotypes, INS-I-2021-19, 23 and 33 and INS-I-2020-11 recorded least foliage damage per cent for thrips and leafhopper (Scale 1) when compared to susceptible check TAG 24 (Scale 6) at Dharwad. The genotype, AIS-2021-1 recorded least per cent foliage damage for *Spodoptera* (Scale 2) when compared to check TMV 2 (Scale 7) at Raichur.
- In yield loss estimation studies against insects, pod yield loss of 42.0% and haulm yield loss of 43.0% was recorded due to sucking pests and defoliators at Dharwad. Similarly, at Raichur,

there was loss of 34.0% and 18.0% loss in pod and haulm yield, respectively, due to defoliators (40.0%). At Vriddhachalam, there was loss of 25.0% in pod yield and 19.0% loss in haulm yield recorded due to defoliator insects (23.0%).

2. *Kharif* 2022

- As per the survey in farmers' field and research station during *Kharif*, 2022, 76 % to 100 % (9 grade) foliage damage was recorded by Spodoptera at 90 DAS in Dharwad followed by Vriddhachalam with 60 per cent damage, whereas, 30 per cent foliage damage was recorded at Latur and Raichur. Highest foliage damage of Helicoverpa (26 %) was recorded in Latur followed by Dharwad (18%). Highest incidence of leaf miner (30%) was recorded at Vriddhachalam followed by Raichur (20 %), Latur (10%) and Dharwad (3%). Among sucking pests, thrips and leafhopper foliage damage was highest at Dharwad (30%), Latur and Vriddhachalam (20%) and Raichur (10%).
- Highest number of natural enemies viz., coccinelid (9 no. /plant) were recorded at Dharwad followed by Latur (6 no./plant), Raichur (2 no./plant) and Vriddhachalam (1 no./plant). Highest spiders (3 no./plant) were observed at Dharwad and Latur. Highest parasitisation per cent was recorded in Latur (18%) followed by Raichur (9%) and Dharwad (6%). Highest natural control by entamopathogenic fungi (42%) and NPV (6%) was recorded only from Dharwad.
- In monitoring of sucking pests and defoliators using traps, highest trap catch of Spodoptera (387 moths/trap) during 33rd MSW was recorded at Dharwad followed by Raichur (85 moths/trap) at 46th MSW and Latur (65 moths/trap) at 36th MSW. Helicoverpa trap catches were recorded highest at Dharwad (34 moths/trap) during 33rd MSW followed by Raichur (30 moths/trap) and Latur (22.0 moths/trap) at 37th MSW. Leaf miner population was highest at Raichur (5 moths/trap) at 36th MSW followed by Dharwad (4 moths/trap) at 30th MSW and in Latur (3 moths/trap) at 32nd MSW. Among sucking pests, highest leafhopper incidence was recorded in Dharwad (88 adults/trap) during 31st MSW followed by Latur (21 adults/trap) at 35th MSW. Thrips incidence was highest in Dharwad (44 adults/trap) at 31st MSW followed by Latur (13.0adults/trap) at 33rd MSW.
- In screening of genotypes against insects under natural conditions, for Spodoptera, twelve genotypes viz., ISK 2022-12,22 (2), IS 2022-33 (1), IVK 2022-1,3 (2), AVTVG 2022-1 (2), IVK-I-2021-14 (2), HOVTSB-I-2021-4 (2), AHOVTSB-2021-3, 4, 6, 7 (2) were found promising with 1-2 scale when compared to susceptible check JL 24 with 8 grades at Dharwad. At Raichur, four genotypes viz., IVK-2022-5, 17, 18 and ALSVT-2022-3 were recorded in 1-3 grade against grade of 7.0 on susceptible check TMV 2 for Spodoptera.
- For thrips, fourteen genotypes viz., HOVTVG –I-2021-2, 4, HOVTSB-I-2021-1, LSVT-I-2021-9, AVK 2021-1, IVK-I-2021-1, 4, 5, 9, 14, 16 and ISK-I-2021-1, 9, 12 were recorded with 2 grade against highest grade of 7 on susceptible check JL 24 for thrips at Latur. Similarly, fifteen genotypes (ISK-I-2022-19, 21, IVK-I-2022-1, 3,8,10, 11 and 18, AVT SB-I-2022-10 (2.91%), AVTSB-I-2022-2 (3.90%), AVTSB-I-2022-11(3.23%), and AVTSB-I-2022-12(3.47%), IVK-I-2021-10, ISK-I-2021-26 and IVK-I-2021-24 scored 1-2 scale against highest damage on susceptible check VRI2 with 7 scale at Vriddhachalam.
- In yield loss estimation studies against Spodoptera, at Vriddhachalam, 22.0% pod yield loss and 19.0 % haulm yield loss was recorded in unprotected plots with highest foliage damage of 26.1% when compared to protected plot with 17.0 % foliage damage. At Raichur, pod yield loss of 36.0 % and haulm yield loss of 22.0 % recorded in unprotected plot with high foliage damage of 42.0 % when compared to protected plot with 2.3 % foliage damage. But at Dharwad, hundred per cent loss was recorded in both pod and haulm yield due to sucking pests and defoliators in unprotected plot.

B. Plant Pathology

1. *Rabi*-summer 2021-22

- Survey in farmers' fields and research station, among foliar diseases, high intensity (4.0 scale) of early leaf spot (ELS) recorded at Kadiri and

Dharwad. High intensity of late leaf spot (9.0 scale) recorded at Vriddhachalam and Dharwad. High rust intensity (7.0 scale) recorded at Aliyarnagar and Dharwad. Highest incidence of collar rot (15.0%) recorded at Pavagada followed by Vriddhachalam. Stem rot incidence ranged from 4.0 to 22.0% at different centres and highest incidence recorded at Jalgaon. Highest incidence of dry root rot (19.0%) at Raichur. Highest peanut bud necrosis disease (PBND) incidence (32.0%) recorded at Raichur.

- Among 33 genotypes (Stage I) screened under natural conditions in different centres, eleven genotypes (INS-I-2021-1, 2, 7, 9, 18, 19, 21, 30, 31, 32; AIS-I-2021-5) recorded resistant reaction for LLS disease. Four genotypes (INS-I-2021-1; 31 and 9; AIS-I-2021-6 recorded resistant reaction against stem rot disease. Similarly, two genotypes (INS-I-2021-19; AIS-I-2021-6) recorded resistant reaction against dry root rot disease. Three genotypes viz., INS-I-2021-21, 30, 31 rerecord resistant reaction against PBND.
- Among fifty-three genotypes (Stage II) screened under natural conditions, one genotype (RST-I-2020-12) recorded resistant reaction against LLS. Similarly, four genotypes (INS-I-2020-9; AIS-I-2020-7; RST-I-2020-3, 12) recorded resistant reaction against stem rot disease.
- In a random survey conducted in farmers' fields over rabi 2017-18 to 2021-2022, to know the relationship between thrips species, incidence of peanut bud necrosis disease (PBND) and different types of weeds and their density, incidence of PBND ranged from 8.0- 9.0% at Kadiri, 13.0-22.0% at Pavagada and 23.0-27.0% at Raichur. Thrips no/plant ranged from 4.0 to 49 and 9.0 to 47.0 on foliage and flower, respectively. Predominant weeds identified with PBND symptoms were *Parthenium hysterophorus, Acanthospermum hispidum, Amarathus viridis* and *Ocimum canum*. Weed density was high at vegetative stage.
- In estimation of yield losses due to soil borne diseases (Stem rot and dry root rot) in different centres, per cent avoidable pod yield loss ranged from 15.0 to 21.0% and haulm yield loss of 10.0 to 30.0%.
- In estimation of yield losses due to foliar diseases (ELS, LLS and rust), per cent avoidable pod yield loss ranged from 24.0 to 51.0% and haulm yield loss ranged from 25.0 to 66.0% among different centres.

2. *Kharif* 2022

- Survey in farmers' fixed field plots, high intensity of early leaf spot (ELS) (6.0 scale) and late leaf spot (9.0 scale) and rust (7.0 scale) recorded at Kadiri, Raichur and Junagadh, respectively. Highest incidence of collar rot (20.0 %) was recorded at Bikaner. Highest incidence of stem rot (33.0 %) and dry root rot (21.0 %) was recorded at Dharwad and Raichur, respectively. Highest incidence of viral diseases viz., peanut bud necrosis disease recorded at Raichur (32.0%) and peanut stem necrosis disease at Kadiri (10.0%).
- In study of correlation relationship between foliar diseases and weather parameters, rainfall, rainy days and temperature minimum were negatively correlated at seven centres. Whereas, temperature (C0) (Maximum), relative humidity morning and evening and bright sunshine hours were positively correlated at four centres.
- Among sixty-three genotypes (Stage I) screened under natural conditions at different centres, twenty-five genotypes were recorded resistant reaction (<3.0 scale) for LLS and fifteen genotypes recorded resistant reaction (<5.0 %) against stem rot. Twenty-four genotypes recorded resistant reaction (<5.0 %) for PBND.
- Among eighty-six genotypes (Stage II) screened under natural conditions, one genotype (HOVTSB-I-2021-5) recorded resistant reaction (<3.0 scale) against LLS at Junagadh. Similarly, three genotypes (HOVTSB-I-2021-5, 16 and 17) recorded resistant reaction (<5.0 %) against dry root rot disease. Two genotypes, HOVTSB-I-2021-16 and 17 recorded resistant reaction (<5.0 %) against stem rot disease.
- Nine genotypes viz., KDG128, GJG32, Dh 294, Dh 254, JL1085, GPBD 4, Dh 256, RHRG 6083, ICGV00350 recorded resistant reaction against LLS (<3.0 scale) under high disease pressure.

- Six genotypes, KDG123, KDG128, HNG69, GJG32, HNG10 and JL-1085, recorded resistant reaction (<5.0 %) against stem rot disease under sick plot conditions. Similarly, four genotypes, VG 19802, VG 19803, VG 19817 and VG 103, recorded resistant reaction (<5.0 %) against dry root rot disease under sick plot condition.
- Six genotypes, Dh-256, GPBD4, HNG 69, IGJG 32, KDG123 and ICGV 00350, recorded resistant reaction for PBND against highest incidence of 28.5% of PBND on susceptible check TMV2.
- Recommendation: In estimation of yield losses due to soil borne diseases of groundnut (collar rot, stem rot, dry root rot) in different centres over three *Kharif* 2020, 2021 and 2022, per cent avoidable yield loss of 36.0% and 37.0% in pod and haulm yield respectively due to stem rot and dry root rot diseases at Kadiri; with 39.0% and 30.0% loss of pod and haulm yield due to stem rot disease at Junagadh, respectively; with 24.0 % and 22.0% loss in pod and haulm yield due to stem rot disease at Dharwad, respectively; with 25 % and 22.0% loss in pod and haulm yield due to dry root rot disease at Vriddhachalam, respectively; with 24.0% and 33.0% loss in pod and haulm due to Stem rot at Raichur, respectively; with 24.0% and 22.0% loss in pod and haulm yield due to collar rot disease at Bikaner, respectively.
- In estimation of yield losses due to foliar diseases (LLS and rust) during Kharif, 2022 at different centres, per cent avoidable pod yield loss ranged from 25.0% to 58.0% and haulm yield loss of 24.0% to 46.0% with maximum reduction of 71.0% LLS at Dharwad and Raichur, and 65.0% reduction at Dharwad.
- Recommendation: In bio-intensive management of collar rot disease of groundnut for *Kharif*, 2021 and 2022, there was 68.2 % reduction in collar rot at 20 DAS with 33.0 % and 24.0 % increase in pod and haulm yield, respectively, at Bikaner with high ICBR of 20; with 53.0 % reduction in collar rot and 29.0 % and 32.0 % increase in pod and haulm yield, respectively, with high ICBR of 5.0 at Vriddhachalam were recorded by adopting integrated bio-intensive practices viz., deep summer ploughing with mould board plough + soil application of *Trichoderma* @ 4 Kg/ ha enriched in 250 Kg FYM /ha + seed treatment with Tebuconazole 2DS @ 1.5 g/ Kg of seed followed by seed treatment with PGPR @ 625 g/ ha of seed + soil application of Trichoderma@ 4 Kg/ ha enriched in 250 Kg FYM /ha at 35 and 80 DAS.
- Recommendation: After three years of experimentation (2019, 2020, 2021) on storage of groundnut pods using different types of storage bags against bruchid infestation at Kadiri, Dharwad, Vriddhachalam, Jalgaon, Aliyarnagar, Raichur and Bikaner, PICS (Purdue Improved Crop Storage) bag was found most efficient with high mean germination per cent of 84.0 % (after 3 months of storage), 71.0 % (after 6 months) and 60.0 % (after 8 months) without bruchid release in bags at different centres. With bruchid release also, PICS bag recorded highest mean germination per cent of 81.0 % (3 months after storage), 64.0 % (6 months) and 52.0 % (8 months). The next best bag for storage was HDPE (High Density Polyethylene) bag with mean germination per cent of 81.0 %, 66.0 % and 52.0 % at 3, 6 and 8 months after storage, respectively, without release of bruchid across locations and with release of bruchids, mean germination per cent varied from 79.0 %, 60.0 % and 45.0 % at 3,6 and 8 months after storage, respectively.
- Lowest mean number of bruchid/250 g of pods was recorded in PICS bag with 1 no., 3 no. and 4 no. of bruchid adults at 3, 6 and 8 months after storage, respectively, without release of bruchids. Similarly, least mean number of bruchid no./250 g of pod was observed with release of bruchid in PICS bag with 2 no., 5 no. and 10 no. of bruchid/250 g pod at 3, 6 and 8 months after storage, respectively. The next best bag with less mean bruchid/250 g of pods was HDPE bag with 2 no., 4 no and 7 no. of bruchid/250 g pod at 3, 6 and 8 months after storage, respectively, without bruchid release and with release of bruchid it recorded 4 no., 7 no. and 16 no. bruchid/250 g pod at 3, 6 and 8 months after storage, respectively.
- Lowest mean damaged pods/250 g pods were recorded with PICS bag with 0.2 no., 2 no. and 3 no. damaged pods/250 g pod at 3, 6 and 8 months after storage, respectively, without

release of bruchid and 2 no., 7 no. and 13 no. damaged pods/250 g pod at 3, 6 and 8 months after storage, respectively, with release of bruchid. Next best bag with less damaged pods/250 g of pod was HDPE bag with 1 no., 5 no. and 7 no. damaged pods/250 g at 3, 6 and 8 months after storage, respectively, with release of bruchid and 3 no, 10 no. and 18 no. damaged pods with release bruchid at 3, 6 and 8 months after storage, respectively.

- Gunny bag recorded very poor mean germination of pods (79.0%, 61.0% and 46.0%) at 3, 6 and 8 months after storage, respectively, without bruchid release and germination per cent varied from 78.0%, 50.0% and 30.0% at 3, 6 and 8 months after storage, respectively, with bruchid release. Gunny bag recorded very high mean population of bruchid adults/250 g of pod (25.0 no) and high mean damaged pods (39.0) at 8 months after storage.
- However, cost of PICS bag was high (Rs.150/50 Kg capacity bag) followed by HDPE bag (Rs. 35/50 Kg capacity bag). Hence, HDPE bag can be recommended for storage of pods as they are cost effective.
- **Recommendation:** In bio-intensive pest management studies in groundnut for *Kharif*, 2021 and 2022, upon testing of bio-intensive (T1: border crop with 4 rows of jowar+ use of resistant/tolerant variety + 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 (2 %) 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+ Trap crops viz., castor and cowpea and marigold; chemical management module (T2: use of resistant/tolerant variety + seed treatment with carbendazim 50% + mancozeb 25% WS @ 3 g/Kg seed + need based foliar spray of imidacloprid 17.8 SL @ 150 ml/ha at 20-30 DAS + need based foliar spray of rynaxypyr 20 EC @ 150 ml/ha for defoliator at 40 and 60 DAS + need based foliar spray of tebuconazole 25.9 EC @ 1.0 ml/L at 50-70 DAS).
- The chemical management practices (T2) were found significant in reduction of foliar diseases (ELS/LLS/rust) at Kadiri (14.0% PDI of ELS), Junagadh (3.0-4.0% PDI of LLS and rust), Dharwad (20.0% PDI of Rust), Jalgaon (36.0% PDI). But, bio-intensive management (T1) was found significant at Vriddhachalam (58.0% PDI) and Raichur (23.0% PDI).
- Reduction of dry root rot disease was non-significant between T1 and T2 at Kadiri, Junagadh, and Raichur but chemical management (T2) was found significant in reduction of dry root rot at Vriddhachalam (8.7%).
- Similarly, reduction of stem rot was non-significant between T1 and T2 at Dharwad, Jalgaon and Raichur but T2 (chemical management) was significant at Kadiri (9.7%), Junagadh (5.0%) and Vriddhachalam (11.0%).
- Significant reduction of thrips damage was obtained with T2 (chemical management) at Kadiri (4.0%) and Dharwad (4.0%) but T1 (Bio-intensive) was significant at Vriddhachalam (16.0%) but T1 and T2 were non-significant at Junagadh and Raichur.
- Similarly, significant reduction of jassid damage was obtained with T2 (Chemical management) at Dharwad (1.0%) and Jalgaon (8.0%).
- There was non-significant in reduction of Helicoverpa damage at Dharwad between T1 and T2 but T1 was significant at Raichur (8.0%).
- Chemical management (T2) was significant in reduction of Spodoptera damage at Kadiri (4.0%), Jalgaon (14.0%), Dharwad (1.5%) but T1 was significant at Vriddhachalam (18.0%).
- Chemical management (T1) was found significant with high pod yield (1590 Kg/ha) at Kadiri with high BCR of 4.4; Junagadh (2679 Kg/ha) with high BCR of 36.6; Dharwad (2810 Kg/ha); Jalgaon (1856 Kg/ha) with high BCR of 2.2: Bio intensive management (T2) was found significant at Vriddhachalam with high pod yield of 2022 Kg/ha with BCR of 1.4 and Raichur (2855 Kg/ha) with BCR of 1.3.

5 Externally Funded projects

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. 4.0 lakh (2023-24 till Feb, 2024)

Summary

Seed production of groundnut varieties released by ICAR-DGR was done under AICRP on Seeds-QSP component during kharif 2023. Nucleus seed of about 72.75 q and 28.75 q was produced for Girnar 4 and Girnar 5, respectively. Besides, breeder seed of about 2313 q and 421 q was obtained for Girnar 4 and Girnar 5, respectively during Kharif 2023 from the production after grading till Feb 2024. A total grant of Rs.4.0 lakh was received till February 2023 under this project during the FY 2023-24, while about Rs.55.89 lakh was accrued as profit (till Feb. 2024). Under HRD component 2 trainings and one field day was organized during 2023-24 as follows.

1) One day "Farmers orientation cum Training programme on High oleate groundnut seed production" at ICAR-Directorate of Groundnut Research, Junagadh on 13.01.2023.

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

2) One day "Farmers orientation cum Training programme on seed production techniques for High oleate groundnut" at ICAR-Directorate of Groundnut Research, Junagadh on 20.03.2023.
3) Farmers' field day programme on High oleate groundnut cultivation on 20.09.2023 at Dhebar village, Visavadar Taluk, Junagadh.

Farmers' field day programme on High oleate groundnut cultivation on 20.09.2023 at Dhebar village

Project Title:

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

Principal Investigator: *Dr. Sandip Kumar Bera*
Co-PI: *Dr. Kirti Rani*
Total Sanctioned: 40,72,356 (INR)
Start Date of the project: 28 Jan, 2022
End Date of the project: 27 Jan, 2025
Funding body: DST-SERB

Research Achievements:

The seeds of both male and female parents have been collected and planted in hybridization blocks as per proposed 10 crosses mentioned in the proposal. Plants were grown following recommended agronomic practices for a healthy crop. Emasculation of individual flower was done manually in the previous day evening and pollination of individual emasculated flower was done with desired pollen from male parent in the next day morning. Number of flowers were pollinated ranging from 21-249 in 10 different crosses combination as per availability of flower buds. Cross pods (F1s) ranging from 5-86 were harvested in 10 different crosses. Putative hybrid seeds, 363 in number from 10 crosses and their parents were planted in field conditions during next crop season and 260 putative hybrid seeds germinated. Genotyping of 260 F1 plants from 10 crosses for presence of ahFAD2a and ahFAD2b mutant alleles have been completed and a total of 20 confirmed F1 plants were identified (Details of number of pollination made, putative cross seeds harvested, number of F1 plants genotyped with ahFAD2a, ahFAD2b alleles and number of confirmed F1 plants identified are mentioned in Table 1). First back crossing of recurring parents with their F1 plants containing both ahFAD2a and ahFAD2b mutant alleles are in progress.

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

Centre PI: *Harish G*

Centre Co-PI: *Ananth Kurella and Nataraja 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.

In Junagadh organic groundnut is produced in an area of around 63 ha. Fourteen farmers are having authentic certificate issued for farmers practicing organic agricultural methods by State Government body ie., Gujarat Organic Products Certification Agency (GOPCA). Farmers belonging to Amarapur, Junagadh, Alidhra (2), Janadi, Jonpur, Rupavati (Ishvariya), Ranidhar (Amarapur), Vadiya (2), Galodar, Khumbhadi and Agatray are involved in organic groundnut cultivation. Insects pests like thirps, Leafhoppers, Spodoptera and Helecoverpa damage groundnut crop during Kharif season. Natural enemies like lady bird beetle, spiders are also common seen in groundnut.

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

PI & Co-PI: *K K Pal & Rinku Dey*

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

- To decipher the mechanism of osmotolerance of Aspergillus sydowii BF5, which is capable of growing at 0-35% of NaCl, the alternate route of carbon gains for growth, multiplication and survival was found as the known mechanisms of salt tolerance was absent. Linearity in expression of the genes linked to alternate route of carbon gain was established across the domain of like (archaea-eubacteria-fungi).
- For validation of the expression of genes involved in alternate route of carbon gain and genes of serine-glyoxylate cycle, gene specific primers were used keeping 18S rRNA gene as reference. The expression of 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) was confirmed. The other genes involved viz. biocarbonate transporter (BicA), phosphoenolpyruvate orthophosphate dikinase (PPDK), and phosphoserine phosphatase (PsP) in the cycles were also confirmed and validated.
- While expression of BicA, PPDK, and PsP were 6.71, 4.21 and 5.58 folds higher respectively at 30% of NaCl in growth medium as compared to 0% NaCl, it was 3.79, 2.81 and 3.46 folds higher, respectively, for BicA, PPDK and PsP, respectively, at 15% NaCl in the growth medium.

6 Publications

Research articles

1. Ajay, B. C., Kumar, N., Kona, P., Gangadhar, K., Rani, K., Rajanna, G. A., & Bera, S. K. (2023). Integrating data from asymmetric multi-models can identify drought-resistant groundnut genotypes for drought hot-spot locations. Scientific Reports, 13, 12705.

   https://doi.org/10.1038/s41598-023-38581-0

2. Gangadhara, K., Ajay, B. C., Kona, P., Rani, K., Kumar, N., & Bera, S. K. (2023). Performance of some early-maturing groundnut (Arachis hypogaea L.) genotypes and selection of high-yielding genotypes in the potato-fallow system. PLoS ONE, 18(4), e0282438.

   https://doi.org/10.1371/journal.pone.0282438

3. Sanyal, R., Pradhan, B., Jawed, D. M., Tribhuvan, K. U., Dahuja, A., Kumar, M., Kumar, N., Mishra, G. P., Ram, C., Mahatma, M. K., Singh, B. K., Mangrauthia, S. K., Singh, A. K., Sharma, T. R., Pattanayak, A., & Bishi, S. K. (2023). Spatio-temporal expression pattern of Raffinose Synthase genes determine the levels of Raffinose Family Oligosaccharides in peanut (Arachis hypogaea L.) seed. Scientific Reports, 13, 795.

   https://doi.org/10.1038/s41598-023-27890-z

4. Singh, S., Singh, A. L., Pal, K. K., Reddy, K. K., Gangadhara, K., Dey, R., Mahatama, M. K., Verma, A., Kumar, N., Patel, C. B., Thawait, L. K., Ahmed, S., Navapara, R., Rani, K., & Kona, P. (2023). Accumulation of resveratrol, ferulic acid and iron in seeds confer iron deficiency chlorosis tolerance to a novel genetic stock of peanut (Arachis hypogaea L.) grown in calcareous soils. Physiology and Molecular Biology of Plants.

   https://doi.org/10.1007/s12298-023-01321-9

5. Singh, A. L., Singh, S., Chaudhari, V., Patel, C. B., Chakraborty, K., Thawait, L. K., & Mahatma, M. K. (2023). Zinc-Sulphate and Zn-EDTA Enhances Zn and Other Nutrients and Yield and Quality of Table-Purpose Peanut Cultivars. Communications in Soil Science and Plant Analysis, 54(13), 1806-1815.

   https://doi.org/10.1080/00103624.2023.2211098

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   https://doi.org/10.1007/s12298-023-01332-6

7. Ajay, B. C., Kumar, N., Kona, P., Gangadhar, K., Rani, K., Rajanna, G. A., & Bera, S. K. (2023). Integrating data from asymmetric multi models can identify drought resistant groundnut genotypes for drought hot spot locations. Scientific Reports, 13:1270.

   https://doi.org/10.1038/s41598-023-38581-0

8. Rani, K., Ajay, B. C., Bera, S. K., Mahatma, M. K., Singh, S., Gangadhara, K., Rathnakumar, A. L., Kona, P., Kumar, N., & Rajanna, G. A. (2023). Genetic exploration of variability and environmental influence on yield, components, and nutritional properties among groundnut germplasm originated from different countries for identification of potential stable donors. Genetic Resources and Crop Evolution. https://doi.org/10.1007 /s10722-023-01761-y

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11. Nathawat, B. D. S., Kumar, D., Choudhary, R. R., & Yadav, R. K. (2023). Survey of Collar Rot Disease Incidence of Groundnut (Arachis hypogaea L.) in Hyper Arid, Partially Irrigated, North-western plain zone (IC) of Rajasthan. Annals of Agricultural Research. New Series, 44(4), 57-60.

12. Kona, P., Ajay, B. C., Gangadhara, K., Kumar, N., Choudhary, R. R., Mahatma, M. K., Singh, S., Reddy, K. K., Bera, S. K., Sangh, C., Rani, K., Chavada, Z., & Solanki, K. D. (2024). AMMI and GGE Biplot Analysis of Genotype by Environment Interaction for Yield and Yield contributing traits in Confectionery Groundnut. Scientific Reports, 4, 2943.

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Book chapters

1. Yadav, S.K., Babu, S., Singh, R., Yadav, D., & Rajanna, G.A. (2023). The role of organic and natural ecosystems in the food industry. In R. Accorsi & R. Bhat (Eds.), Sustainable Development and Pathways for Food Ecosystems (pp. 115-128). Academic Press. https://doi.org/10.1016/ B978-0-323-90885-6.00007-7
2. Praveen, B.R., Sannagoudar, M.S., Babu, R.T.C., Rajanna, G.A., Singh, M., Kumar, S., Kumar, R., & Wasnik, V.K. (2023). Sustainable Use of Paddy Straw as Livestock Feed: A Climate Resilient Approach to Crop Residue

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3. Sannagoudar, M.S., Kumar, G.K.P., Khandibagur, V., Ghosh, A., Singh, A.K., Rajanna, G.A., Halli, H.M., Wasnik, V.K., Praveen, B.R., & Babu, R.T.C. (2023). Potentials and Opportunities of Agroforestry Under Climate Change Scenario. In R.K. Singhal, S. Ahmed, S. Pandey, & S. Chand (Eds.), Molecular Interventions for Developing Climate-Smart Crops: A Forage Perspective. Springer, Singapore. https://doi.org/10.1007/978-981-99-1858-4_9

4. Das, A., Dutta, A., Kumar, N., Nath, C.P., Hazra, K.K., & Praharaj, C.S. (2023). Foliar nutrition of pulses under rainfed condition (Chapter 12). In N. Kumar, C.P. Nath, U. Sah, C.S. Praharaj, & N.P. Singh (Eds.), Sustainable production of pulses in diverse Agro-ecosystems (Vol. 2, pp. 185-200). Scientific Publishers.

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6. Narendra, K., Nath, C.P., Praharaj, C.S., Hazra, K.K., & Dutta, A. (2023). Technological interventions for enhancing pulses production under rice fallows in India (Chapter 15). In N. Kumar, C.P. Nath, U. Sah, C.S. Praharaj, & N.P. Singh (Eds.), Sustainable Production of Pulses in Diverse Agro-ecosystems (Vol. 1, pp. 261-273). Scientific Publishers.

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1. Kumar, N., Nath, C.P., Sah, U., Praharaj, C.S., & Singh, N.P. (Eds.). (2023). Sustainable Production of Pulses in Diverse Agro-ecosystems, Vol. 1: Strategies for Enhancing Production. Scientific Publishers.

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3. Nanwal, R.K., & Rajanna, G.A. (2023). Rainfed Agriculture. CRC Press, New India Publishing Agency. https://doi.org/10.4324/9781003364917

Technical bulletins/ Manual/ Folders/ Popular articles

1. Kona, P., Bera, S. K., Maheshala, N. V., Mohan, C., Ajay, B. C., Kumar, N., Chavada, P. Z., & Solanki, K. (2023). High oleic groundnut varieties released in India. DGR/PME/PF/01-2023(E)(H)(G).
2. Kona, P., Reddy, K. K., & Bera, S. K. (2023). Drone technology use in groundnut at ICAR-DGR. DGR/PME/PF/04-2023.
3. Patel, J. B., Babariya, C. A., Kona, P., & Bera, S. K. (2023). Success of seed hub project on creation of seed hubs for enhancing quality seeds availability of major oilseeds crops-Groundnut at JAU, Junagadh. DGR/PME/PF/02-2023.
4. Punia, M., Rolaniya, L. K., Kumar, S., Jat, R. L., & Choudhary, R. R. (2023). Revolutionizing Plant Breeding with Grafting and Mobile CRISPR: A New Era in Genome Editing. Eco-farming (e-Magazine), 03(04), 384-388.
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12. Maheshala, N., Harish, G., Kurella, A., Padvi, R., & Chavda, H. (2022). Severe incidence of wheat root aphids in black calcareous soils of Junagadh, Gujarat. DGR Newsletter, XXI (2), 2.
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Extended Summaries/Abstracts Published in Symposia/Conferences

1. Praharaj, C. S., Reddy, K., Pal, K. K., & Hirapara, K. (2023). Bridging the yield gap of groundnut (Arachis hypogaea L.) through augmented integrated crop management practices (ICMP). In Proceedings of National Symposium on "Climate Smart Agronomy for Resilient Production Systems and Livelihood Security" (pp. 22-24). CCARI Goa.
2. Praharaj, C. S., Reddy, K., Kumar, N., Singh, U., Nath, C. P., Dutta, A., Hazra, K. K., Singh, R., Kancheti, M., & Kumar, S. (2023). Achieving sustainability in production in India through tech-innovations is crucial in realizing self-reliance in the pulses sector. International Conference on Pulses: Smart crop for agricultural sustainability and nutritional security, p. 256 (S3.18). NASC, New Delhi.
3. Nath, C. P., Kumar, N., Hazra, K. K., Dutta, A., Singh, R., Praharaj, C. S., Singh, S. S., & Hashim, M. (2023). Conservation agriculture and efficient weed management in rice-chickpea cropping system for intensification of rice fallows. International Conference on Pulses: Smart crop for agricultural sustainability and nutritional security, p. 288 (S3.50). NASC, New Delhi.
4. Nath, C. P., Kumar, N., Hazra, K. K., Dutta, A., Singh, R., Praharaj, C. S., & Singh, S. S. (2023). Post-emergence herbicide tolerance in pulse crops: A new dimension in weed management. International Conference on Pulses: Smart crop for agricultural sustainability and nutritional security, p. 291 (S3.53). NASC, New Delhi.
5. Singh, R., Praharaj, C. S., Kumar, N., Nath, C. P., & Dutta, A. (2023). Conservation tillage integrated with sprinkler-based irrigation scheduling could enhance productivity and farm income in fieldpea under resource constraints. International Conference on Pulses: Smart crop for agricultural sustainability and nutritional security, p. 287 (S3.49). NASC, New Delhi.
6. Singh, R., Praharaj, C. S., Kumar, N., Nath, C. P., Dutta, A., Shakya, R. P., & Babu, S. (2023). Effect of conservation tillage and precision irrigation scheduling on productivity and resource use efficiency in fieldpea. In Proceedings of National Symposium on "Climate Smart Agronomy for Resilient Production Systems and Livelihood Security" (pp. 184-185). CCARI Goa.
7. Singh, U., Dev, P., Choudhary, R., Kumar, M., & Praharaj, C. S. (2023). Biofortified pulses: An option to alleviate dual problem of hidden hunger and nutritional insecurity. International Conference on Pulses: Smart crop for agricultural sustainability and nutritional security, p. 362 (S8.18). NASC, New Delhi.

Lead/Invited Paper Published in Symposia/Conferences

1. Bera, S. K., & Praharaj, C. S. (2023). Attaining self-sufficiency in edible oils in India: Research strategies for groundnut. In Souvenir of "International Conference on Vegetable Oils (ICVO 2023): Research, Trade, Value Chain and Policy" (pp. 28-33). ICAR, ISOR and IIOR, Hyderabad, India.
2. Praharaj, C. S., Kumar, N., Nath, C. P., Singh, U., & Shivay, Y. S. (2023). Pulses and oilseeds as the climate and nutrition smart crops. In Proceedings of National Symposium on "Climate Smart Agronomy for Resilient Production Systems and Livelihood Security." CCARI Goa. (Lead Lecture published).
3. Verma, P., & Praharaj, C. S. (2023). Postharvest technology and value addition in pulses. In Proceedings of National Symposium on "Climate Smart Agronomy for Resilient Production Systems and Livelihood Security." CCARI Goa. (Lead Lecture published).

7 Work Plan 2023

Programme 1: Crop Improvement

- **Development of Groundnut Production technologies for arid region of Rajasthan**

  (Narendra Kumar, Rajaram Choudhary, BDS Nathawat)

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

  (Ajay BC, Praveen Kona, Rajanna GA, KK Reddy, Sushmita Singh)

- **Breeding groundnut for earliness, fresh seed dormancy and confectionary types**

  (Praveen Kona, Narendra Kumar, Chandramohan S)

- **Genetic enhancement of groundnut through genome editing and molecular approaches**

  (Chandramohan S, SK Bera)

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

  [Sushmita Singh, Rinku Dey, KK Pal (left on 30.06.2023), KK Reddy, GA Rajanna, Rajaram Choudhary]

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

  (SK Bera, Narendra Kumar, Chandramohan S, Ajay BC)

Programme 2: Crop Production

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

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

- **Salinity and heat stress in groundnut: basis of tolerance and mechanism**

  [KK Pal (left on 30.06.2023), Rinku Dey, Kiran K Reddy, Sushmita Singh, Praveen Kona, Rajaram Choudhary]

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

  (Rinku Dey, Chandramohan Sangh, Narendra Kumar, Rajaram Choudhary)

Programme 3: Crop Protection

- **Studies on white grub and bruchid beetle and their management 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, Harish G

8 Training and Capacity Building

Trainings/ workshops/ field days organized:

Dr. C. S. Praharaj organized

- A village adoption programme as "PEANUT VILLAGE" on 12.07.2023 at "MITHAPUR" (Gram Panchayat Mithaapur) of Mendarda Taluka of Junagadh District, Gujarat 362 260 (Area 498.02 hectares with population of 1087 as per 2011 census).
- Institutional Programmes: World Soil Day (December 5, 2023), Vigilance Day (August 16 to November 15, 2023), QRT (2017-21), RAC 2023 (June 7-8, 2023), RAC 2024 (4-5 Jan 2024) etc.

Dr. Praveen Kona organized

- One day "Farmers orientation cum Training programme on High oleate groundnut seed production" at ICAR-Directorate of Groundnut Research, Junagadh on 13.01.2023.
- One day "Farmers orientation cum Training programme on seed production techniques for High oleate groundnut" at ICAR-Directorate of Groundnut Research, Junagadh on 20.03.2023.
- Farmers' field day programme on High oleate groundnut cultivation on 20.09.2023 at Dhebar village, Visavadar Taluk, Junagadh.

Dr. Ajay BC and Dr. GA Rajanna organized

- The one-day training program on "Drought mitigating technologies in groundnut in scarce rainfall situations of Anantapur" to 30 numbers of farmers was organized at ICAR-Directorate of Groundnut Research, Regional Research Station, Anantapur on 05.08.2023.

Dr. Harish G and Dr. Sushmita Singh organized

- A one-day training program for UG Students of Shree Sardar Patel Mahila B.Ed. College

Dr. Narendra Kumar organized

- A Groundnut Field Day on August 12, 2023 at ICAR-Directorate of Groundnut Research-Regional Research Station, Bikaner

Trainings attended

Dr. Aaradhana Chilwal attended

- 113th Foundation Course for Agricultural Research Service (FOCARS) during 18 Jul, 2023 - 17 Oct, 2023 at ICAR-NAARM, Hyderabad.

Ms. Shanmuka Adupa attended

- An Online training program on "ICTs for Agricultural Extension: Advances and Trends" on 26th -27th October, 2023
- An Online Training Program on "ICT in Plant Protection "during November 06 - 10, 2023 - Organized by ICAR-National Research Centre for Integrated Pest Management (NCIPM), New Delhi & National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India.

Dr. Manjunath Paled attended

- Three months Professional Attachment Training from 15.09.2023 to 14.12.2023 at Department of Agricultural Economics, College of Agriculture, Junagadh Agricultural University under the mentorship of Dr. B. Swaminathan, Assistant Research Scientist
- One month ORIENTATION TRAINING PROGRAMME at ICAR-DGR, Junagadh from 25.07.2023 to 24.08.2023.
- Three months FOCARS training at ICAR-NAARM from 11.04.2023 to 10.07.2023

Dr. Rajaram Choudhary attended

- Drone Flying Training at Rashtriya Raksha University, Gandhinagar, Gujarat from 22-30 March, 2023.

Participation and paper presentation in conferences/ meetings/ seminars/ symposia/ meetings

Dr. C.S. Praharaj

- Participated in QRT 2017-21 Meeting held at ICAR-DGR, Junagadh (Virtual Mode) for evaluation of AICRPG Centers viz., Bhubaneswar, Jhargram and Imphal on 29 December 2023.

- Participated in QRT-IMC interface meeting held at IACR-DGR, Junagadh (Virtual Mode) on 22 December 2023.
- Participated in QRT 2017-21 Meeting held at UAS Dharwad for evaluating AICRPG Centers of Tamil Nadu and Karnataka during 5-6 December 2023 as Member Secretary QRT (Physical Mode).
- Participated and presented a lead paper (Physical Mode) on Pulses and Oilseeds as the climate and nutrition smart crops. In: XXII Biennial National Symposium of the Indian Society of Agronomy on "Climate Smart Agronomy for Resilient Production Systems and Livelihood Security" held at CCARI Goa during 22-24 Nov., 2023 (Organized by ISA, New Delhi and ICAR-CCARI, Goa).
- Participated in QRT 2017-21 Meeting held at JAU Junagadh and DGR Junagadh during 4-6 November 2023 (Physical Mode).
- As Member Secretary in RAC of ICAR-DGR, Junagadh and its RRSs held during June 7-8 2023 held on Physical mode.
- As a Member in IMC Meetings of ICAR-DGR, Junagadh and its RRSs held on April 25, 2023 held on virtual mode.
- Participated in Annual Groundnut Workshop 2023 (AGW 2023) held at Junagadh Agricultural University (JAU), Junagadh during 24-26 May 2023; and Co-chaired the session on FRONT LINE DEMOS" on 25.5.2003 (Physical Mode)
- Participated in QRT Meetings of ICAR-DGR, Junagadh and AICRP on Groundnut held during March 01-02, 2023 held on virtual mode. Presented achievements made during 2017-22 for Crop Production Unit, ICAR-DGR, Junagadh.
- Participated in a lecture/webinar on "Reimagining law, sovereign and property rights through pastoralism held on January 05, 2023 and organized by IGFRI, Jhansi. This is delivered by Dr Nupur Chowdhary, Deptt of law, JNU, New Delhi (Virtual Mode).

Dr. Aaradhana Chilwal

- Delivered poster presentation in the National Symposium on "Sustainable Mountain Agriculture: Challenges and Opportunities for Achieving Zero Hunger and Nutritional Security" July 5–6, 2023 at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora.

Ms. Shanmuka Adupa

- Presented paper on Sustainable Agriculture Economics: A Comparative Cost Analysis of Conventional and Natural Farming Methods in Andhra Pradesh Community-Managed Natural Farming in International Conference on Food and Nutritional Security through Agricultural Ecosystem from 01.02.2024 to 02.02.2024, at MANAGE, Hyderabad.

Awards/ Recognitions

Dr. C.S. Praharaj

- Acted as Convener in the Technical Session on "Post-harvest management to achieve the farm to fork concept-Session-9" in National Symposium on "Climate Smart Agronomy for Resilient Production Systems and Livelihood Security" held at CCARI Goa during 22-24 Nov., 2023 (Organized by ISA, New Delhi and ICAR-CCARI, Goa).
- Nominated as Editor and Reviewer of Indian Journal of Agronomy published by Indian Society of Agronomy, Division of Agronomy, ICAR-IARI, Pusa, New Delhi vide l. No Nil dated March 15, 2023.
- Nominated as Member Secretary of QRT 2017-2021 for ICAR-Directorate of Groundnut Research, Junagadh Vide Council Order No. CS.8/8/2023-O&P (Comp Mo. 263429) dated 10/07/2023.
- Acted as Convener in Technical Session of FLDs in AGM of AICRP on Groundnut held during 24-26 May 2023 at JAU Junagadh.
- Nominated as Member Secretary of RAC for ICAR-Directorate of Groundnut Research, Junagadh 2023-26 Vide Council order No. CS.12/5/2009/IA/III (e-36377) dated 03/05.2023 for the period of 24-3-2023 to 23-03-2026.

Dr. Praveen Kona

- Guided one M.Sc. student as major guide {Thesis title: Genotype × Environment Interaction for Yield and Quality Related Traits in Groundnut for Selection of Climate Resilient Genotypes}

Dr. Aaradhana Chilwal

- Received best poster presentation award in the National Symposium on "Sustainable Mountain Agriculture: Challenges and Opportunities for Achieving Zero Hunger and Nutritional Security" July 5–6, 2023 at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora

Ms. Shanmuka Adupa

- Received best oral presentation award in National Conference on Next Generation Agriculture - Organic and Natural farming Pathways: Extension Strategies and Approaches Conference from 28.01.2024 to 30.01.2024 at ATARI, Jabalpur, Madhya Pradesh.
- Presented paper on Sustainable Agriculture Economics: A Comparative Cost Analysis of Conventional and Natural Farming Methods in Andhra Pradesh Community-Managed Natural Farming in International Conference on Food and Nutritional Security through Agricultural Ecosystem from 01.02.2024 to 02.02.2024, at MANAGE, Hyderabad.
- Editorial member in Krishi Netra an open access peer reviewed monthly e-magazine.

Dr. GA Rajanna

- Received copy right certificate received from Copyright Office, Government of India for developing rice residue management techniques

Extracts from the Register of Copyrights

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Dated: 30/11/2023

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5.	Title of the work	VARIOUS TECHNIQUE FOR HANDLING PADDY LEFTOVERS IN PADDY WHEAT ROTATION
6.	Language of the work	ENGLISH
7.	Name, address and nationality of the author and if the author is deceased, date of his decease	DR. SANTOSH KORAV , PHAGWARA JALANDHAR-144411 INDIAN DR. SUJATHA H.T. , PHAGWARA JALANDHAR-144411 INDIAN DR. ASHOK KUMAR KOSHARIYA , PHAGWARA JALANDHAR-144411 INDIAN DR. RAJANNA G.A. , JUNAGADH, GUJRAT-362001 INDIAN
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9 Important events

Annual Groundnut Workshop 2023

The Annual groundnut workshop (AGW) 2023 was organized at Junagadh Agricultural University (JAU) during 24-26th May, 2023. The workshop was graced by the presence of Dr. T.R. Sharma, Deputy Director General (CS), ICAR, New Delhi, Dr. V.P. Chovatia, Vice Chancellor, JAU, Dr. Sanjeev Gupta, Assistant Director General (ADG), Oilseeeds and Pulses, ICAR, New Delhi, Dr. SN Nigam, Former Principal Groundnut Breeder, ICRISAT, Hyderabad and Dr. Sanjay Kumar, Director, ICAR-IISS, Mau. The achievements of AICRPG were highlighted by Dr. S.K. Bera, Director, ICAR-DGR emphasizing 100% budget (859.93 crores) utilization in 2022-23; release of eight varieties by CVRC and 11 varieties by SVRC during 2021 & 2022. Besides, 3 crop production and 4 crop protection technologies were recommended during the period. Dr. S.K. Bera also highlighted the major accomplishments of crop improvement, crop production, crop protection and Front-line demonstrations. The major constraints in groundnut including low seed replacement rate (25%), seed multiplication rate (8%) and shortfalls in breeder seed production were addressed ans ways to overcome were also discussed. The concerted efforts and timely interventions from ICAR-DGR and AICRPG in contributing to boost the production of groundnut was greatly appreciated. It was emphasized to strengthen the basic and collaborative research with partners in similar areas to progress further.

In the AGM 2023, the following awards were conferred

(1) Best Performing Groundnut Seed Hub to Mega Seed Hub, Junagadh (JAU, Junagadh);

(2) Best Performing AICRP-G Regular Centre to Main Agricultural Research Station, Dharwad (UAS, Dharwad); and

(3) Best Breeder Seed Producing Centre to Agricultural Research Station, Kadiri (ANGRAU, Guntur)

Inaugural session of Annual groundnut workshop (AGW) 2023 at Junagadh Agricultural niversity (JAU)

QRT (2017-21) reviewed ICAR-DGR

The ICAR established a Quinquennial Review Team (QRT) on Groundnut on June 15, 2022, headed by Dr. SK Sharma, with the aim of assessing the research and development (R&D) achievements and future strategies of ICAR - DGR and associated All India Coordinated Research Project on Groundnut (AICRPG) during the period of 2017-21. The other distinguished Members include Dr. V. Muralidharan (Former Director, ICAR-DGR, Junagadh & Former Professor, TNAU, Coimbatore, Tamil Nadu), Dr. A.K. Saxena (Former Director, ICAR-NBAIM, Mau, Uttar Pradesh), Dr. Rajinder Parshad (Former ADG-Extension, ICAR, New Delhi), Dr. O. P. Sharma (Former Principal Scientist, ICAR-NCIPM, New Delhi), Dr. S.G. Savalia (Dean - Agriculture Faculty), JAU, Junagadh, Gujarat, and Dr. C.S. Praharaj (PS & Head, ICAR-DGR, Junagadh) as the Member Secretary. The QRT conducted a series of virtual and physical meetings across AICRPG Centres over the past year. During these sessions, the team meticulously evaluated the progress made in groundnut crop R&D, including visits to laboratories, field experiments, and seed plots, culminating in a range of recommendations to enhance R&D efforts in the field. Suggestions included the activation of National Crossing Programs, the development of trait-specific groundnut varieties, and the reinforcement of scientific and administrative personnel at ICAR-DGR.

In addition to reviewing R&D progress, the QRT proposed various strategies to strengthen the ICAR-DGR's capabilities, such as conducting non-human pathogenicity tests, exploring biocontrol methods, studies on VAM fungi and non-pathogenic *Aspergillus* and *Sclerotium* fungi for bio control, use of *Trichoderma viride* with Tebuconazole instead of *T. harzianum* (due to compatibility issue), bio control of white grub using *Bacillus subtilis*, use of pheromone traps for monitoring/control of *Spodoptera* and *Helicoverpa*, , continuation of registration of varieties under PPV&FRA, working on policy for yield-gap reduction through technology adoption and case studies, and above all, recruiting additional scientists as needed. The meetings concluded with expressions of gratitude to the chair for his leadership throughout the review process. These recommendations underscore a collective commitment to advancing groundnut crop research in India, aiming not only to improve productivity but also to address emerging challenges such as climate change and pest management.

QRT Meeting held at ICAR-DGR and JAU, Junagadh during 4-6 November, 2023

Taking over of Laboratory-cum-office-building and other infrastructure from CPWD

The construction of the Laboratory-cum-office-building for RRS ICAR-DGR Anantapur was managed by CPWD, Kurnool division in Andhra Pradesh. Following preliminary planning tasks such as soil analysis and topographic surveys, CPWD commenced construction on December 29, 2022. Additionally, CPWD was responsible for building other essential infrastructure facilities including a Threshing yard, Implement shed, Seed godown, and Hybridization block. Throughout the construction process, scientists stationed at RRS DGR Anantapur, Dr. Ajay BC and Dr. GA Rajanna, maintained regular communication with CPWD to oversee the progress of these projects. All construction tasks, including the Laboratory-cum-office-building and associated facilities, were completed as scheduled and handed over to ICAR-Directorate of Groundnut Research on December 28, 2023. During the handover process, Mr. J. Pruthviraj AE and Mr. Balaram Mali from CPWD represented the construction team, while Dr. Ajay BC, Dr. Harish G, Mr. Dilip Kumar, and Dr. GA Rajanna from ICAR-DGR were present to receive the infrastructure facilities.

RAC Held at ICAR-DGR, Junagadh

The 24th RAC meeting of ICAR- DGR was held at Junagadh during 07-08, June 2023 under the chairmanship of Dr. A.R. Pathak, Former Vice Chancellor, JAU, Junagadh and NAU, Navsari. The honourable members of RAC *viz.*, Drs. Sanjeev Gupta, ADG (O & P), ICAR, New Delhi, D.M. Hegde, Former Director, ICAR-IIOR, Hyderabad, M. Sujatha, PS, ICAR-IIOR, Hyderabad, T.K. Mondal, PS, ICAR-NIPB, New Delhi, S.K. Bera, Director, ICAR-DGR, Junagadh, and C.S. Praharaj, PS & Head and Member Secretary, ICAR-DGR, Junagadh participated offline in this Meeting, while Dr. P.N. Sharma, Former HoD, CSKHPKV, Palampur participated in virtual mode. Dr. Praharaj commenced the meeting, followed by a presentation from Dr. S.K. Bera on the Institute's recent activities and future plans. Concerns were raised regarding long-standing staff vacancies, urging prompt recruitment to fulfil the Institute's mandates of research, knowledge dissemination, and capacity building. The meeting featured presentations on 12 projects and detailed discussions among scientists to enhance project outcomes.

Specific recommendations emerged across various domains. In Plant Breeding and Biotechnology, priorities included germplasm characterization, gene-specific marker development for fresh seed dormancy, and collaboration for disease resistance screening. Crop production and protection discussions highlighted the need for cropping system-based practices, rainwater management, bio-intensive pest management, and aflatoxin testing. Besides these, some general recommendations /suggestions were also made by the RAC members. This included amalgamation of all these projects to few theme based major projects, planning for seed production of high oleic 'Girnar 4' & 'Girnar 5' varieties released by ICAR-DGR, initiation of breeding work on confectionary traits, confirmation of F_1 hybrids through markers, strengthening backcross breeding programs, and developing MAGIC population esp. for FSD trait, adopting GWAS for identification of gene for FSD, taking care of soil moisture and plant stand in experiments, developing INDELS/SNP markers in CAM variants, review of ongoing experiments for its feasibility/viability, working out agronomy of large seeded varieties, adopting a nearby village for showcasing Institute Varieties/technologies, evaluation of novel pesticides for sucking pests, and project based linkages/collaboration with concerned stake holders of groundnuts. The committee concluded with satisfaction over progress made, emphasizing ongoing improvements and modifications for future endeavours.

RAC Meeting held at ICAR-DGR, Junagadh during June 2023

Independence celebration at ICAR-DGR

On August 15, 2023, ICAR-DGR marked 77th Independence Day with celebrations across its campuses in Junagadh (Gujarat), Bikaner (Rajasthan), Medinipur (West Bengal), and Anantapur (Andhra Pradesh). Dr. SK Bera, the Director, hoisted the National Flag at the main campus, addressing the staff and children present. He emphasized ICAR-DGR's achievements and outlined future goals for enhancing groundnut area, production, and overall productivity in the country. Similarly, at the Regional Research Stations, the heads hoisted the National Flag in their respective centres.

45th Foundation Day and Kisan Mela

ICAR-Directorate of Groundnut Research, Junagadh celebrated its 45th Foundation Day on 1st October, 2023. Kisan Mela was organised during this occasion which was chaired by Dr. V. P. Chovatia, Hon'ble Vice Chancellor, Junagadh Agricultural University, Junagadh. The chief guest of the function was Sh. Sanjay Koradia, Hon'ble Member, Gujarat Legislative Assembly, Junagadh. Dr. R. B. Madariya, Director of Research, Junagadh Agricultural University, Junagadh, as the special guest and Dr. Ajit Kumar Shasany, Director, CSIR-National Botanical Research Institute, Lucknow as the Guest of Honour graced the occasion on this auspicious day. Dr. Manjunatha P Paled, Scientist, ICAR-DGR, Junagadh was the chairman of exhibition committee of Kisan Mela including press, publicity & reporting committee. More than 600 farmers from various districts of Gujarat actively participated in the Kisan Mela and about 19 agro-based companies showcased their products in the stalls. Five progressive farmers were awarded by the Directorate for their significant contribution in groundnut production and for adopting advanced groundnut technologies that are developed by ICAR-DGR. Farmers expressed positive response on Directorate's high oleic groundnut varieties, Girnar-4 & Girnar-5, and other technologies of ICAR-DGR.

Inauguration of 45th Foundation Day and Kisan Mela at ICAR-DGR, Junagadh

Farmers visiting stalls in the exhibition

Exhibition committee at ICAR-DGR stall

Inauguration of Regional Research Station of ICAR-DGR Cum Farmers Mela at Bikaner, Rajasthan

The inauguration of the Regional Research Station (RRS) of ICAR-Directorate of Groundnut Research (DGR) was done at Bikaner, Rajasthan on September 27, 2023. The event was graced by esteemed dignitaries including Shri Jagdeep Dhankhar, Hon'ble Vice President of India; Shri Narendra Singh Tomar, Hon'ble Union Minister of Agriculture and Farmers Welfare; Shri Arjun Ram Meghwal, Hon'ble Minister of State for Law & Justice, Parliamentary Affairs, and Culture; Shri Kailash Chaudhary, Hon'ble Minister of State for Agriculture and Farmers Welfare; and Dr. Himanshu Pathak, Hon'ble Secretary, Department of Agricultural Research and Education (DARE) & Director General, Indian Council of Agricultural Research (ICAR). Also in attendance were other notable figures such as Shri Bihari Lal, Hon'ble Member of Legislative Assembly; Smt. Siddhi Kumari, Hon'ble Member of Legislative Assembly; Shri Sumit Godara, Hon'ble Member of Legislative Assembly; Smt. Sushila Rajpurohit, Mayor; and Dr. Sandeep Kumar Bera, Director of ICAR-DGR. Dr. Himanshu Pathak extended a warm welcome to the dignitaries and farmers. In his address, Dr. Himanshu Pathak highlighted the benefits of the groundnut research station at Bikaner would bring to local farmers.

Addressing the gathering, Sh. Arjun Ram Meghwal, Hon'ble Minister of State for Law & Justice, Parliamentary Affairs, and Culture, praised the exceptional quality of groundnuts produced in Bikaner, comparable to those from America. Sh. Jagdeep Dhankhar, Hon'ble Vice President of India, emphasized the significant contribution of Bikaner to the country's groundnut production, advocating for a focus on value addition in groundnut cultivation. The event saw the participation of scientists, heads, officers, and directors from various ICAR institutes, alongside representatives from state agriculture departments, agricultural universities, and the Bikaner District Administration. Approximately 2500 farmers attended the program, which also featured exhibitions from ICAR institutes and agricultural universities, showcasing technologies developed by agricultural scientists for the benefit of farmers.

Inauguration of ICAR-DGR, RRS, Bikaner, Rajasthan

ICAR-DGR-RRS, Bikaner organized Field Day on 12th August 2023

The Regional Research Station of ICAR-Directorate of Groundnut Research in Bikaner organized a Groundnut Field Day on August 12, 2023, which observed the participation of thirty-three groundnut farmers from Bhadrasar, Sattasar, and Surpura villages in the Bikaner district. Dr. Narendra Kumar, the program convener, addressed the farmers, emphasizing the importance of using high-yielding groundnut varieties recommended for Rajasthan and advocating for the use of good quality seeds of the latest varieties. Literature on weed management, recommended varieties, disease management, and insect management related to groundnuts was distributed during the event. Additionally, Dr. Sudhir Kumar, Head of ICAR-IIPR-RRC in Bikaner, highlighted the significance of crop diversification with legume crops, while Dr. Rajaram Choudhary provided insights into groundnut cultivation practices during his interactions with farmers in the field.

Dr. BDS Nathawat, a pathologist from SKRAU in Bikaner, discussed disease management practices for groundnuts, while Dr. SK Bera, Director, ICAR-DGR, engaged with farmers, listening to their concerns regarding groundnut cultivation and offering advice on the judicious use of insecticides, pesticides, and fertilizers. Dr. Bera encouraged farmers to adopt improved groundnut varieties such as Girnar 4, Girnar 5, and RG 638 to enhance the benefits of groundnut cultivation and stressed the importance of using high-quality seeds from reliable sources.

Groundnut Field Day at ICAR-DGR-RRS, Bikaner

Training program for UG Students of Shree Sardar Patel Mahila B.Ed. College

UG Students of Shree Sardar Patel Mahila B.Ed. College attended one day training program organized at ICAR- Directorate of Groundnut Research, Junagadh as per the request letter dated 18.10.2023. Around 58 students were given training on groundnut production technologies and nutrient management strategies in groundnut. Training program was organized by Dr. Harish G, Coordinator and Dr. Sushmita Singh, Co-Coordinator on 08.11.2023. The students also visited Museum, and Lab of physiology and microbiology.

Students' interaction during Lab visit

One day training program for UG Students of Shree Sardar Patel Mahila B.Ed. College

Dr. P.N. Sharma, Member, RAC visited at ICAR-DGR, RRS, Bikaner

During September 1-2, 2023, Dr. P.N. Sharma, a member of ICAR-Directorate of Groundnut Research's Research Advisory Committee (RAC), visited the Regional Research Station (RRS) and groundnut fields in Bikaner. On September 1st, he discussed the groundnut collar rot disease research program with Dr. Narendra Kumar, In-Charge & Senior Scientist at DGR, RRS, Bikaner, offering valuable insights given the disease's significant impact on seedling mortality. Dr. Sharma also reviewed experiments at CSWRI-ARC farm and AICRP-G center, SKRAU, Bikaner, focusing on systematic collar rot management strategies. On September 2nd, Dr. Sharma, alongside experts including Dr. Raja Ram Choudhary and Dr. B.D.S. Nathawat, visited farmers' fields to assess disease incidence and crop management practices for collar rot. Farmers were advised to adopt improved groundnut production technologies for higher crop yields.

DGR-RRS field visit

SKRAU, Bikaner sick plot visit

Farmers field visit

Parthenium Awareness Day

ICAR-DGR, Junagadh celebrated Parthenium Awareness Day as a part of Parthenium Awareness Week (16-22, August 2023) on 22nd August 2023 at Model Peanut Village "Mithapur". About 50 farmers attended the event. Dr. C. S. Praharaj, Co-convenor gave detailed information about Parthenium weed including its history and its adverse effects on soil, animal, and human health. Dr. Kiran K Reddy, Convenor and Sh. R. D. Padvi, Co-convenor briefed about preparation of compost from Parthenium biomass. Dr. Kiran K Reddy also explained in detail about integrated weed management practices of Parthenium and created awareness among farmers about agri-startups under Agri-Business Incubator. In addition to this, Dr. Manjunatha P Paled highlighted the extent of economic loss across crops due to Parthenium weed.

Explanation to the farmers about integrated management approaches of Parthenium

Uprooting of Parthenium in the farmer's field

10 Staff list / General Information

1. Staff List during 01.01.2023 to 31.12.2023

Sl.No	Name	Designation
1.	Dr. S.K. Bera	Director
2.	Dr. C.S. Praharaj	Principal Scientist (Agronomy)
3.	Dr. K.K. Pal	Principal Scientist (Microbiology) Transferred to NIASM Baramati 30.06.2023
4.	Dr. Rinku Dey	Principal Scientist (Microbiology) Transferred to NIASM Baramati date 22.12.2023
5.	Dr. Harish G.	Senior Scientist (Entomology)
6.	Dr. Narendra Kumar	Senior Scientist (Plant Breeding)
7.	Dr. Ajay BC	Senior Scientist (Plant Breeding)
8.	Dr. M.V. Nataraja	Senior Scientist (Entomology)
9.	Dr. Sushmita	Scientist (Senior Scale) (Plant Physiology)
10.	Dr. Sangh Chandramohan	Scientist (Senior Scale) (Agricultural Biotechnology)
11.	Dr. K.K. Reddy	Scientist (Senior Scale) (Soil Science)
12.	Dr. Kona Praveen	Scientist (Senior Scale) (Plant Breeding)
13.	Dr. G.A. Rajanna	Scientist (Senior Scale) (Agronomy)
14.	Sh. Ananth Kurella	Scientist (Plant Pathology)
15.	Dr. Raja Ram Choudhary	Scientist (Agronomy)
16.	Dr. Papa Rao Vaikuntapu	Scientist (Agricultural Biotechnology) Transferred to IIRR-Hyderabad (dated 31.03.2023)
17.	Dr. Aaradhana Chilwal	Scientist (Agronomy) Joined on 11.04.2023
18.	Dr. Manjunatha P. Paled	Scientist (Economics) Joined on 18.07.2023
19.	Ms. Shanmuka Adupa	Scientist (Extension) Joined on 28.08.2023
20.	Sh. P.V. Zala	Chief Technical Officer
21.	Dr. M.V. Gedia	Chief Technical Officer
22.	Sh. Ranvir Singh	Chief Technical Officer
23.	Dr.S.D. Savaliya	Chief Technical Officer (Retired date 31.01.2023)
24.	Sh. R.D. Padvi	Technical Officer
25.	Sh. C.B. Patel	Technical Officer
26.	Sh. N.M. Safi	Technical Officer (Driver) (VRS 31.08.2023)

27.	Sh. Lokesh Kumar	Technical Officer
28.	Sh. Pitabas Das	Senior Technical Assistant
29.	Sh. M.A. Shaikh	Driver
30.	Sh. M.B. Shaikh	T-1
31.	Sh. V.N. Kodiatar	T-1
32.	Sh. Dilip Kumar	Administrative Officer
33.	Sh. Anupam Chaubey	AAO (on deputation) at ICAR-DGR till 29.09.23
34.	Sh. Badri Narayan Meena	F&AO Joined on 16.06.2023
35.	Sh. Y.S. Kariya	Personal Secretary
36.	Sh. L.V. Tilwani	Personal Assistant
37.	Mrs. Santha Venugopalan	Assistant (Retired date 31.05.2023)
38.	Sh. C.G. Makwana	Assistant
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 (Retired dated 30.09.2023)
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

2. Staff position on 31.12.2023

Category of	Sanctioned Strength as on 31.12.2023	Filled as on 31.12.23	Vacant As on 31.12.23
Scientific	35+01RMP	15+01 RMP	20
Technical	39	10	29
Admn.	18	05	14
SSS	30	23	07

3. DPC meeting on 01.01.2023 to 31.12.2023

1. DPC Held on 28.08.2023 for Scientist Staff, 04 employees
2. DPC Held on 06.01.2023 for Admin Staff, 03 employees

4. IMC held on 05.09.2023

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	Ex-Officio
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	Ex-Officio
9	Director of Agriculture (Rajasthan) Pant Krishi Bhavan, Jaipur, Rajasthan	Member	Ex-Officio
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

5. Retirement of Staff

1. Dr. S.D. Savaliya, CTO (Superannuated on 31.01.2023)
2. Mrs. Santha Venugopalan, Assistant (Superannuated on 31.05.2023)
3. Sh. N.G. Vadher, SSS (Superannuated on 30.09.2023)

6. Transfer from ICAR-DGR

1. Dr. K.K. Pal, Principal Scientist (Microbiology), ICAR-DGR, Jungadh to NIASM Baramati (Date:-30.06.2023)
2. Dr. Rinku Dey, Principal Scientist (Microbiology), ICAR-DGR, Jungadh to NIASM Baramati (Date:-22.12.2023)
3. Dr. Papa Rao Vaikuntapu, Scientist (Biotechnology) ICAR-DGR, Jungadh to IIRR-Hyderabad (Date:31.03.2023)
4. Sh. Anupam Kumar Chaubey, AAO (on deputation) ICAR-DGR, Jungadh to ICAR-IISS, Mau (Date 29.09.2023)

7. Institute Joint Staff Council:-

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

Members: Staff side

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

Member:- Office side

Administrative officer, DGR, Junagadh.

8. Contractual Staff

1.	RA	04
2.	SRF	05
3.	YP-2	03
4.	YP-1	28
5.	Data Entry Operator	02
6.	Security Staff -Ex. Army	22
7.	Cleaning Staff	05
8.	Farm Tractor Driver	8
9.	Reception	04
10.	Electrician/Plumber	02+01
11.	DPL	08

9. Research Advisory Committee of ICAR-DGR

Dr. A. R. Pathak Former Vice Chancellor, JAU, Junagadh and NAU, Navsari	Chairman
Dr. Sanjeev Gupta ADG (O&P), ICAR, New Delhi	Member
Dr. M. Sujatha PS, ICAR-IIOR, Hyderabad	Member
Dr. D. M. Hegde Former Director, IIOR, Hyderabad	Member
Dr. P. N. Sharma Former HoD, Deptt of Plant Pathology, CSK HPKV, Palampur	Member
Dr. Tapan Kumar Mondal PS, ICAR-NIPB, New Delhi	Member
Smt Shubha Thakur Joint Secretary (Crops, Oilseeds, & Admin, CVO), DA & FW, Krishi Bhawan, New Delhi	Member
Persons representing **Agricultural / Rural interests** nominated by DA & FW	Member
Persons representing **Agricultural / Rural interests** nominated by DA & FW	Member
Dr. S. K. Bera Director, ICAR-DGR, Junagadh	Member
Dr. Chandra Sekhar Praharaj Principal Scientist (Agronomy), ICAR-DGR, Junagadh	Member Secretary

10. Member of Institute Research Committee

Chairman
Director ICAR-DGR, Junagadh

Member Secretary
Dr. Sushmita
Scientist (Senior Scale) (Plant Physiology) ICAR-DGR, Junagadh

Members
All Scientists

Funds received and utilized

DGR Main Unit (Rs. In Lakhs)	Fund received	Funds utilized
Establishment charges	779.26	759.71
Wages	0	0
Admininstrative Expenses	298.97	366.33
Pension	91.60	123.89
T.A.	34.13	30.63
Research and Operational Expenses	315.27	317.41
HRD	0	0
Works	147.13	240.56
Equipment	60.37	53.84
Furniture	13.11	1.20
IT	9.38	5.73
Books	0	0
Vehicle	15.00	0
Miscellaneous	3.11	6.63
TSP	40.00	4.33
NEH capital	9.75	3.99
NEH General	37.50	6.57
SCSP General	87.00	12.15
SCSP Capital	9.00	1.00
Total	**1950.58**	**1933.97**

AICRPG

Capital	7.50	7.49
Pay & Allowance	889.23	911.89
TA	13.91	13.91
Recurring Contigency& Need Based Research	145.36	135.47
TSP	37.50	12.75
NEH	10.5	4.6
Total	**1104.00**	**1086.11**

भाकृअनुप
ICAR

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

Agrisearch with a human touch