ICAR - IIOPR वार्षिक प्रतिवेदन Annual Report 2022

भाकृअनुप – भारतीय तेल ताड़ अनुसंधान संस्थान
ICAR - Indian Institute of Oil Palm Research
पेदवेगी – 534 435, एलुरू जिला, आन्ध्र प्रदेश
Pedavegi - 534 435, Eluru District, Andhra Pradesh
Website: https://iiopr.icar.gov.in

वार्षिक प्रतिवेदन
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1. High yielding oil palm
2. FFB ready to harvest
3. Diseased rugose spiralling whitefly
4. Tissue culture generated plantlet

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1. PREFACE

I have assumed the charge of Director, ICAR-Indian Institute of Oil Palm Research on January 23, 2023 and feel privileged to present the Annual Report -2022 of this prestigious Institute which is committed for oil palm research and development in the country. ICAR-IIOPR is the only Institute in India conducting basic, applied and strategic research on oil palm and disseminate the technologies to oil palm stakeholders. The Institute is also handholding oil palm development programme of country by conducting feasibility studies, establishment of seed gardens, production of germinated seeds and conducting capacity building programmes. DA&FW has launched National Mission of Edible Oils - Oil Palm (NMEO-OP) during 2021-22 and targets fixed by Mission include covering an area of 10.00 lakh ha under oil palm plantations by 2025 and increasing crude palm oil production to 11.20 lakh tonnes. Based on the targets fixed, import of vegetable oil in the country could be reduced from the present 60 % (15 million tonnes) to 40 % (10 million tonnes) by 2027. During August 2022, a research programme entitled "Enhancing production, productivity and profitability of oil palm through novel technological interventions" with a total outlay of Rs. 2742.26 lakhs (2022-23 to 2026-27) was sanctioned by DA&FW (under NMEO-OP) for implementation at ICAR-IIOPR. I am confident that the sustained and pro-active efforts of ICAR-IIOPR could make the country self reliant in vegetable oil production (Aatma Nirbhar Bharat) in coming years.

During the past year, ICAR-IIOPR was awarded ISO 9001:2015 certification in recognition of the organization's Quality Management System; Two patents were granted and 14 copyrights were registered. The Institute could achieve 99% utilization of funds during 2022-23. The Institute plays a key role in augmenting the indigenous production of quality oil palm planting material and agro-techniques have helped in improving the resource use efficiency of oil palm plantations. ICAR-IIOPR is also extending support for promotion of oil palm crop in NER on a large scale. ICAR flagship programmes like Mera Gaon Mera Gaurav (MGMG), Farmers First programme (FFP), Tribal Sub Plan (TSP)/Scheduled Tribe Component (STC), Scheduled Cast Sub Plan (SCSP), North East Hill (NEH) etc., are being implemented. The Govt. of India promoted programmes like Swachh Bharat and Azadi ka Amruth Mahotsav were celebrated as per the directives of ICAR. During November 2022, ICAR-IIOPR in association with SOPOPRAD organised third National Conference on oil palm "Oil palm the way forward for increasing vegetable oil pool through Aatma Nirbhar for doubling the income and providing social security to farmers".

I take this opportunity to thank Secretary, DARE and Director General, ICAR, Dr. Himanshu Pathak and former Secretary, DARE and Director General, ICAR, Dr. Trilochan Mohapatra for their valuable guidance and support. I would like to place on record my gratitude to Dr. A.K. Singh, Deputy Director General (Hort. Sc.), for his constant encouragement and guidance in all the endeavors of the Institute. I thank Dr. R. K. Mathur, Director (A), ICAR-IIOPR and Dr. M. V. Prasad, In-charge Director, ICAR-IIOR (Nov 2022-Jan 2023) for all their efforts in taking the Institute forward.

I would like to thank Dr. V. B. Patel, Asst. Director General (Fruits & Plantation Crops), Dr. Sudhakar Pandey, Asst. Director General (FVSM&A) and other staff of Hort. Subject matter division for all the support and help extended to the Institute. I acknowledge the support received from DA&FW and DST by funding the oil palm research projects, which will further help in strengthening the sustainability and profitability of crop.

I would like to express my appreciations to the Editorial Team of Annual Report for bringing out the report in time. I would also like to thank all the scientific, technical, administrative, supporting and contractual staff members who are supporting and contributing towards the progress of ICAR-IIOPR.

(Kancherla Suresh)
Director

2. कार्यकारी सारांश EXECUTIVE SUMMARY

आईआईओपीआर, पेदावेगी में बनाए गए सात अलग–अलग जननद्रव्य ब्लॉकों में स्वदेशी तेल ताड़ जननद्रव्य वंषक्रमों (एक्सेसन) के प्रदर्शन का मूल्यांकन किया जा रहा है। प्रजनन कार्यक्रमों में आगे उपयोग हेतु बेहतर ताड़ के चयन के लिए ऊंचाई वृद्धि, लिंग अनुपात, उपज मापदंडों, गुच्छा विश्लेषण मापदंडों पर टिप्पणियों को दर्ज किया जा रहा है। जम्बुगा, आदिलाबाद में अफ्रीकी जर्मप्लाज्म (गिनी बिसाऊ, जाम्बिया और तंजानिया) के मूल्यांकन के परिणामस्वरूप 15 सेमी ऊंचाई वृद्धि, 5.76 वर्गमीटर पत्ती क्षेत्र और 150 किग्रा एफएफबी/ताड़/वर्ष के साथ एक बौने ताड़ की पहचान हुई। 30 सेमी से कम ऊंचाई वृद्धि और 120–150 किग्रा/ताड़/वर्ष की एफएफबी उपज वाले 80 से अधिक ताड़ों की पहचान की गई। पलोड, केरल (गिनी बिसाऊ, कैमरून, तंजानिया और जाम्बिया) में अफ्रीकी जननद्रव्यों का मूल्यांकन कार्य जारी है; थोडुपुझा पराग के साथ दो डीXडी संकर बनाए गए थे और कुलाथुपुझा बीज बागान में ड्यूरा मदर पाम सीडलिंग की आपूर्ति के लिए पौधे उगाए गए थे।

पेदावेगी में डीXडी संकर (ड्यूरा इम्प्रूवमेंट ट्रायल III, IV, V और VI) का मूल्यांकन कार्य जारी है और आगे उपयोग के लिए ऊंचाई वृद्धि, सूखा सहिष्णुता, उच्च एफएफबी उपज और तेल से गुच्छा का उच्च अनुपात के आधार पर बेहतर ताड़ की पहचान की गई। प्रमुख घटकों के विष्लेशण ने संकेत दिया कि ऑयल पाम ड्यूरा जीनप्ररूपों में 100% भिन्नता को समझाने के लिए छह लक्षणों की आवश्यकता थी। पहले छह प्रमुख घटक (पीसी) जो कुल भिन्नता के 83.75% के लिए जिम्मेदार थे, का ईजेन मान एक से अधिक था और केवल PC1 और PC2 सबसे उपयोगी प्रतीत होते हैं क्योंकि उन्होंने ज्यादातर तेल और तेल से संबंधित लक्षणों में भिन्नता का उल्लेख किया था। पालोड में डीXडी संकर (ड्यूरा इम्प्रूवमेंट ट्रायल IV और V) का मूल्यांकन कार्य जारी है और उच्च उपज देने वाले ताड़ की पहचान की गई है। कायकीय और जैव रासायनिक लक्षणों के आधार पर सूखे और लवण सहनशीलता के लिए तेल ताड़ की पौध की जांच की गई। विभिन्न कायकीय और जैव रासायनिक लक्षणों का साप्ताहिक अंतराल पर विश्लेषण किया गया और संकरों को उनकी सहनशीलता के आधार पर वर्गीकृत किया गया। परीक्षण किए गए 13 संकरों में से, पांच संकर (2DEX2DE, 44DEX74DE, 13DEX2DE और 410CDX410 CD) ने अध्ययन किए गए सभी कायकीय और जैव रासायनिक लक्षणों में भिन्नता व्यक्त की और सूखे की लवणता के लिए महत्वपूर्ण सहिष्णुता दर्षायी हैं।

The performance of indigenous oil palm germplasm accessions is being evaluated in seven different germplasm blocks maintained at IIOPR, Pedavegi. Observations on height increment, sex ratio, yield parameters, bunch analysis parameters are being recorded for selection of superior palms for further utilization in breeding programmes. Evaluation of African germplasm (Guinea Bissau, Zambia and Tanzania) at Jambuga, Adilabad resulted in identification of one dwarf palm with 15 cm height increment, 5.76 sq. m leaf area and 150 kg FFB/palm/year. More than 80 palms were identified with less than 30 cm height increment and FFB yield of 120- 150 kg/palm/year. African germplasm evaluation at Palode, Kerala (Guinea Bisau, Cameroon, Tanzania and Zambia) is continued; two DXD crosses were made with Thodupuzha pollen and seedlings were raised to supply dura mother palm seedlings to Kulathupuzha seed garden.

Evaluation of DxD crosses (Dura Improvement Trials III, IV, V and VI) at Pedavegi is continued and superior palms were identified based on height increment, drought tolerance, high FFB yield and high oil to bunch ratio for further utilization. Principal component analysis indicated that six traits were required to explain 100 % variation in oil palm dura genotypes. The first six principal components (PC) which accounted for 83.75 % of total variation, had eigen value greater than one and only PC1 and PC2 appear to be the most useful as they described mostly the variation in oil and oil related traits. Evaluation of DXD crosses (Dura Improvement Trials IV and V) at Palode is continued and high yielding palms were identified. Screening of oil palm seedlings for drought and salt tolerance based on physiological and biochemical traits was taken up. Various physiological and biochemical characters were analyzed at weekly intervals and the crosses were classified based on their tolerance. Amongst the 13 crosses tested, five crosses (2DEX2DE, 44DEX74DE, 13DEX2DE and 410CDX410 CD) expressed variation in all the studied physiological and biochemical traits and showed significant tolerance to drought and salinity.

तेल ताड़ के बीज भंडारण में प्रभावकारिता के लिए चार पैकिंग सामग्री जैसे कपड़े के बैग, पॉलिथीन बैग – 400 गेज, सुपर ग्रेन बैग और ट्राइ–लेमिनेटेड एल्यूमीनियम फॉयल बैग का मूल्यांकन किया गया था। परिणामों ने संकेत दिया कि सुपर ग्रेन बैग में संग्रहीत बीजों ने 3 महीने के भंडारण के बाद 54% अंकुरण दिया जबकि इसी अवधि के दौरान कपड़े के बैग में अंकुरण प्रतिशत 30% तक कम हो गया। डी–ऑपरकुलेटेड कर्नेल तकनीक में अंकुरण प्रतिशत में भिन्नता 76 और 82% के बीच थी। पोट्रेस में रोपित प्राथमिक नर्सरी में मध्यम (3–5 सें.मी. लंबाई) तथा बड़े आकार (>5 सें.मी. लंबाई) के अंकुरों का प्रदर्शन बेहतर था। षेल और ऑपेरकुलम के माइक्रोबियल विघटन के लिए उच्च सेल्युलोज और पेक्टिनेज गतिविधि वाले एक संभावित सूक्ष्मजीव *एस्परगिलस* एसपी VM–1 की पहचान की गई है।

आईसीएआर–आईआईओपीआर, पेदावेगी और आईसीएआर–आईआईओपीआर, क्षेत्रीय केन्द्र, पालोड के बीज बागान ने व्यावसायिक रोपण हेतु नर्सरी तैयार करने के लिए विभिन्न कंपनियों को क्रमशः 36,740 और 1,19,500 अंकुरित बीजों की आपूर्ति की। बागवानी विभाग, आंध्र प्रदेश सरकार के तहत एलूरु जिला, आंध्र प्रदेश के मुथन्नवीडु में नए तेल ताड़ बीज बागान की स्थापना के लिए उन्नत ड्यूरा पैतृक सामग्री के पंद्रह संकर संयोजन विकसित किए गए हैं। मौजूदा बीज बागानों के विस्तार के लिए मोरमपुडी तेल ताड़ बीज बागान को 358 मातृ तेल ताड़ पौध (सीडलिंग) और तारका तेल ताड़ बीज बागान को 350 मातृ तेल ताड़ पौध (सीडलिंग) की आपूर्ति की गई थी। कर्नाटक राज्य में मैसूर जिले के ताड़का और काबिनी तेल ताड़ के बीज बागानों, पष्चिमी सेरजवाल, मिजोरम; आन्ध्र प्रदेष में एलूरू जिले के गोपन्नापालेम और केरल के ओपीआईएल तेल ताड़ बीज बागानों को तकनीकी सलाह दी गई।

अपरिपक्व नर पुष्पक्रम, अप्रत्यक्ष दैहिक भ्रूणजनन के लिए और तेल ताड़ में आगे के पुनर्जनन के लिए सबसे उपयुक्त कर्तोतक (एक्सप्लांट) हैं। अपरिपक्व नर पुष्पक्रम के उपयोग से 2820 कल्चरों के टीकाकरण के लिए पांच मीडिया संयोजन (M1 से M5) का उपयोग किया गया था। 1200 दैहिक भ्रूण, जो विभिन्न चरणों में हैं, लाइट ग्रोथ की स्थिति में मौजूद थे। ये दैहिक भ्रूण शूट इंडक्शन मीडियम के लिए तैयार थे। शूट पहल के साथ पूरी तरह से परिपक्व भ्रूणजन्य कैली को सक्रिय चारकोल (500 मिलीग्राम / एल) की कम सांद्रणता के साथ जीए, बीए और एनएए से युक्त पुनर्जनन मीडिया में स्थानांतरित किया गया था। बेसल मीडिया भी उचित वृद्धि के लिए आधी सांद्रणता तक कम कर दिया गया था।

Four packing materials *viz.*, cloth bag, polythene bag – 400-gauge, super grain bag and tri-laminated aluminium foil bag were evaluated for efficacy in oil palm seed storage. Results indicated that seeds stored in super grain bag gave 54 % germination after 3 months storage whereas, germination per cent was reduced to 30 % in cloth bag during the same period. The germination per cent in de-operculated kernel technique varied between 76 and 82 %. The performance of medium (3-5 cm length) and large size (> 5cm length) sprouts was better in primary nursery planted in portrays. A potential microbe *Aspergillus* sp. VM-1 with high cellulase and pectinase activity is identified for microbial disintegration of shell and operculam.

The seed gardens at ICAR-IIOPR, Pedavegi and ICAR-IIOPR, RC, Palode supplied 36,740 and 1,19,500 germinated seeds, respectively to different companies to raise nurseries for commercial planting. Fifteen cross combinations of advanced dura parental materials have been developed for establishment of new oil palm seed garden at Muthannaveedu, Eluru Dt., Andhra Pradesh under Department of Horticulture, Government of Andhra Pradesh. 358 mother palm seedlings to Morampudi oil palm seed garden and 350 mother palm seedlings to Taraka oil palm seed garden were supplied to take up extension of existing seed gardens. Technical advices were given to oil palm seed gardens at Taraka and Kabini, Mysuru Dt., Karnataka; at West Serzwal, Mizoram; Gopannapalem, Eluru Dt., Andhra Pradesh and OPIL, Kerala.

Immature male inflorescence is the most suitable explant for indirect somatic embryogenesis and for further regeneration in oil palm. Five media combinations (M1 to M5) were used for inoculation of 2820 cultures using immature male inflorescence. 1200 somatic embryos, which are at different stages were present in light growth conditions. These somatic embryos are ready for shoot induction medium. Fully matured embryogenic calli with shoot initiation were transferred to a regeneration media consisting of GA, BA and NAA with reduced

एक बार जब शूट की ऊंचाई 4 से 5 सेमी तक पहुंच गई, तो इन कल्चर को सक्रिय चारकोल (500 उह/स) की कम सांद्रता पर NAA और इंडोल–3–ब्यूटिरिक एसिड (IBA) जैसे हार्मोन के साथ रूटिंग मीडिया (आधा बेसल मीडिया) में स्थानांतरित कर दिया गया। कल्चरों को रूटिंग मीडिया के तहत तब तक रखा गया जब तक कि वे अच्छी जड़ प्रणाली प्राप्त नहीं कर लेते हैं। इस अच्छी तरह से स्थापित जड़ (>5 सेमी लंबाई) और शूटिंग (>10 सेमी लंबाई में) वाले पौधों को रेत, वर्मी कम्पोस्ट और कोको पीट के 1:1:1 अनुपात के साथ जीवाणुरहित मृदा वाले पॉटेड मिश्रण में स्थानांतरित किया गया था। इन गमलों में नमी बनाए रखने के लिए इन्हें पॉलीथिन शीट से ढक दिया जाता था। अब तक 85 पौधे कठोर हो चुके थे, जिनमें से चार सख्त माध्यम में हैं जिन्हें हाल ही में स्थानांतरित किया गया था। क्लोनल फिडेलिटी परीक्षण से पता चला है कि दैहिक भ्रूणजनन से प्राप्त क्लोनल सामग्री आणविक स्तर पर मातृ तेल ताड़ के लिए सजातीय है।

एसएसआर मार्करों का उपयोग करके तेल ताड़ के महत्वपूर्ण लक्षणों के लिए जीनोम वाइड एसोसिएशन (GWAS) मानचित्रण किया गया। आनुवंशिक विविधता, जनसंख्या संरचना विश्लेषण और GWAS विश्लेषण के लिए जननद्रव्य ब्लॉक 4 से 53 जीनप्ररूप, जननद्रव्य ब्लॉक 5 से 95 जननद्रव्य और ब्लॉक 7 से संबंधित 123 जननद्रव्य का उपयोग किया गया था। प्रमुख घटक विश्लेषण और चार गुच्छों की उपज और तेल उपज के चार लक्षणों के साथ ऊंचाई में वृद्धि के अंतर–संबंध का अध्ययन किया गया और पाया गया कि ऊंचाई में वृद्धि का अन्य लक्षणों की तुलना में औसत गुच्छा वजन के साथ सकारात्मक रूप से सहसंबद्ध है। qtlH2 से जुड़े एक एसएसआर मार्कर को अनेक जननद्रव्यों पर मान्य किया गया था और इसका उपयोग बौने लक्षणों के लिए मार्कर सहायक प्रजनन कार्यक्रमों में किया जा सकता है।

प्लास्टिक मल्चिंग संयोजन के साथ में ड्रिप या इनलाइन ड्रिपर सिस्टम की सहायता से तेल ताड़ की सिंचाई करने से 25 प्रतिशत तक पानी की बचत होती है। सिंचाई की इन दो विधियों में प्रत्येक किलोग्राम एफएफबी का उत्पादन करने के लिए क्रमशः 233 और 251 लीटर पानी का उपयोग किया गया था। माइक्रोजेट सिंचाई में मल्च्ड (*इन सीटू*) और नॉन–मल्च्ड स्थितियों के अंतर्गत एक किलोग्राम एफएफबी का उत्पादन करने के लिए क्रमशः 530 और 608 लीटर पानी का उपयोग हुआ था। आंध्र प्रदेश के दो निकटवर्ती जिलों (कृष्णा और पश्चिम गोदावरी) के बीच डीआरआईएस सूचकांकों और महत्वपूर्ण पत्ती पोषक तत्वों की सांद्रता में बड़े अंतर देखे गए, जो तेल ताड़ के बागानों में सटीक पोषक तत्व प्रबंधन के लिए स्थान विशिष्ट मानकों के विकास की मांग करते हैं।

concentration of activated charcoal (500 mg/l). The basal media also reduced to half the concentration for proper growth. Once the shoot height reached to 4 to 5 cm, these cultures were transferred to rooting media (half basal media) with hormones like NAA and indole -3 –butyric acid (IBA) with less concentration of activated charcoal (500 mg/l). The cultures were kept under rooting media till they attain good root system. These well rooted (>5 cm length) and shooting (>10 cm in length) plants were transferred to potted mixture having sterile soil with 1:1:1 ratio of sand, vermi compost and coco peat. Then these pots were covered with polythene sheet to maintain the humidity. Till now 85 plants were hardened, of which four are in hardening medium which were transferred recently. The clonal fidelity test showed that the clonal material obtained from somatic embryogenesis is homogeneous to the mother palm at molecular level.

Genome Wide Association (GWAS) mapping for important traits in oil palm using SSR markers was done. Fifty-three genotypes from germplasm block 4, 95 germplasm from germplasm block 5 and 123 germplasm belongs to germplasm block 7 were used for genetic diversity, population structure analysis and GWAS analysis. The principal component analysis and inter-relationships of height increment with four bunch yield and oil yield traits was studied and found that height increment is positively correlated with average bunch weight than the other traits. One SSR marker linked to qtlH2 was validated on large germplasm and can be used in marker assisted breeding programmes for dwarf trait.

Irrigating oil palm through drip or inline dripper system in combination with plastic mulching is effective in water saving up to 25 per cent. Water utilized to produce each kg of FFB in these two methods of irrigation was 233 and 251 litres, respectively. Microjet irrigation utilized 530 and 608 litres of water respectively to produce one kg of FFB in mulched (*in-situ*) and non-mulched conditions. Large variations were noticed in DRIS indices and critical leaf nutrient concentrations between two adjacent districts of Andhra Pradesh

तेल ताड़ के बागानों में उर्वरकों की मांग आधारित अंतर विभाजन अनुप्रयोग के अध्ययन से संकेत मिलता है कि जिन उपचारों में नाइट्रोजन और पोटाषियम को अप्रैल और जुलाई के दौरान उच्च दरों पर और जनवरी एवं अक्टूबर के दौरान कम दरों पर अनुप्रयोग किया गया था, उनमें उच्च एफएफबी उपज दर्ज की गई। तेल ताड़ में शुरू किए गए फसल ज्यामिति अध्ययनों से संकेत मिलता है कि उच्च एफएफबी उपज 10 X 7 मीटर के आयत में दर्ज की गई थी, और इसके करीब ही 9 मी. हेक्सागोन प्रणाली का स्थान था। विभिन्न फसल ज्यामिति के तहत भी, अलग–अलग महीनों के दौरान एफएफबी उत्पादन व्यापक रूप से भिन्न होता है। मृदा में बोरॉन (B) अधिषोशण का क्रम इस प्रकार हैः वर्टिसोल > अल्फिसोल > इंसेप्टिसोल > एंटिसोल जो दर्षाता है कि मृदा में चिकनी मिट्टी की मात्रा बढ़ने से बोरॉन अधिषोशण बढ़ जाता है। बोरॉन संतुलन, अल्फिसोल में 36 घंटे, इंसेप्टिसोल और एंटिसोल में 24 घंटों में प्राप्त होता है, जबकि वर्टिसोल में संतुलन 72 घंटों तक पूरा नहीं होता है। एंटिसोल में जोड़े गए अधिकांश बोरॉन सांद्रताओं में बोरॉन का विशोषण अधिक होता है।

तेल ताड़ बागानों में खरपतवार की गतिशीलता पर किए गए अध्ययनों से संकेत मिलता है कि तेल ताड़ में पहचानी गई 39 खरपतवार प्रजातियों में, *पार्थेनियम हिस्टेरोफोरस* पौधों की बहुलता (उच्चतम संख्या) है और उच्च आवृत्ति के साथ *अकलिफा इंडिका* प्रमुख है। प्राथमिक नर्सरी चरण के दौरान सिंगल की तुलना में डबलेट्स और ट्रिपलेट्स से तेल ताड़ सीडलिंग्स में वृद्वि और ओझ अध्ययन हेतु प्रयोग किए गए हैं। डबलेट्स और ट्रिपलेट्स को बिना किसी नुकसान के हाथ से आसानी से अलग किया जा सकता है और प्राथमिक चरण पूरा होने के बाद द्वितीयक बैग में रोपित किया जा सकता है। दो रोपण अवधियों के दौरान तेल ताड़ संकरों के विकास और उपज प्रदर्शन पर किए गए अध्ययनों से संकेत मिलता है कि पौधे की ऊंचाई, तने का घेरा, पत्तियों की संख्या और 9वीं पत्ती का क्षेत्रफल दिसंबर रोपण की तुलना में जुलाई रोपण में अधिक था। जुलाई में पौध रोपण से मानसून की बारिश के कारण त्वरित स्थापना और मजबूत विकास में मदद मिली और त्वरित प्रारंभिक वृद्धि के परिणामस्वरूप विकास मापदंडों के साथ–साथ उपज विशेषताओं दोनों में बेहतर प्रदर्शन हुआ है।

परिपक्व तेल ताड़ के बागानों में सजावटी अदरक जैसे, टार्च जिंजर (*एटलिंगरा एलाटियर*), अंडमान टार्च जिंजर (*एटलिंगेराफेन्ज़ली*), सियाम रोज़ (*एटलिंगेराकोर्नेरी*), मलय रोज़ (*एटलिंगेरावेनुस्टा*), शैंपू जिंजर (*ज़िंजिबर ज़ेरुम्बेट*), शेल जिंजर

(Krishna and West Godavari) which warrant development of location specific standards for precise nutrient management in oil palm plantations.

Studies on demand based differential split application of fertilizers in oil palm plantations indicated that the treatments in which N and K were applied at higher rates during April and July and at lower rates during January and October recorded higher FFB yield. Studies initiated on crop geometry in oil palm indicated that higher FFB yield was recorded in 10 x 7 m rectangle which was closely followed by 9m hexagon system. Even under different crop geometries, FFB production varied widely during different months. Boron (B) adsorption in soils followed the order: Vertisols>Alfisols>Inceptisols>Entisols indicating an increase in B adsorption with increase in the clay content of the soil. The B equilibrium attained in 36 h in alfisols, 24 h in inceptisols and entisols, whereas in vertisols, the equilibrium is not completed until 72 hours. Desorption of B is higher in entisols in most of the added B concentrations.

Studies on weed dynamics in oil palm plantations indicated that among 39 weed species identified in oil palm basins, *Parthenium hysterophorus* was found to be more predominant with highest count of plants and *Acalypha indica* with high frequency. Experiments were taken up to observe the growth and vigour of oil palm seedlings from doublets and triplets in comparison with singles during the primary nursery stage. Doublets and triplets can be separated easily by hand without any damage and planted in secondary bags after completion of primary stage. Studies on growth and yield performance of oil palm crosses under two planting times indicated that plant height, stem girth, number of leaves and leaf area of 9th leaf were more in July planting in comparison to December planting. Planting the seedlings in July helped in quick establishment and robust growth due to monsoonal rains and the early initial growth has continuously resulted in better performance both in growth parameters as well as yield attributes.

The ornamental gingers *viz.,* Torch ginger (*Etlingera elatior*), Andaman Torch ginger (*E. fenzlii*),

(*एल्पिनिया ज़ेरुम्बेट*), बीहाइव जिंजर (*ज़िंजिबर स्पेक्टैबाइल*), रेड बटन जिंजर (*कॉस्टसवुडसोनी*), पाइन एप्पल जिंजर (*टेपिनोचिलोसैनानासे*), ऑरेंज ट्यूलिप जिंजर (*कोस्टसकरविब्रेक्टेटस*), रेड जिंजर (*एल्पिनिया पुरपुराटा*), रेड टावर/स्पाइरल जिंजर (*कोस्टसकैमोसस*) और पेंटेड स्पाइरल जिंजर (*कोस्टसपिक्टस*) का मूल्यांकन किया जा रहा है। रेड बटन जिंजर में पुष्पन अवस्था तक पहुँचने में लगभग 4 महीने, पेंटेड स्पाइरल जिंजर और आरेंज ट्यूलिप जिंजर में 8 महीने, रेड जिंजर में 9 महीने, रेड टावर/स्पाइरल जिंजर और बीहाइव जिंजर में 12 महीने, शैंपू जिंजर में 16 महीने और शेल जिंजर एवं टार्च जिंजर में 17 महीनां को समय लगा था। शेष प्रजातियां अभी भी वनस्पतिक चरण में थीं, जो तेल ताड़ बागानों की घनी छाया (लगभग 76%) के कारण हो सकती हैं, जिसके परिणामस्वरूप वनस्पतिक चरण लंबा हो गया है।

तेल ताड़ के अंकुरों के विकास पर *जीवामृतम* के प्रभाव के अध्ययन ने नियंत्रण वाले तेल ताड़ की तुलना में 20% *घनाजीवामृतम* से अंकुर की ऊंचाई, पत्ती और प्राथमिक जड़ उत्पादन, तने का घेरा और बायोमास में काफी बेहतर पाए जाने का संकेत दिया। इसी तरह, नियंत्रण वाले तेल ताड़ की तुलना में 1.5 *एलद्रवजीवामृतम* से उच्चतर अंकुर ऊंचाई, पत्ती और प्राथमिक जड़ उत्पादन, पत्ती क्षेत्र, तने का घेरा, अंकुरों का बायोमास देखा गया। द्वितीयक नर्सरी के दौरान ऑयल पॉम मिल वेस्ट–बॉयलर ऐश के उपयोग से तेल ताड़ के अंकुरों के विकास पर प्रभाव से संकेत मिलता है कि बॉयलर ऐश 500 ग्राम/बैग के उपयोग से नियंत्रण की तुलना में ऑयल पॉम सीडलिंग की ऊंचाई, पत्ती और प्राथमिक जड़ संख्या, पत्ती क्षेत्र, तना घेरा और बायोमास बेहतर होता है।

तेल ताड़ के कीट नाषीजीवों में से, रगोज़ स्पाइरलिंग व्हाइटफ्लाई और बोंडर नेस्टिंग व्हाइटफ्लाई सह–अस्तित्व में और जनवरी, 2022 के दौरान इनका संक्रमण चरम सीमा पर पाया गया, जबकि फरवरी 2022 के दौरान रुक–रुक कर हुई बारिश ने व्हाइटफ्लाई की आबादी में भारी कमी की। प्रजातियों के परिसीमन अध्ययनों से संकेत मिलता है कि दोनों प्रजातियां फ्रोंड के टिप पत्रक को पसंद करती हैं। आबादी की चरम सीमा के दौरान, RSW और BNW दोनों के निम्फ+वयस्क संख्या में एक दूसरे के बराबर थे जबकि मौसमी औसत में RSW (1.88 प्रति पत्रक) की तुलना में BNW (2.84 प्रति पत्रक) की संख्या काफी अधिक थी। संशोधित कीट बेयटिंग तकनीक का उपयोग करके तेल ताड़ के बागानों से एकत्र किए गए मृदा के नमूनों की जांच के परिणामस्वरूप

Siam rose (*E. cornerii*), Malay rose (*E. venusta*), Shampoo ginger (*Zingiber zerumbet*), Shell ginger (*Alpinia zerumbet*), Beehive ginger (*Z. spectabile*), Red button ginger (*Costus woodsonii*), Pine apple ginger (*Tapeinochilos ananasae*), Orange tulip ginger (*Costus curvibracteatus*), Red ginger (*A. purpurata*), Red tower/spiral ginger (*C. camosus*) and Painted spiral ginger (*C. pictus*) are being evaluated in mature oil palm plantations. Time taken for reaching flowering phase was about 4 months in red button ginger, 8 months in painted spiral ginger and orange tulip ginger, 9 months in red ginger, 12 months in red tower/spiral ginger and beehive ginger, 16 months in shampoo ginger and 17 months in shell ginger and torch ginger. Rest of the species were still in vegetative phase which might be due to thick shade (about 76 %) of oil palm plantation resulting in prolonged vegetative phase.

Studies on influence of *jeevamrutham* on growth of oil palm seedlings indicated significantly better seedling height, leaf and primary root production, stem girth and biomass at 20% *ghana jeevamrutham* when compared with control. Similarly, higher seedling height, leaf and primary root production, leaf area, stem girth, biomass of seedlings were observed with 1.5 L *drava jeevamruatham* which is significantly higher as compared with control. Effect of oil palm mill waste-boiler ash on growth of oil palm seedlings during secondary nursery indicated that boiler ash @ 500 g/bag had markedly increased oil palm seedling height, leaf and primary root number, leaf area, stem girth and biomass when compared with the control.

Amongst the insect pests of oil palm, Rugose spiraling whitefly (RSW) and Bondar nesting whitefly (BNW) are found to be predominant and coexisting with peak incidence during January 2022, while the intermittent rains during February 2022 drastically reduced whitefly population. Species delimitation studies indicated that both the species preferred tip of leaflets of frond. During the peak population time, nymphs + adults of both RSW and BNW are at par with each other, whereas the seasonal average showed significantly higher population of BNW (2.84 per leaflet) than RSW (1.88

BNW के खिलाफ रोगजनकता वाले 20 कवक उपभेदों को अलग किया गया। दो प्रमुख आइसोलेट्स 41ए और 55बी में RSW के मुकाबले 93.5 और 94.7% मृत्यु दर पाई गई और सेमी–फील्ड अध्ययनों में प्रति पत्रक (लीफलेट) में कीट आबादी में 96.7 और 89. 8% की कमी पाई गई। पोलिनेटिंग वीविल्स पर किए गए अध्ययन ने पीले और नीले चिपचिपे ट्रैप में क्रमशः 250.81 और 234.15 वीविल/ट्रैप/3 दिन के औसत ट्रैप कैच के साथ वीविल के लिंगानुपात 3.85 और 3.66 का संकेत दिया। एंथेसिस के दौरान नर पुष्पक्रम पर परागण करने वाले घुन दर्शाता है कि एंथेसिस के तीन दिनों के बीच घुन की कुल संख्या में कोई महत्वपूर्ण अंतर नहीं होने के साथ पहले दिन नर पुष्पक्रम में मादा घुन की काफी अधिक संख्या देखी गई।

गैनोडर्मा के खिलाफ देशी ट्राइकोडर्मा आइसोलेट्स के बहुस्तरीय मूल्यांकन से दो शक्तिशाली आइसोलेट्स की पहचान हुई, जोधपुर से *टी. लॉन्गिब्राकियाटम* (टीएल) और मऊ से Up3 आइसोलेट, जिनसे *जी. बोनिनेंसिस* मायसेलिया और ड्राई वेट में 70% से अधिक की कमी हुई। *ट्राइकोडर्मा एस्पेरेलम* को हेक्साकोनाजोल के अनुकूल पाया गया। *जी. बोनिनेंसिस* के प्रसार को रोकने के लिए एग्रोवेस्ट्स के उपयोग पर एक प्रारंभिक अध्ययन ने संकेत दिया कि कवकनाशी के साथ उपचारित गाय के गोबर का गैनोडर्मा संक्रमण पर कोई प्रभाव नहीं पड़ा और इससे भी अधिक, नियंत्रण (केवल गैनोडर्मा उपचार) की तुलना में रोग प्रसार में तेजी आती है। वनस्पतिक तीव्रता में कमी के संदर्भ में सबसे अच्छा उपचार चावल की भूसी + धान का पुआल + क्रस्टेशियन अपशिष्ट और ट्राइकोडर्मा + नीम केक हैं। ताड़ के मरने में देरी के मामले में, 52.3 दिनों तक ताड़ के जीवित रहने के साथ सबसे अच्छा इलाज धान का पुआल था।

राज्य कृषि विभाग के 348 अधिकारियों, तेल ताड़ प्रसंस्करण इकाइयों के कर्मचारियों, राज्य कृशि विष्वविद्यालयों/आईसीएआर संस्थानों के वैज्ञानिकों और तकनीकी कर्मचारियों के लिए तेल ताड़ प्रौद्योगिकियों पर कुल 11 प्रशिक्षण कार्यक्रम आयोजित किए गए थे। कुल 5727 किसानों के लिए 16 किसान प्रशिक्षण कार्यक्रम आयोजित किए गए थे। प्रशिक्षण कार्यक्रमों में प्रशिक्षण कार्यक्रमों में आंध्र प्रदेश, तेलंगाना, अरुणाचल प्रदेश और ओडिशा के किसानों ने भाग लिया। ऑयल पॉम टिशू कल्चर में डेटा प्रबंधन के लिए इंट्रानेट एप्लिकेशन में डेटा एंट्री स्क्रीन को डिजाइन और विकसित किया गया, ताकि ऑयल पाम ऊतक संवर्धन डाटा का भंडारण, पुनर्प्राप्ति और संपादन किया जा सके।

per leaflet). Screening of 49 soil samples collected from oil palm plantations using modified insect baiting technique resulted in isolation of 20 fungal strains with pathogenicity against BNW. Two prominent isolates 41A and 55B were found to have 93.5 and 94.7 % mortality against RSW and 96.7 and 89.8 % reduction in pest population per leaflet in semi-field studies. Studies on pollinating weevils indicated a sex ratio of 3.85 and 3.66 weevils in yellow and blue sticky traps, respectively with an average trap catch of 250.81 and 234.15 weevils/trap/3 day respectively. The visits of pollinating weevils on male inflorescence during anthesis showed a significantly high female weevil population visiting the male inflorescence on 1st day with no significant difference in total number of weevils between the three days of anthesis.

The multiphasic evaluation of native *Trichoderma* isolates against *Ganoderma* led to identification of two potent isolates, *T. longibrachiatum*(Tl) from Jodhpur and Up3 isolate from Mau with more than 70% reduction in *G. boninensis* mycelia and dry weight. *Trichoderma asperellum* was found to be compatible with Hexaconazole. A preliminary study on the use of agrowastes in restricting the spread of *G. boninensis* indicated that cow dung treated with fungicides did not have any impact on the *Ganoderma* infection and more over, the disease progression is rapid in comparison to control (only Ganoderma treatment). The best treatments with respect to reduced foliar severity are Rice husk+Rice straw+Crustacean waste and *Trichoderma*+neem cake. In case of delay in death of the palms, the best treatment was rice straw with palm survival of 52.3 days.

A total of 11 training programmes organized on oil palm technologies to 348 officers of state department of agriculture, staff of oil palm processing units, scientists & technical staff of SAU's/ICAR institutes. A total of 16 farmers training programmes organized to 5727 farmers. Farmers from Andhra Pradesh, Telangana, Arunachal Pradesh and Odisha participated in the training programmes. Designed and developed data entry screens in intranet application for Data Management in Oil Palm Tissue Culture for storage, retrieval and editing of oil palm tissue culture data.

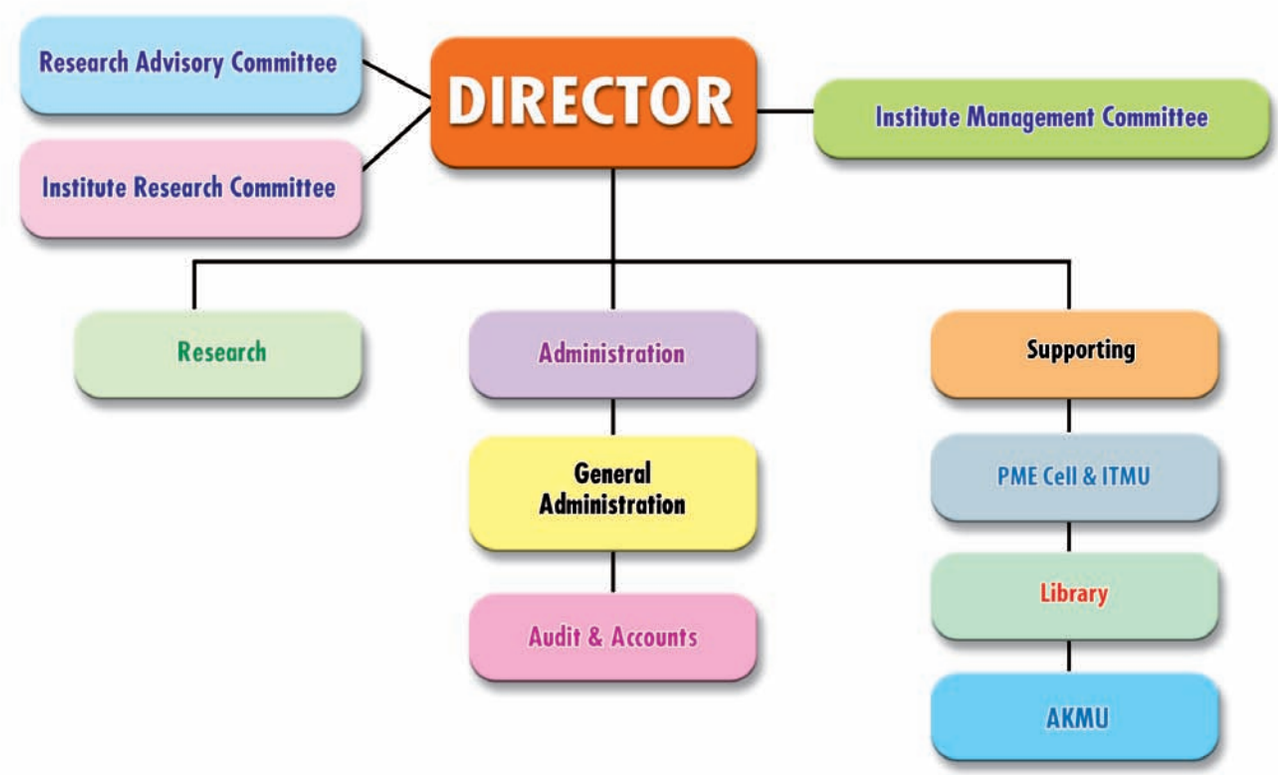
3. INTRODUCTION

To strengthen the research on all aspects of oil palm under irrigated conditions, Indian Council of Agricultural Research established the National Research Centre for Oil Palm (NRCOP) at Pedavegi, Andhra Pradesh on February 19, 1995. The Centre possess an area of 100 ha. It is 13 km away from Eluru city, located in Andhra Pradesh. During April 1999, the CPCRI, Research Centre at Palode was merged with NRCOP. The Research Centre at Palode is 35 km away from Thiruvananthapuram in Kerala state. The NRCOP was re-designated as Directorate of Oil Palm Research (DOPR) during the XI Plan and as ICAR-Indian Institute of Oil Palm Research (ICAR-IIOPR) during XII Plan. Since 1995, systematic efforts are being made at this Institute to develop technologies to cater the needs of oil palm fraternity targeted towards enhancing the production and productivity of the crop, reduction in cost of production and increasing profitability by evolving production technologies under rainfed and irrigated conditions. The Institute is conducting and coordinating research on all aspects of oil palm germplasm management, genetic improvement, production system management, plant health management, farm mechanization and post harvest technology and transfer of technology.

3.1. Mandate

- Basic, strategic and applied research on genetic resource management, crop improvement and production technologies for enhancing productivity of oil palm.
- Transfer of technologies and capacity building of stakeholders for increasing production of oil palm.

3.2 Organisational setup



3.3 Financial outlay 2022

Head	Amount (Rs. in lakhs)
General	**294.00**
Capital	**105.00**
Salary	**701.00**
Pension	**41.96**
Total	**1141.96**

3.4 Externally funded projects 2022

Name of the scheme/ project	Amount (Rs. in lakhs)
National Agricultural Innovation Fund - Intellectual Property Management and Technology Transfer/ Commercialization (ITMU)	10.57
Enhancing profitability of oil palm based cropping system through resource use efficient technologies with farmer- Scientist and Stakeholders Interface (Farmers FIRST programme)	26.47
Agricultural Mechanization-Drone Technology Demonstration	35.44
All India Co-ordinated Research Project (Palms)	4.25
DST-Women scientist scheme Genetical and functional analysis for phosphorus and zinc efficiency of mycoblome associated with rhizosphere of oil palm in India	3.71
DST-SERB - Genomic selection for enhancement of oil quality and yield traits for their use in oil palm (*Elaeis guineensis*) breeding programs using whole genome SNP markers	8.78
DA & FW (Under NMEO - OP) Enhancing production, productivity and profitability of oil palm through novel technological interventions	256.53
Consultancy project - Technical guidance and management of oil palm seed garden, Gopannapalem, Andhra Pradesh	5.43
Consultancy project - Technical guidance and management of oil palm seed garden, Taraka and Kabini, Karnataka	7.70
Contractual training - Oil palm production technology	2.81

3.5 Resource Generation

During the year 2022, a total revenue of Rs. 111.24 lakhs has been generated.

3.6 Staff position (as on 31-12-2022)

Category	Sanctioned	In-position	Vacant
RMP	01	0	01
Principal Scientist	02	0	02
Senior Scientist	04	0	04
Scientist	16	14	02
Total Scientific	**22**	**14**	**08**
Technical	15	12	03
Administrative	16	08	08
Skilled Support Staff	14	09	05
Total	**68**	**43**	**25**

Library

The library has a collection of around 1700 reference books.The ICAR-IIOPR library is a member in CeRA (Consortium for e-Resources in Agriculture), which is one of the best e-journal portals. As part of the resource sharing programme under CeRA, Library provided online document delivery services to scientists of other ICAR Institutes. During the year 2022, Oil World Annual 2021 was subscribed. ICAR-IIOPR publications worth Rs. 50,000/- [200 copies of Best management practices for growing irrigated oil palm in India; 100 copies of Pests, Diseases, Nutrient Deficiencies and Disorders of oil palm and 100 copies of Pocket book on Oil palm cultivation (Telugu) were provided to Director of Horticulture, Government of Telangana, Hyderabad.

Website

The Institute website houses the information regarding location map, organizational setup, cadre strength, AICRP, collaboration, awards, patents, databases/ software, advisory training services and information pertaining to farmers and entrepreneurs. Downloads of annual reports and newsletters were incorporated in the website. Information pertaining to other related sub heads is being maintained. The Website ID is: https://iiopr.icar.gov.in/.

Agricultural Knowledge Management Unit (AKMU)

AKMU is committed to promote Information and Communication Technology (ICT) driven technology and information dissemination system for effective and quick delivery of information to the stake holders in oil palm, keeping in pace with the current knowledge. AKMU at IIOPR facilitates network connectivity in the Institute and is disseminating and sharing the knowledge and information on oil palm through web mode. The local area network of ICAR-IIOPR was enhanced with Optic Fiber Connectivity from AKMU to Farm Office in the main campus, and to Bunch Analysis Lab and Guest House in Old Campus. The BSNL fiber optic broadband with FTTH connectivity was subscribed for internet services. In order to organize virtual programmes, the GoToMeeting software catering to 250 participants at a time was procured. During 2022 more than 60 virtual programmes were organised. Renewed the software licence for networking Firewall. Facilitated live streaming of Pusa Krishi Vigyan Mela 2022 on YouTube. Maintenance of Computers and peripherals, Networking equipment and UPS Systems of the institute is being done by AKMU.

4. RESEARCH ACHIEVEMENTS

PROJECT No. 1000761001: COLLECTION, CONSERVATION, CATALOGUING & EVALUATION OF OIL PALM GERMPLASM

Collection and Evaluation of oil palm germplasm

Evaluation of oil palm germplasm at Pedavegi

Germplasm block I: Among the indigenous germplasm, Palm No. 59 (IC0610001) recorded high FFB yield (368.78 kg/palm/year) with maximum bunch number (16). Twenty two palms were identified as better oil yielding palms based on oil to bunch ratio out of which six are dura palms (18.01-26.15 %) and 16 are tenera palms (18.72-30.30%) (Fig. 1). The highest oil to bunch ratio of 30.30% was recorded in Palm no. 93 (IC0610004).

Germplasm block II: Among the indigenous germplasm, Palm No. 138 recorded high FFB yield (269.67 kg/palm/year) with maximum number of bunches (11). Nineteen palms were identified as good oil yielders based on oil to bunch ratio (Fig. 2), comprising four dura palms (18.64-18.93 %) and 15 tenera palms (25.46-22.24%). Palm No. 181 (IC0610011) recorded highest oil to bunch ratio of 24.85%.

Germplasm block III: Among the 22 indigenous germplasm, AND27 recorded highest FFB yield (252.83 kg/palm/year) with bunch index of 0.41 (Fig.3). Whereas, palm no. 123 (IC0610027) recorded highest yield (264.71 kg/palm/year) with 14 number of bunches (Fig. 3). Accession CO 1 recorded less height increment (22.92 cm) followed by IC0610015 (28.77 cm).

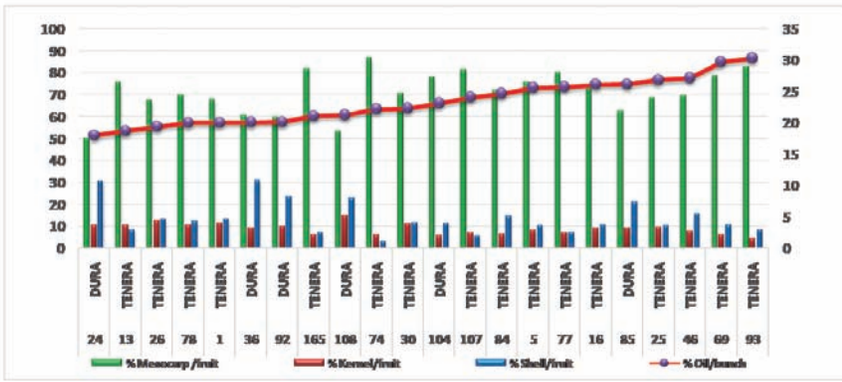


Fig. 1: Performance of identified palms in Germplasm Block I

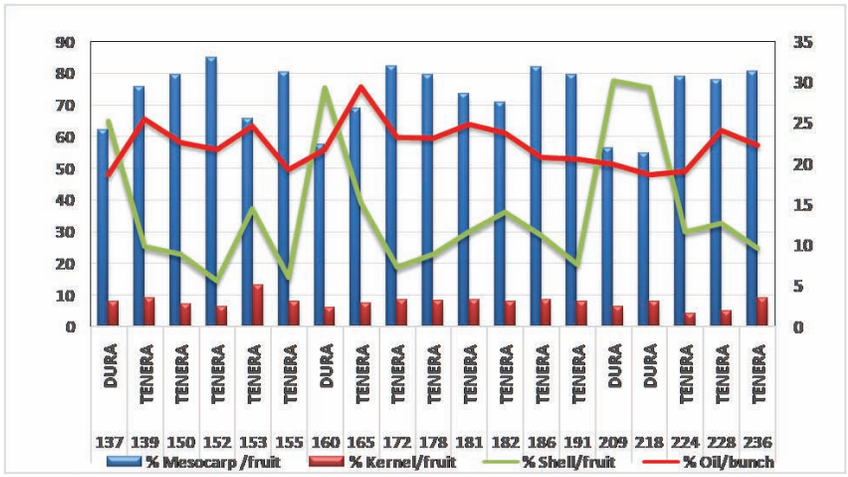


Fig. 2: Performance of identified palms in Germplasm Block II

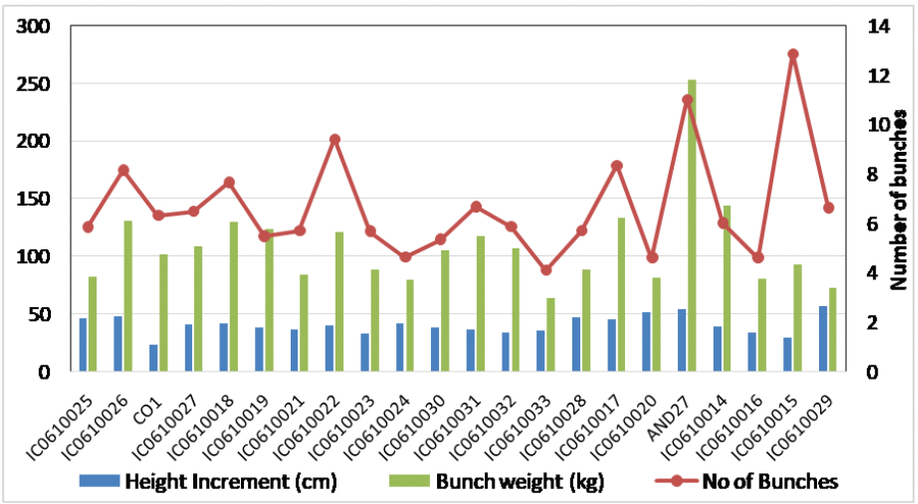


Fig. 3: Performance of different accessions in Germplasm block III

Germplasm block IV: Growth and yield performance of 10 accessions in germplasm block IV were recorded (Fig. 4). High FFB yield was recorded in IC0610039 (135.18 kg/palm/ year) with bunch index of 0.26. Highest sex ratio was recorded in IC0610037 (0.60). Low height increment was recorded in IC0610034 (35.11 cm). The palm no. 254 (IC0610041) recorded high FFB yield (206.94 kg/ palm/year).

Germplasm block V: Among the eight accessions, IC0610051 recorded highest FFB yield (155.89 kg/ palm/year) with height increment of 61.17 cm and sex ratio of 0.37 (Fig. 5). Among the palms, palm no. 71(IC0610051) recorded FFB yield of 345.68 kg/ palm/year. Oil to bunch ratio of more than 20 % was reported in 3 palms; palm no. 70 (25.42 %), palm no. 73 (20.43 %) and palm no. 74 (23.67 %).

Germplasm block VI: Growth and yield performance was evaluated for 55 different accessions in germplasm block VI. Among the accessions, FFB yield varied from 27.48 to 128.76 kg/palm/year and number of bunches varied from 4 to 13.5. Among the palms, palm no. 340 (IC0621415) recorded 238.2 kg/palm/year with maximum number of bunches (22). Based on oil to bunch ratio, 15 dura palms (18.44-26.86 %) and 44 tenera palms (18.58-35.37 %) were identified.

Germplasm block VII: Growth and yield performance was evaluated in 12 exotic oil palm

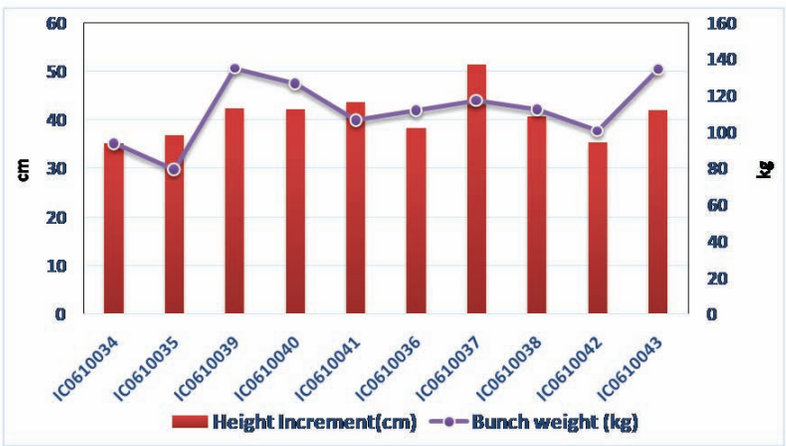


Fig. 4: Performance of different accessions in Germplasm block IV

germplasms in block VII; the FFB yield varied from 24.18- 62.97 kg/palm/year and number of bunches varies from 11.11 to 17.6. Among the different accessions, EC869407 has yielded 62.97 kg FFB/palm/year (Fig. 6). Palm no. 112 (EC869413) has recorded 131.87 kg FFB/palm/year with 24 bunches.

Multi-location evaluation of African germplasm

At Jambuga, Telangana: African germplasm from 3 sources, Guinea Bissau (4 accessions), Zambia (3 nos.) and Tanzania (2 nos.) were evaluated at Jambuga, Adilabad. One dwarf palm (Palm no. 183) identified with 15 cm height increment, 5.76 Sqm leaf area and 150 Kg/Palm/Year of FFB. More than 80 palms identified as a less than 30 cm height increment in this trial with FFB of 120-150 Kg/Palm/Year.

At Palode, Kerala: The African oil palm germplasm consists of 87 palms of Guinea Bisau, Cameroon, Tanzania and Zambia source planted in 1998 were evaluated for FFB yield. The yield varied between 43.55 kg and 216.09 kg. The highest yield of 216.09 kg was recorded in palm no. 58 (Tanzania 4)

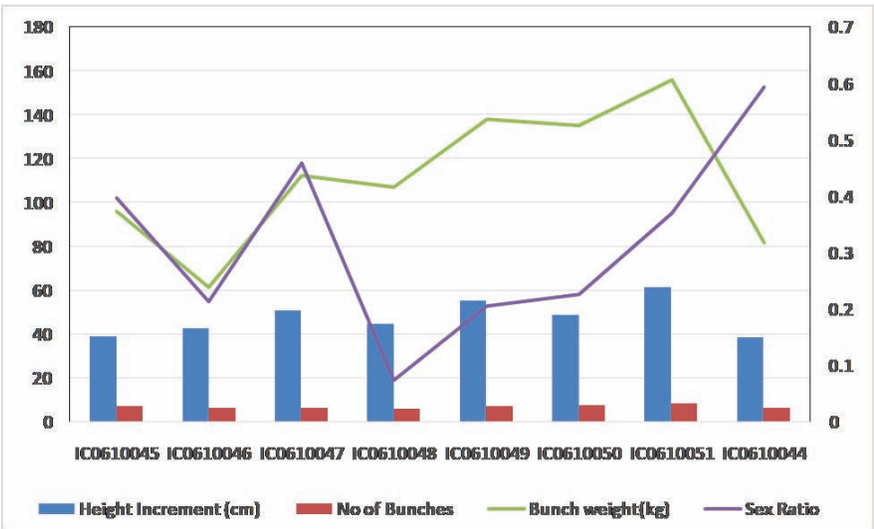


Fig 5: Performance of different accessions in Germplasm block V

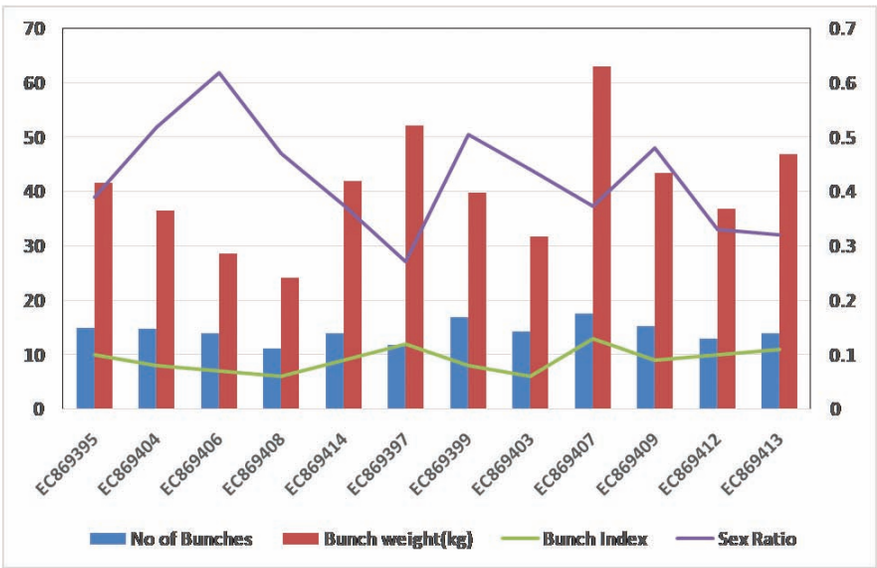


Fig. 6: Performance of different accessions in Germplasm block VII

followed by 207.86 kg in palm no. 52 (Zambia 7). Similarly, bunch number varied between 3 and 9. The highest number of bunches per year of 9 was recorded in palm no. 8 (GB 29/318) and 58 (Tanzania 4) followed by 8 bunches in a year in palm no. 52 (Zambia 7) and 76 (Tanzania 10). Two DXD crosses (Palm nos. 72 and 80) were made with Thodupuzha pollen and seedlings were raised to supply dura mother palm seedlings to kulathupuzha seed garden.

PROJECT No. 1000761002: GENETIC ENHANCEMENT IN OIL PALM

Breeding for high yield in oil palm

Evaluation of DxD crosses (Dura Improvement Trial III) at Pedavegi: Oil palm cross I [44 CD (ZS-1) X 435 CD (CA-12)] and oil palm cross II [60 CD X 62 CD (ZS-8 inter se cross] with 50 palms in each cross were evaluated during 2022-23 for FFB yield, dwarfness and bunch parameters. Among the Cross I, palm no. 9 has been identified as having slow vertical growth with height increment of 17.65 cm and 8 palms were having less than 30 cm height increment. In Cross II, palm no. 76 recorded slow vertical growth with 20.61 cm height increment and 16 palms recorded less than 30 cm height increment. Ten palms were identified as highest yielders (>200 kg/palm/year) in Cross I. In Cross II, five palms recorded more than 200 kg FFB/palm/year (Fig.7). Palm no. 11 was identified as highest yielder (296.46 kg/palm/year) followed by Palm No. 2 (285.26 kg/palm/year). Palm nos. 82, 97 and 35 were identified as good oil yielders with more 18 % of oil to bunch ratio.

Evaluation of DxD crosses (Dura Improvement Trial IV) at Pedavegi: Principal component analysis indicated that six traits were required to explain 100 % of the variation present in the oil palm dura genotypes. However, only the ûrst six principal components (PC) which accounted for 83.75 % of total variation, had eigen value greater than one and only PC1 and PC2 appear to be the most useful as they described mostly oil and oil related traits variation. The first PC explained 48.24 % of the variation was positively correlated with oil-to-wet mesocarp ratio, kernel oil-to-fruit ratio, kernel oil-to-bunch and oil-to-bunch ratio. The second PC accounted for 22.29 % of the variation. The highest loadings for PC1 came from oil-to-wet mesocarp ratio. The discrimination of oil palm dura genotypes based on its fruit and oil related traits was observed when genotypes were projected on two-dimensional graphs formed by PC1 and PC2, (Fig.8). Moving from the bottom of the Y axis where coefficients were negative to the top where coefficients were positive.

Among the 680 population in dura improvement IV, 32 palms have more than 20 % oil to bunch ratio. Comparative analysis (ANOVA, $P < 0.01$) of 680 oil palm dura genotypes and their

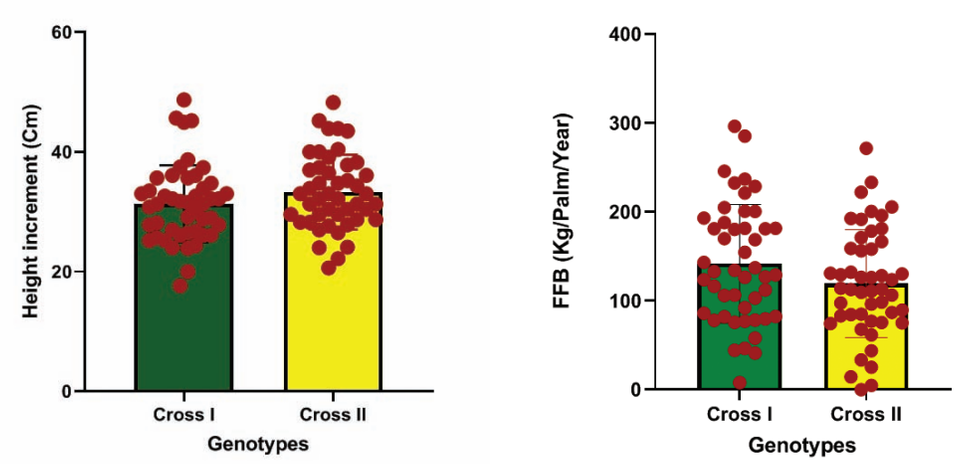


Fig.7: Distribution of genotypes among two DXD cross

bunch traits are shown in box plots (Fig. 9). Large variability was observed for all bunch quality traits among the genotypes, as fruit-to-bunch ratio (0.56-0.79), mesocarp-to-fruit ratio (38.60-73.80), kernel-to-fruit ratio (5.60-15.00), shell-to-fruit ratio (10.40-39.40), oil-to-wet mesocarp ratio (29.44-64.85), oil-to-bunch ratio (11.76-27.50). Palm number 134 (316 kg/palm/year) and palm number 197 (310 kg/palm/year) recorded more than 20 bunches (Fig 10 & 11).

Evaluation of DXD crosses (Dura Improvement Trial IV) at Palode: Eight dura crosses consisting of 460 palms planted in 2015 at Palode were evaluated. Among eight crosses, height increment varied between 38 and 52 cm. The lowest height increment of 38 cm in a year was recorded in D47 X D61 followed by 42 cm/year in D 80 X D 85. The highest sex ratio of 0.48 was recorded in D36 X D36 followed by 0.46 in D47 X D61. The average bunch yield among crosses varied between 39.43 (D48 X

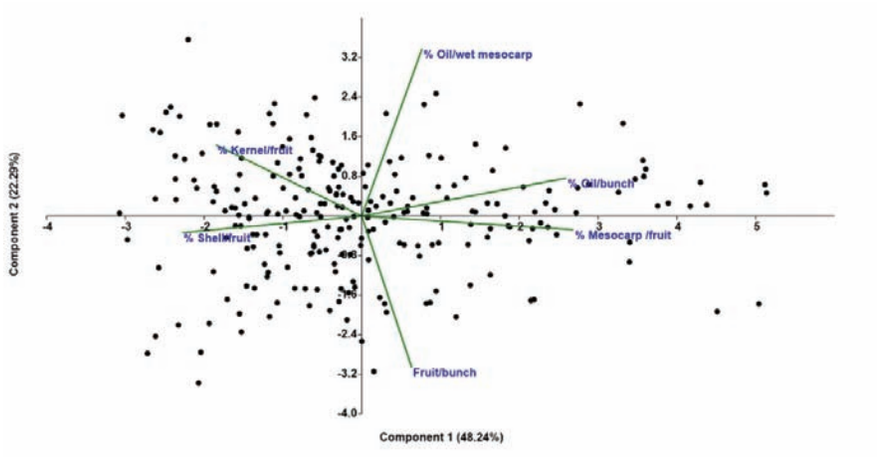


Fig 8: Principal component analysis for bunch traits

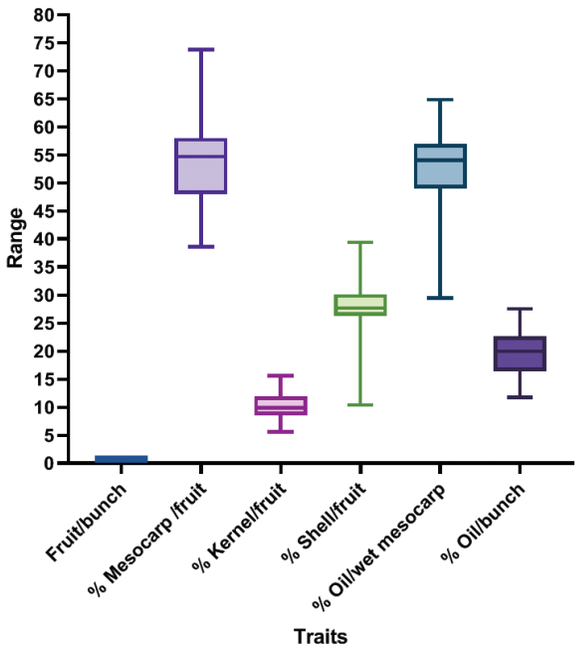


Fig 9: Box plots based on bunch traits

Fig 10: High yielding palm (P.No. 134)

Fig 11: High yielding palm (P.No. 197)

Table 1: Growth and yield performance of different crosses in Dura Improvement trial V

Treatment	Sex ratio	Girth (Cm)	Height increment (Cm)	Number of bunches	FFB (Kg/Palm/ Year)	Bunch index (%)
T1 (42CDx43CD)	0.47	272.88	24.08	8.44	99.23	0.25
T2 (497CDX43CD)	0.45	340.38	23.84	9.54	106.27	0.27
T3 (497CDX465CD)	0.50	281.01	27.44	9.87	113.50	0.28
T4 (465CDX42CD)	0.52	290.21	35.28	7.82	130.22	0.24
T5 (40CDX282CD)	0.51	270.74	29.06	11.35	121.73	0.38
T6 (410CDX42CD)	0.59	272.93	37.09	9.45	105.92	0.38
T7 (42CDX93CD)	0.48	286.26	33.50	11.62	124.89	0.40
T8 (42CDX42CD)	0.46	265.95	22.17	7.05	84.28	0.39
T9 (40CDX42CD)	0.55	290.82	34.27	9.03	109.89	0.39
T10 (42CDX257CD)	0.49	263.49	32.02	8.69	110.69	0.38
T11 (206CDX4D)	0.60	264.00	18.77	7.68	67.81	0.39

D61) and 73.58 (D84 X D61) kg/palm/year and similarly, number of bunches in a year varied between 4.3 (D48 X D61) and 6.9 (D84 X D61).

Palm no. 53 provided highest yield of 235.91 kg/palm/year with 21 bunches followed by 200.37 kgs from 12 bunches in palm no. 18 and 199.57 kgs from 16 bunches in palm no. 9. Similarly, average bunch weight varied between 9.3 (palm no. 3) to 26.6 (palm no. 82) kg/bunch.

Evaluation of DXD crosses (Dura Improvement Trial V) at Palode: Dura V improvement trail at Palode was planted in 2016 with twenty-five crosses. Among the crosses, lowest height increment of 36.1 cm/year was recorded in TP.011D with average FFB yield 84.63 Kg/palm/year followed by 39.6 cm/year in TP.032D with average FFB yield of 73.86 kg/palm/year. The highest sex ratio of 0.52 was observed in TP.021D with average FFB yield of 89.89 kg/palm/year from 9.1 bunches followed by 0.51 in PL.015D with average FFB yield of 95.29 kg/palm/year from 10.2 bunches. Among the 25 crosses, average FFB yield varied between 51.81 and 103.50 kg/palm/year. The highest average FFB yield of 103.50 kg/palm/year from 8.8 bunches was recorded in TK.005D followed by 102.50 kg/palm/year from 9.1 bunches in TP.025D.

Out of 675 palms, 13 palms were recorded FFB yield of more than 200 kg/palm/year and 22 palms recorded more than 180 kg/palm/year. The highest yield of 296.58 kg/palm/year from 24 bunches with average bunch weight of 12.4 kgs was recorded in palm no. 451 followed by 282.51 kg/palm/year from 32 bunches with average bunch weight of 8.8 kgs in palm no. 424. The highest average bunch weight of 19.0 kg/bunch with 247.02 kg/palm/year was recorded in palm no. 129 followed by 17.6 kg/ bunch with 193.66 kg/palm/year in palm no. 598.

Breeding for dwarfness in oil palm

Evaluation of DxD crosses (Dura Improvement Trial V) at Pedavegi: This experiment was planted in 2013 with 11 different crosses. Palm number 68 was identified as a highest yielder (267.6 kg/palm/ year) with 16 number of bunches followed by palm number 164 with 254.6 kg FFB/palm/year. Among the 11 crosses, 42CDX93CD recorded high FFB yield with 11.62 bunches and height increment of 33.50 cm (Table 1). Among the different progeny, total 23 palms recorded more than 200 kg FFB/palm/ year. (Table 2).

Evaluation of D x D crosses (Dura Improvement VI): All the palms among the five different crosses were screened and categorized based on height increment (14.75 - 58.50cm), leaf area (2.23 - 12.33 Sq. m), bunch index (0.09-0.72%) and FFB yield (10.24-148.97 kg/palm/year). Palm number 41 was identified as good yielder (148.97 kg FFB /palm/year) with 18 number of bunches (Fig. 12).

Evaluation of DXP hybrids at Pedavegi: DXP materials were planted during 2013 which included 8 different crosses *viz.,* 409CDX195P (T1), 100CD X 78P (T2), 540CD X 110P (T3), 45CDX110P (T4), 166CDX76P (T5), 83CDX76P (T6), 45CDX76P (T7) and 94dX76P (T8). Among the different crosses, 540CDX110P recorded high FFB yield (93.96 kg/palm/year) with 7.46 bunches and less palm height (29.99 cm) was recorded in 83CDX76P (Table 3). Individual palms were analyzed for yield data.Three palms recorded more than 150 kg FFB/palm/year, among which palm number 108 was identified as a good yielder (195.9 kg/palm/year) with 12 number of bunches.

Evaluation of precocity planting material: Non replicated trial of precocity material (DxD) was planted in the year 2016 and evaluated for growth and yield parameters. Palm number 16 was identified as better yielder with FFB yield of 114.5 kg/palm/year followed by palm number 36 (104.15 kg/palm/year). Among the different crosses, 230CDX465CD was identified as good yielder with less height increment (Fig 13).

Seed studies in oil palm

Experiments on breaking seed dormancy

To save time and increase the germination percentage, an experiment was conducted with Carbon-di-sulphide (CS_2) and Ethephon for breaking physical dormancy in oil palm hybrid seeds. Medium size Dura x Pisifera (DxP) seeds were used. Seeds were incubated in three concentrations (T1: 2.5ml/60 seeds, T2: 5 ml/60 seeds, T3: 7.5 ml/60 seeds and T4: Water as Control) with six soaking durations (P1: 5 days, P2: 10 days, P3: 15 days, P4: 20

Table 2: High yielding palms in Dura Improvement V

S. No.	Range of FFB (kg/palm/year)	No. of Palms	Number of Bunches	FFB yield recorded(kg/palm/year)
1.	>200	23	10-23	200.8 (P. No.184) to 267.6 (P. No.68)
2.	150-200	73	4-22	150.2 (P. No.205) to 199.3 (P. No.266)
3.	<150	96	3-18	106.3 (P. No.137) to 149.8 (P. No.410)

Table 3: Growth and yield performance of different DxP crosses

	Sex ratio	Height increment (cm)	Leaf Area (Sq. m)	Number of Bunches	FFB yield (kg/palm/year)	Bunch Index (%)
T1 (409CDX195P)	0.27	36.53	7.13	6.00	77.00	0.19
T2 (100CD X 78P)	0.35	34.56	7.12	4.92	60.11	0.23
T3 (540CD X 110P)	0.40	34.99	7.44	7.46	93.96	0.24
T4 (45CDX110P)	0.31	35.00	7.40	6.15	79.38	0.22
T5 (166CDX76P)	0.25	37.33	11.87	5.00	69.15	0.13
T6 (83CDX76P)	0.26	29.99	8.27	4.62	62.81	0.18
T7 (45CDX76P)	0.24	34.07	7.71	6.05	84.50	0.21
T8 (94dX76P)	0.29	41.24	6.86	5.23	76.90	0.20

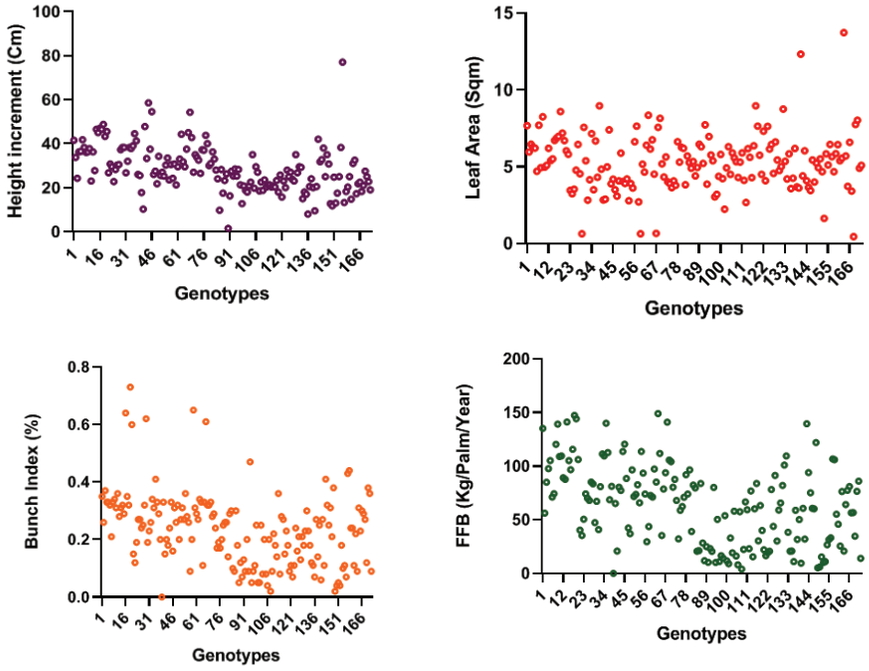


Fig .12: Scattered population of DxD crosses

Fig. 13: Growth and yield performance of different DxP crosses

days, P5: 25 days, P6: 30 days and P0: Control). Observations were recorded for germination of embryo (in two media *viz.*, germination paper and filter paper), seed and kernel germination and cellulose, hemi-cellulose and lignin contents in operculum plug of seed (Fig. 14). Microscopic observation was done on operculum disintegration and staining pattern of lignin through phloroglucinol (Fig. 15). From the results, embryo germination was observed only in filter paper. Control has recorded higher percentage of embryo germination (80%) followed by 5-10 days exposure of CS_2 irrespective of exposure period. More than 20 days exposure resulted in reduced germination in all the concentrations. Kernel did not germinate. Seed could germinate (7 to 47%) in 5 minute exposure of CS_2 in all concentrations. Analysis of cellulose, hemicellulose and lignin contents in the operculum plug indicated significant differences among the treatments and exposure periods, especially with respect to cellulose. Germination was completely affected by Ethephon treatment and no germination was noticed.

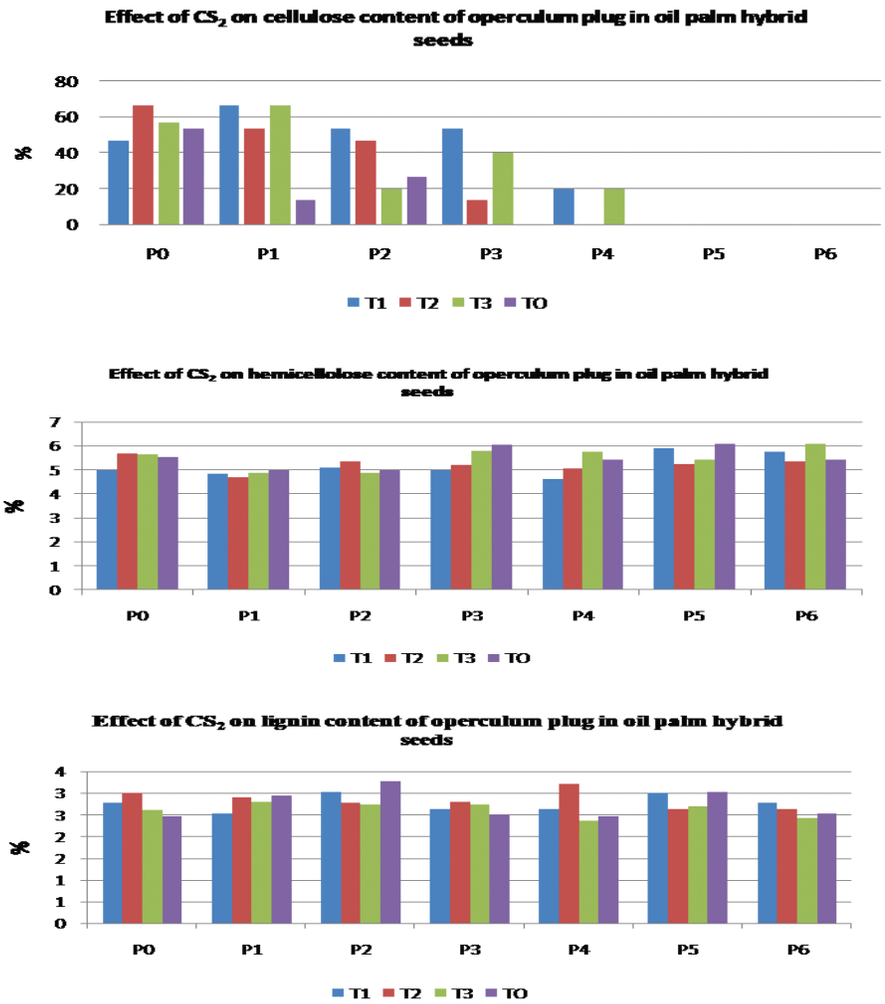


Fig. 14: Effect of CS_2 on cellulose (a), hemi-cellulose (b) and lignin (c) content of operculum plug in oil palm hybrid seeds

Evaluation of packing material for oil palm seed storage

Four packing materials viz. cloth bag, polythene bag – 400-gauge, super grain bag and tri-laminated aluminium foil bag were evaluated for efficacy in oil palm seed storage. During the six-month storage, though oil palm seed moisture content fluctuated in all packing materials, highest fluctuation of 14.2 to 8.9 per cent noticed in cloth bag whereas moisture fluctuation was lesser in super grain bag (between 14.8 to 12.1%) and tri-layered aluminium foil bag (between 14.8 to 11.2%). The loss in seed viability during six months storage was reduced from 98 to 78% in super grain bag and 98 to 72% in tri-layered aluminium foil bag whereas in cloth bag, seed viability reduced from 98 to 38% during six months storage.

The seed germination (radicle emergence) of stored seeds after breaking dormancy through heat treatment at 40^{0}C for 60 days showed that oil palm seeds stored in super grain bag gave 54% germination after 3 months storage whereas germination per cent was reduced to 30% in cloth bag during the same period.

De-operculated kernel germination technique

The seeds from four DXP crosses were evaluated for de-operculated kernel germination technique. The manual de-operculation efficiency

Fig. 15: Microscopic view of operculum plug and staining pattern of lignin content after treatments

varied between 85 and 100% which was totally depends on skill of the worker. The germination per cent in de-operculation technique varied between 76 and 82 per cent. The performance of medium and (3-5 cm length) large size (> 5cm length) sprouts were better in primary nursery planted in portrays.

Microbe-mediated dormancy breaking and enhanced germination in seeds of oil palm

Identified a crude enzyme of *Aspergillus* sp. VM-1 having high pectinase activity (551 U/ml) which was obtained from solid state fermentation of agro-residues (banana pseudo-stem and cotton residues). The crude enzyme of *Aspergillus* sp. VM-1 and its spore suspension (10^4 cells/ml) was evaluated for its effect on surface of oil palm seed coat. The oil palm seeds were treated with *Aspergillus* sp. VM-1 spore suspension at the rate of 1 % and incubated for one week showed the disruption of seed coat through the development of fungal growth in surface. This indicates that the fungus has the ability to grow on the surface of seed coat and disrupts the lignocellulosic structure which might be helpful in enhancement of seed germination. The small-scale germination test (30 seeds/treatment, consisting of three replications) showed the germination percentage was higher (70 %) in *Aspergillus* sp. VM-1 treated seeds than the conventional heat-treated seeds (40 %).

Oil palm hybrid seed production

At Pedavegi: 36,740 germinated seeds were supplied to different companies from Pedavegi seed production center.

At Palode: 1,19,500 number of oil palm DXP hybrid sprouts were supplied to palm oil companies to raise nursery for commercial planting.

Establishment of new oil palm seed gardens

Fifteen cross combinations of advanced dura parental materials have been developed

(1(13DEX74DE, 2DEX2DE, 543CDX207CD, 44DEX74DE, 2DEX74DE, 16DEX19DE, 13DEX2DE, 43DEX19DE, 410CDX410CD, 207CDX207CD, 8DEX47DE, 74DEX74DE, 13DEX47DE, 91DEX74DE, 17DX17D). 1500 seedlings are in secondary stage nursery, which are to be supplied for the establishment of new oil palm seed garden at Muthannaveedu, Eluru Dt., Andhra Pradesh under Department of Horticulture, Government of Andhra Pradesh.

Technical advices were given to oil palm seed gardens at Taraka and Kabini, Mysuru Dt., Karnataka; at West Serzwal, Mizoram; and at Gopannapalem, Eluru Dt., Andhra Pradesh for the early selection of mother palms.

294 mother palms were identified at Morampudi oil palm seed garden based on yield potential and advised to carry out bunch analysis.

358 mother palm seedlings to Morumpudi oil palm seed garden and 350 mother palm seedlings to Taraka oil palm seed garden were supplied to take up extension of existing seed gardens.

Project No. 1000761003: BIOTECHNOLOGICAL STUDIES IN OIL PALM

Standardization of oil palm tissue culture protocol for oil palm at Pedavegi

Immature male inflorescence is the most suitable explant for indirect somatic embryogenesis and for further regeneration in oil palm. In India, till now no efficient repeatable indirect somatic embryogenesis protocol is available. To meet the demand of world vegetable oil, there is a need to develop efficient *In-vitro* regeneration protocol to produce homogeneous and high yielding oil palm.

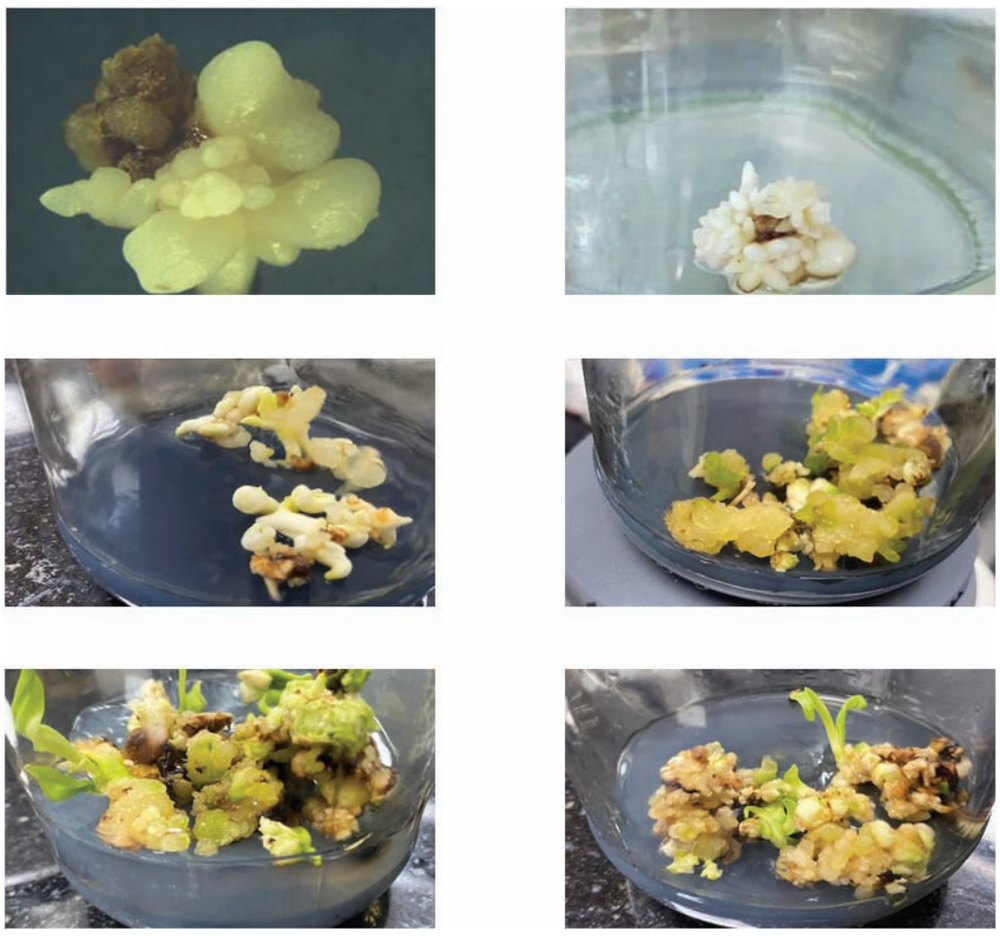


Fig. 16: Different stages of callus and somatic embryogenesis in oil palm

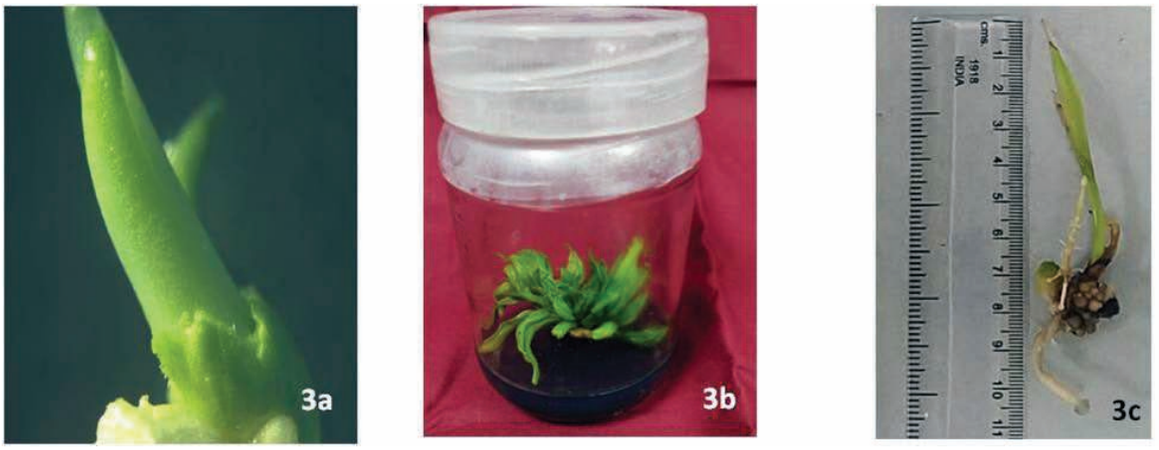


Fig. 17: Oil palm Shoot (3a, 3b) and root (3c) formation through *in-vitro* somatic embryogenesis from immature male inflorescence

Callusing and somatic embryogenesis: Five media combinations *viz.,* M1 to M5 were used for inoculation of 2820 cultures using immature male inflorescence. A total of 125 callus cultures were obtained which are all at the initiation stage, since the callus initiation takes nearly 4-9 months in oil palm. At present, 1200 somatic embryos, which are at different stages were present in the light growth conditions. These somatic embryos are ready for shoot induction medium. Different stages of somatic embryos are given in Fig. 16 and 17.

Organogenesis: The fully matured embryogenic calli which shown shoot initiation were transferred after five sub cultures (at 2-month interval) to a regeneration media (RM) consisting of GA, BA and NAA with reduced concentration of activated charcoal (500 mg/l). The basal media also reduced to half the concentration for proper growth. Once the shoot height reached to 4 to 5 cm, these cultures were transferred to rooting media (half basal media) with hormones like NAA and indole - 3 –butyric acid (IBA) with less concentration of

Fig.18: Glimpses of hardening of plants in the hardening chamber

activated charcoal (500 mg/l). The cultures were kept under rooting media till they attain good root system. Well rooted and shoot plants were moved to pots with agropeat which were covered with polythene sheet for a period of approximately two months.

Hardening: These well rooted (>5 cm length) and shooted(>10 cm in length) plantlets were transferred to potted mixture having sterile soil with 1:1:1 ratio of sand, vermi compost and coco peat for better growth. Then these pots were covered with polythene sheet to maintain the humidity. Two types of pots were used. One is big pots having 1 lit capacity and another is small with 200 ml cups which were covered with same cup with holes (Fig 18). During the first week, 10 to 20 ml of distilled water was used for irrigation, then ¼ MS basal liquid media was used for irrigating the plants. Till now 85 plants were hardened, of which four are in hardening medium which were transferred recently.

The clonal fidelity test was performed on five random ramets which were generated through somatic embryogenesis from immature male inflorescence. A total of 100 genome wide micro satellite markers (SSRs) were amplified among the five clonal materials. The agarose gel banding pattern showed that no deviation of allelic pattern was observed among the five ramets with 100 markers. It showed that clonal material obtained from somatic embryogenesis is homogeneous to mother palm at molecular level.

Standardization of oil palm tissue culture protocol at Palode

In the development of standardized oil palm tissue culture protocol both immature inflorescence and immature leaf explants exhibited improved callusing and better *in vitro* response. The immature unopened leaves located in the spear region were used as the explant. Callus appears along the ribs or cut side of the explant. Leaf explants inoculated in different media combination had shown earlier callus development and embryogenesis compared to the inflorescence explants. Within 2 to 8 months, 10-40% callusing was achieved in the refined medium using immature leaf explants. The explants callused early and efficiently on the Y3 medium supplement with Zeatin. Better somatic embryo maturation and polyembryonic development were observed in media supplemented with Picloram. For inflorescence explant, the callusing duration ranged from 3 to 18 months. The MS and Y3 media revealed to be the optimum for early callus initiation, potentially reducing callus initiation timing to three months. Although the leaf explants callused faster with more frequency (40-50%), the immature inflorescence gave better organogenic response. More than 1000 culture bottles are at different stages of development both in dark and light conditions.

Genomics approaches for enhancement of oil palm germplasm

Genome Wide Association (GWAS) mapping for important traits in oil palm using SSR markers: The GWAS is powerful tool, especially in perennial crops like oil palm, where generation of linkage mapping populations is a difficult task due to their long breeding cycle. It is more preferable than linkage mapping in oil palm due to its ability to give more mapping resolution, higher alleles in less time and use of natural diverse population. For identification of QTLs for economic traits, 550 micro satellite markers which were spread throughout the genome were used for association mapping. Natural population (germplasm obtained from different sources) was used for GWAS analysis. Fifty-three genotypes from germplasm block 4 (GP4), 95 germplasm from germplasm block 5 (GP5) and 123 germplasm belongs to germplasm block 7 (GP7) experiments of the institute were used for genetic diversity, population structure analysis and GWAS analysis.

A total of 154 polymorphic primers were used for genotyping of 53 genotypes of GP4 block, 75 polymorphic markers were used for screening of 95 genotypes of GP5 block, whereas 50 polymorphic primers were used for genotyping of 123 GP7 genotypes. The polymorphism

information content (PIC) across the primers varied from 1.14 to 0.75 at an average of 0.47. The polymorphism content like gene diversity, heterozygosity, PIC values, major allele frequency are given in Table 4.The UPGMA dendrogram analysis of GP 7 block has showed that the genotypes were broadly grouped into three major groups (Fig. 19). However, the genotypes *viz.,* palm number 70 and 34 formed a separate cluster. Likewise, four genotypes (palm no. 21, 24, 72, 74 and 77) formed a separate cluster. These genotypes might be having special characters which need to be studied in detail.

Principal component analysis of height increment (HI) with other traits: Height increment was found to be positively correlated with average bunch weight than the other traits. The principal component analysis and inter-relationships of height increment with four bunch

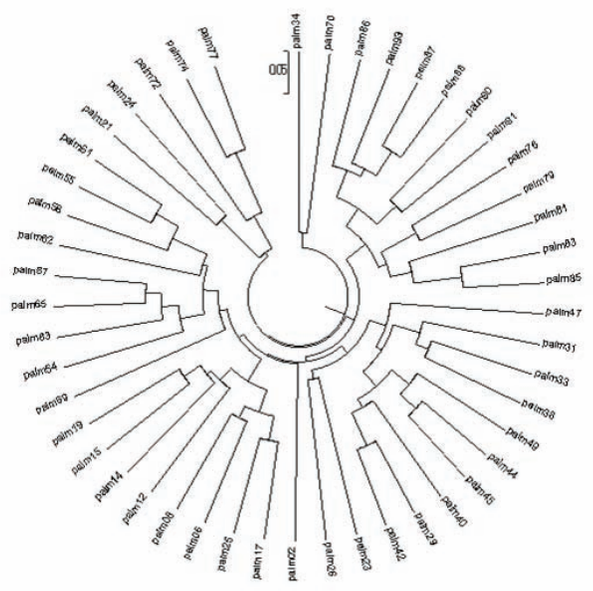


Fig. 19:The UPGMA analysis of the GP7 genotypes using microsatellite markers.

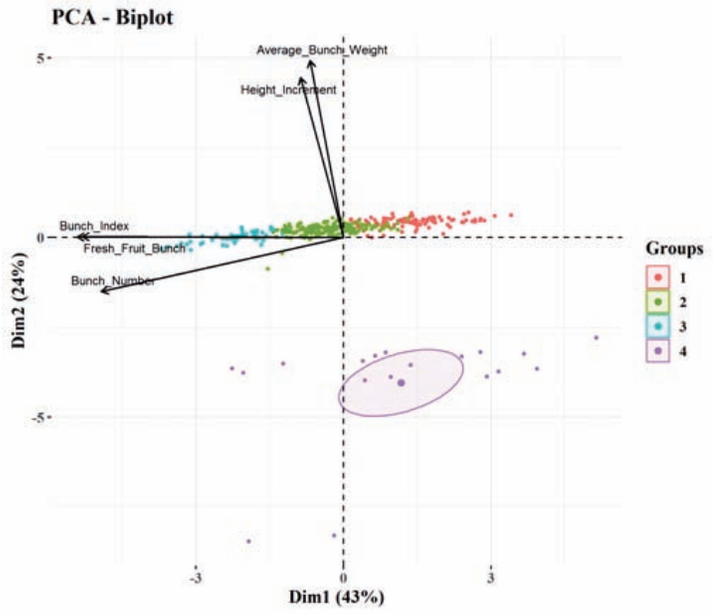


Fig. 20: Principal component analysis of African germplasm for height increment with other traits

Table 4: Polymorphism details of micro satellite markers among germplasm

Parameter	Maximum	Minimum	Mean
Major allele frequency	0.92	0.35	0.57
Allele no	5.00	2.00	3.61
Gene Diversity	0.74	0.15	0.53
Heterozygosity	0.96	0.08	0.43
PIC	0.69	0.14	0.46

yield and oil yield traits was studied. The first two PCA components explained maximum amount of variation, while subsequent components contributed less. The optimal number of clusters obtained was four (Fig.20).

Validation of the significant SSR locus linked to qtlH2 for less height increment: Number of populations were used for validation of the major QTL (qtlH2) identified for less height increment by the integrated molecular approaches. Initially the marker was checked for its differentiation among the African germplasm which was used for GWAS analysis. In this germplasm, it could be able to differentiate dwarf and tall germplasm, which was also correlated with the phenotypic data (Height increment observations) of more than 7 years (Fig. 21a). The same marker was also validated in the progeny derived from the cross between dwarf and tall germplasm. The microsatellite marker could be able to differentiate the progeny into dwarf and tall types which is correlated with the phenotypic data of four years (Fig. 21b). Then the marker was also tested against one highly dwarf palm (Palode dura, PD) which is available at our experimental farm since manyyears. This palm also showed dwarf banding pattern (Fig. 21c). Based on the integrated molecular approaches and its validation analysis, this SSR locus is considered as a major QTL for stem height increment which is responsible for dwarfness. This marker can be effectively used in marker assisted selection programmes in selecting dwarf germplasm at an early stage and for their further pre breeding applications.

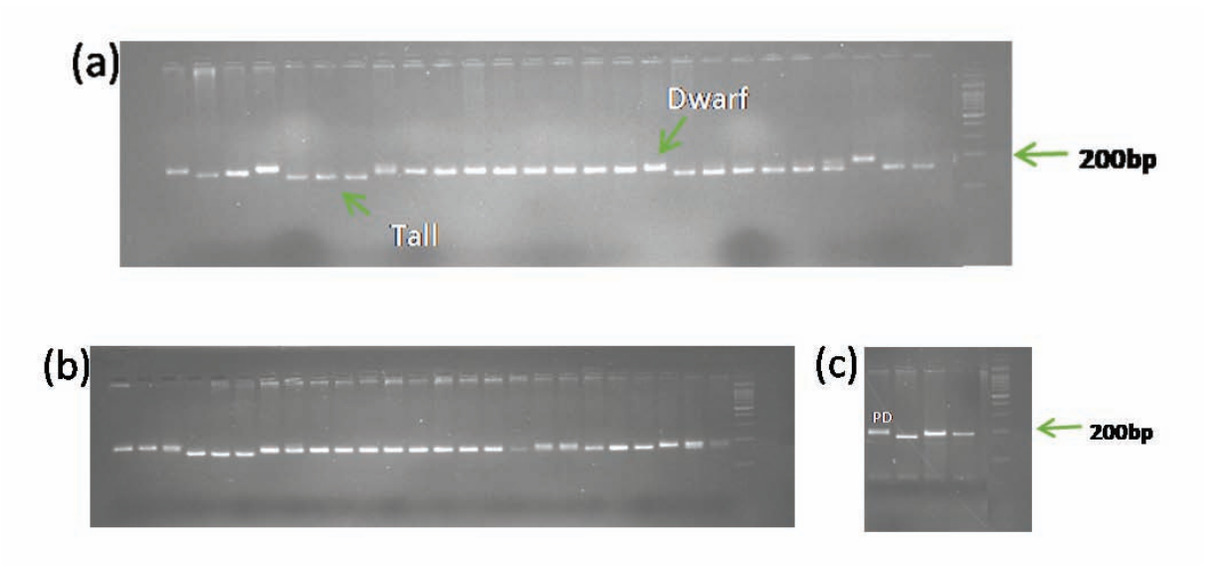


Fig. 21. Differentiation of dwarf and tall germplasm using SSR marker mEgCIR0059 on (a) African germplasm, (b) progeny and (c) Palode dwarf

Project No. 1000763002: EFFICIENT RESOURCE MANAGEMENT STRATEGIES IN OIL PALM PRODUCTION SYSTEM

Irrigation management strategies in oil palm

Oil palm requires about 150 mm of water per month at an averaged crop ET_0 rate of 5 mm per day. Being indeterminate in nature, ample water supply is essential throughout the year. The rainfall pattern in India is bimodal monsoon type and both the monsoons are not effective in majority locations. Therefore, in India, major part of oil palm plantations is under irrigation. As mentioned earlier, indeterminate habit of growth in this crop warrants continuous supply of water for harvesting better FFB yields. So, for efficient water management micro-irrigation techniques are adopted through drip or micro-jet methods. This has resulted in considerable reduction in water application rates in oil palm. Consequent to this, further improvement in water application and water use efficiencies has been tried through various water application and conservation techniques *viz.*, plastic mulching, inline drippers and in-situ mulching with oil palm fronds were compared with drip and micro-jet systems under different levels of deficit irrigation. This trial was initiated on 15.5.2019. Yield attributes *viz.,* bunch number and weight were recorded from each harvest. Water use efficiency in terms of litres of water used to produce one kg FFB was estimated. Treatments were also evaluated for difference in sex ratio (Table 5).

Plastic mulching under drip system with 25 per cent deficit irrigation was effective in producing higher yield on-par with that of 100 per cent irrigation under drip or inline dripper or micro-jet methods as it resulted in 25 per cent saving in water. This combination has utilized minimal quantity of water (233 litres) to produce one kg FFB in

Table 5: Effect of mulching and different micro-irrigation methods on irrigation use efficiency of oil palm

Treatment	Number of Bunches	Bunch weight (kg/palm)	Water used (litres/kg FFB)	Sex ratio
Plastic mulching + 100% drip	7.5	216.72	301	0.574
Plastic mulching + 75% drip	7.7	210.23	233	0.522
Plastic mulching + 50% drip	6.7	149.22	219	0.447
Plastic Mulching with inline drippers 100%	7.7	215.23	303	0.559
Plastic Mulching with inline drippers 75%	8.3	195.23	251	0.486
Plastic Mulching with inline drippers 50%	6.7	141.34	231	0.425
No mulching Drip 100%	6.6	165.72	394	0.473
No mulching Drip 75%	5.2	150.35	326	0.452
No mulching -In line drippers 100%	6.3	163.23	400	0.466
Micro-jets (Normal practice)	8.8	207.22	608	0.545
In-situ mulching Drip 100%	7.4	197.24	331	0.504
In-situ mulching -Inline drippers 100%	6.8	190.42	343	0.517
In-situ mulching with micro-jets	9.0	234.27	538	0.593
CD (0.05)	1.24	52.23	47	NS

comparison with all other treatments. Though micro-jet method of irrigation could record higher yields both under mulched and non-mulched conditions, water used to produce each kg of FFB has been very high in comparison with any other method. Sex ratio did not get affected significantly under different methods of irrigation.

Irrigating oil palm through drip or inline dripper system in combination with plastic mulching is effective in water saving up to 25 per cent. Water utilized to produce each kg of FFB in these two methods of irrigation was 233 and 251 litres respectively. Microjet irrigation utilized 530 and 608 litres of water respectively to produce one kg of FFB in mulched (*in situ*) and non-mulched conditions, respectively.

Nutrient management strategies in oil palm plantations

A factorial field trial with 27 treatments has been initiated in January 2018 with two tenera crosses (54DX77P and 170DX76P) to optimize the most economic nutrient dose for NPK. Observations on growth, yield parameters and physiological parameters were collected. Improvement in SPAD chlorophyll index was recorded with higher levels of N application. Among the three nutrients evaluated, response to potassium application was high and it was followed by nitrogen application. FFB yield recorded was high in N1P2K2 and it was closely followed by N2P1K2 and then N1P1K1. Plant height and stem girth are also good in these two treatments. Among these three treatments, higher number of leaves and taller plants were recorded in N2P1K2, followed by N1P2K2 and N1P1K1 (Table 6).Seasonal variation in FFB production under different nutrient regimes has been estimated and presented in the fig. 22. In general, FFB production was higher during September in different nutrient regimes which is influenced by South-West monsoon during bunchdevelopment stage. Correlations were estimated between soil characteristics, leaf nutrient levels and bunch number and yield across different nutrient regimes and presented in Table 7.

Comparison of DRIS indices of Krishna and West Godavari districts: DRIS norms and DRIS indices generated are of great help in designing efficient nutrient management schedules for the surveyed area especially in crops like oil palm. A positive index of DRIS represents adequate and exceeding levels of the nutrient under consideration, whereas a negative DRIS index points out below a sufficiency level; thus, the nutrient requirement can be ordered comparative to one another. A study on comparison between the DRIS indices and optimal leaf nutrient concentrations of two adjacent districts in Andhra Pradesh viz., West Godavari and Krishna has been made to find out whether district level DRIS norms need to be developed for precise application of nutrients in oil palm (Fig. 23). The optimal leaf nutrient concentrations and DRIS derived order of importance of nutrients varied widely among the two districts compared. In West Godavari, the order of importance of nutrients is B > Mg > K > N > P. The optimum concentrations of leaf nutrients were 1.57–2.63% for N, 0.08–0.16% for P, 0.48–0.88% for K, 22.6–60.2 mg kg^{-1} for B and 0.25–0.71% for Mg. In case of Krishna district, it is Nitrogen (N)>B> K>P>Mg. Optimum leaf nutrient ranges varied from 2.07-4.29%, 0.13-0.27%, 0.52-0.94%, 44.97-102.70 mg/kg and 0.44-0.76% for N,P,K, B and Mg respectively. On the basis of DRIS-derived optimum ranges, oil palm plantations of Krishna basin consisted of 15%, 6%, 16%, 9%, and 12% of populations with less than optimum concentration for nitrogen (N), P, K, Mg, and B, respectively. Large variations noticed in DRIS indices and critical leaf nutrient concentrations of adjacent districts (Krishna and West Godavari) of Andhra Pradesh which warrant development of location specific standards for precise nutrient management in oil palm plantations.

Spatial analysis of soil properties: The advantage of spatial analysis is that we can estimate the degree of spatial dependence of different geographic properties which would help in estimating the values for unsampled locations. The semi variogram is an effective tool for evaluating spatial variability of soil properties. ArcMap 10.3

Table 6: Yield and biometric parameters under different nutrient regimes

	Plant Height (cm)	Stem girth (cm)	No. of leaves	Leaf P (%)	Leaf K (%)	Leaf Mg	Leaf S (%)	Leaf B (ppm)	Bunch Number	Bunch Weight (kg/palm)
N0	519.94	241.44	33.64	0.164	0.631	4.306	0.157	90.808	4.27	23.76
N1	556.77	258.84	36.18	0.143	0.635	3.867	0.141	97.494	5.32	30.18
N2	556.23	260.99	35.53	0.145	0.619	3.972	0.181	98.942	5.56	32.22
P0	539.62	250.17	35.37	0.155	0.655	4.033	0.159	96.735	3.91	19.09
P1	546.79	256.52	35.37	0.155	0.633	3.967	0.174	93.127	5.43	33.24
P2	546.53	254.59	34.60	0.142	0.598	4.144	0.144	97.381	5.78	33.82
K0	543.31	248.48	34.69	0.137	0.573	4.128	0.148	95.833	4.40	25.95
K1	537.24	253.89	35.16	0.169	0.596	4.000	0.168	100.358	5.10	28.32
K2	552.39	258.91	35.50	0.147	0.716	4.017	0.161	91.051	5.62	31.89
N0P0K0	494.69	235.00	35.75	0.146	0.651	4.652	0.105	80.672	3.56	13.56
N0P0K1	511.71	230.59	30.93	0.221	0.659	4.311	0.106	136.985	2.67	11.24
N0P0K2	550.73	257.19	34.73	0.152	0.634	3.752	0.116	89.691	7.15	34.39
N0P1K0	513.61	227.92	27.80	0.157	0.303	4.134	0.163	66.108	4.30	30.71
N0P1K1	520.87	242.14	36.55	0.184	0.809	5.252	0.208	109.407	3.81	19.87
N0P1K2	529.37	250.62	35.19	0.174	0.725	2.624	0.197	45.361	4.56	20.82
N0P2K0	522.52	252.91	38.06	0.074	0.586	5.453	0.215	92.912	3.92	24.43
N0P2K1	511.25	241.56	32.44	0.191	0.500	4.152	0.112	87.113	5.31	24.76
N0P2K2	524.69	235.00	31.25	0.181	0.812	4.534	0.186	109.021	3.13	14.05
N1P0K0	531.28	240.59	29.47	0.148	0.578	3.925	0.095	83.763	3.26	14.45
N1P0K1	545.55	256.71	45.10	0.132	0.536	4.252	0.203	97.036	4.77	27.01
N1P0K2	578.13	256.87	36.06	0.183	0.717	2.867	0.141	95.492	3.50	15.63
N1P1K0	590.18	261.43	41.64	0.161	0.634	3.323	0.088	117.268	4.37	25.13
N1P1K1	564.46	265.71	36.41	0.131	0.512	3.952	0.152	100.902	8.29	46.32
N1P1K2	523.44	274.06	30.51	0.145	0.806	4.224	0.238	83.119	5.38	36.67
N1P2K0	554.79	249.91	35.77	0.118	0.618	3.921	0.096	101.418	4.23	19.86
N1P2K1	554.44	255.97	29.28	0.139	0.588	4.215	0.157	98.196	6.05	38.05
N1P2K2	568.61	268.33	41.39	0.129	0.731	4.362	0.112	100.258	8.06	48.78
N2P0K0	556.04	257.19	36.27	0.129	0.695	4.051	0.191	96.263	4.35	26.20
N2P0K1	533.12	261.25	37.81	0.182	0.802	4.223	0.234	93.041	2.44	11.92
N2P0K2	555.28	256.11	32.22	0.106	0.619	4.421	0.242	97.682	3.44	17.42
N2P1K0	561.32	259.93	35.05	0.173	0.537	4.552	0.242	107.088	5.43	24.61
N2P1K1	535.62	264.37	31.21	0.145	0.558	2.823	0.192	108.247	5.15	28.04
N2P1K2	582.19	262.52	44.00	0.121	0.813	4.951	0.086	100.644	7.56	47.29
N2P2K0	565.36	251.43	32.36	0.123	0.553	3.252	0.138	117.01	6.21	34.55
N2P2K1	558.09	266.72	36.72	0.194	0.406	2.933	0.148	72.294	7.37	47.97
N2P2K2	559.07	269.46	34.14	0.134	0.586	4.652	0.148	98.196	7.77	51.97
CD 5%										
1 Factor	23.549	6.366	3.201	0.027	0.118	0.716	0.064	14.846	0.874	8.778
2 Factors	40.788	11.026	5.544	0.047	0.204	1.240	0.111	25.715	1.513	15.204
3 Factors	70.647	19.097	9.603	0.081	0.354	2.147	0.192	44.439	2.621	26.334

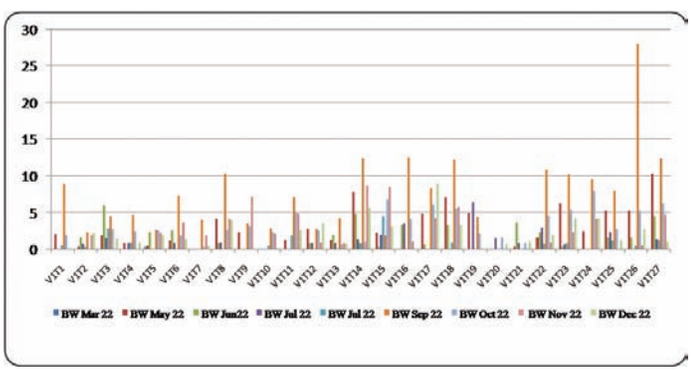


Fig. 22: Seasonal variation in FFB yield (T/ha) under different nutrient levels

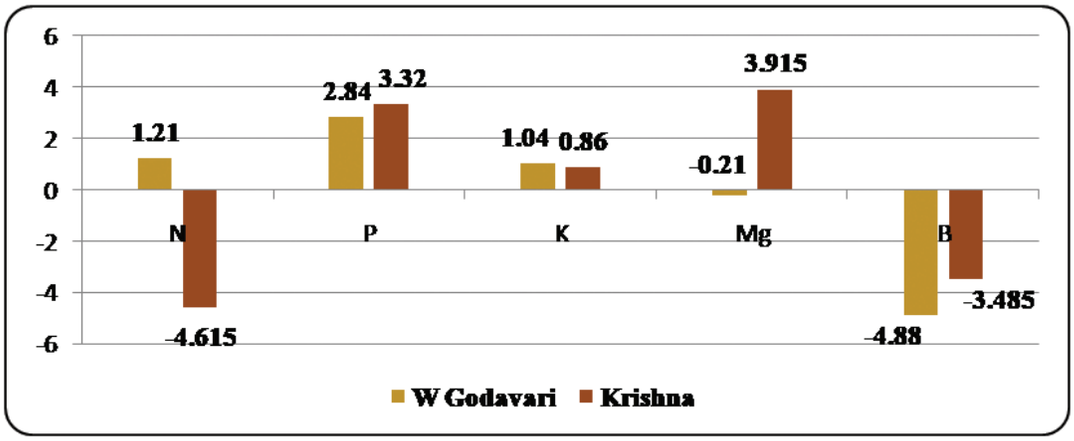


Fig. 23: Comparison of DRIS indices of Krishna and West Godavari Dts., Andhra Pradesh

Table 7: Correlation matrix among soil parameters, leaf nutrients and FFB production

	pH	EC	OC% (kg/ha)	K (kg/ha)	Ca (meq/ 100g)	Mg	SO4-S	B	BW	BN	Leaf P%	K %	Ca %	Leaf Mg %	S %	B ppm	P
pH	1.000																
EC	-0.172	1.000															
OC%	0.286	-0.001	1.000														
P (kg/ha)	-0.033	-0.317	-0.276	1.000													
K (kg/ha)	0.203	-0.082	0.040	0.236	1.000												
Ca (meq/100g)	0.257	-0.015	-0.081	0.209	0.234	1.000											
Mg	0.187	-0.097	-0.085	0.121	0.163	0.220	1.000										
SO4-S	0.026	-0.163	-0.122	0.057	-0.035	0.182	0.108	1.000									
B	-0.118	0.296	-0.020	0.038	-0.124	0.051	0.071	0.077	1.000								
BW	**-0.052**	**-0.201**	**0.027**	**0.149**	**0.219**	**0.075**	**0.063**	**0.030**	**0.020**	**1.000**							
BN	-0.051	-0.193	-0.024	0.149	-0.193	0.014	0.174	0.151	-0.042	**0.860**	1.000						
Leaf P%	-0.154	-0.079	-0.043	0.200	0.000	0.084	-0.081	-0.240	-0.388	**0.088**	0.118	1.000					
K %	0.074	0.143	0.223	-0.060	0.255	0.213	0.045	-0.323	-0.174	**-0.125**	-0.054	0.127	1.000				
Ca %	-0.064	0.025	-0.056	0.025	-0.066	-0.020	0.305	-0.060	0.100	**-0.116**	-0.129	0.201	-0.056	1.000			
Leaf Mg %	-0.019	0.003	-0.116	-0.213	-0.092	0.032	-0.131	0.239	0.004	**-0.059**	-0.017	-0.071	0.137	-0.110	1.000		
S %	-0.081	-0.017	-0.017	-0.080	-0.159	0.008	0.142	0.206	0.125	**-0.057**	-0.062	-0.057	-0.204	0.449	-0.058	1.000	
B ppm	-0.027	0.264	-0.235	0.123	0.158	0.399	0.037	0.085	0.128	**-0.044**	-0.046	-0.077	0.207	0.130	0.032	-0.020	1.000

was used to analyze the spatial structure of surface soil properties of samples collected from Krishna district and to define the semi variograms. From semi variograms, differences in nugget/sill ratio and range were examined for soil properties. For Krishna district, all semi variograms in anisotropic form were fit using stable, circular, spherical and exponential models. Spatial dependence of surface soil properties ranged between weak to strong. Among them, pH, exch. Ca and exch. Mg had shown strong spatial dependence because of low N:S (Nugget/Sill) ratio (<0.25). Moderate spatial dependence was noticed in EC, soil OC, Olsen-P, NH4OH-K and CaCl2-S. Only HWB recorded to have low spatial dependence. Strong spatial dependence is ascribed to the intrinsic factors like rock from which the soil is formed, minerology, slope etc. Whereas, weak spatial dependence could be attributed to the extrinsic factors mostly anthropogenic ones which influence the soil properties like management practices, fertilizer application, irrigation, ploughing, crop rotation etc. Moderate spatial dependence could be due to both extrinsic and intrinsic factors combined together.

Demand based differential split application of fertilizers in oil palm plantations: In May 2019, a field trial has been initiated to find out rational doses of nutrients in different seasons based on nutrient demand. Under this nine treatment combinations were evaluated and observations on yield attributes and sex ratio were recorded. The treatments in which N and K were applied at higher rates during April and July and at lower rates during

January and October recorded higher FFB yield. No significant differences in sex ratio were observed among different treatments (Table 8).

Crop geometry studies in oil palm

In order to optimize the spacing between and within the rows of oil palm, a field trial was initiated in 2018 under irrigated conditions of India with seven different treatments, which include square, rectangle and equilateral triangle orientations. Among different treatments, 9 m hexagon recorded the maximum plant height and 10 x 7 m rectangle recorded maximum stem girth and number of leaves per plant. Higher FFB yield was recorded in 10 x 7 m rectangle and it was closely followed by 9 m hexagon system (Table 9). Even under different crop geometries, FFB production varied widely during different months. Higher production recorded during monsoon period especially during SWM (Fig 24). All the geometries behaved almost similarly during different months.

Best management practices for boron fertilization in oil palm plantations

The soil samples under different taxonomical class *viz.,* entisols, alfisols, inceptisols, vertisols were collected for understanding the boron fractions and their relationship with the soil properties. The total B content in soils ranged between 114 – 176, 84.9- 157 and 62.5-115 mg/kg, respectively in 0-20, 20-40, and 40-60 cm soil depths. Irrespective of the soil depth, inceptisols had higher content of total soil B (Fig. 25). Considering the relationship between boron fractions and soil properties, readily soluble B is positively correlated with soil pH, and negatively correlated with sesquioxides and Fe_2O_3 content. Specifically adsorbed and organically bound B have significant positive correlation with SOC. Oxide bound B is positively correlated with sesquioxides and Fe_2O_3 content. The residual B is

Table 8: Yield parameters and sex ratio as influenced by differential splits of nutrients

Trt	Nutrient	Jan (%)	Apr (%)	Jul (%)	Oct (%)	No of bunches	FFB yield (kg/palm)	Av bunch yield (kg)	Sex ratio
T1	N	20	30	30	20	7.63	183.79	24.09	0.589
T2	N	15	35	35	15	7.47	169.85	22.75	0.660
T3	N	20	30	30	20	6.29	148.59	23.62	0.480
	K	20	40	20	20				
T4	N	15	35	35	15	8.74	206.14	23.58	0.589
	K	20	40	20	20				
T5	N	20	30	30	20	4.81	117.31	24.39	0.423
	K	20	40	20	20				
	B	0	50	50	0				
T6	N	15	35	35	15	5.81	125.11	21.52	0.502
	K	20	40	20	20				
	B	0	50	50	0				
T7	N	20	30	30	20	7.33	209.71	28.60	0.572
	K	20	40	20	20				
	B	0	50	50	0				
	Mg	0	0	50	50				
T8	N	15	35	35	15	6.12	209.07	34.16	0.601
	K	20	40	20	20				
	B	0	50	50	0				
	Mg	0	0	50	50				
T9	Control	25	25	25	25	6.18	140.98	22.82	0.589
	CD 5%					1.13	32.27		NS

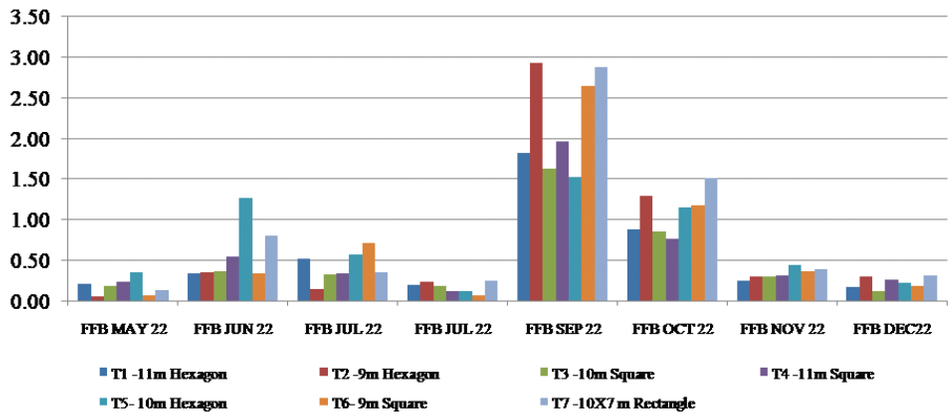


Fig. 24: Seasonal influence on FFB production under different crop geometries

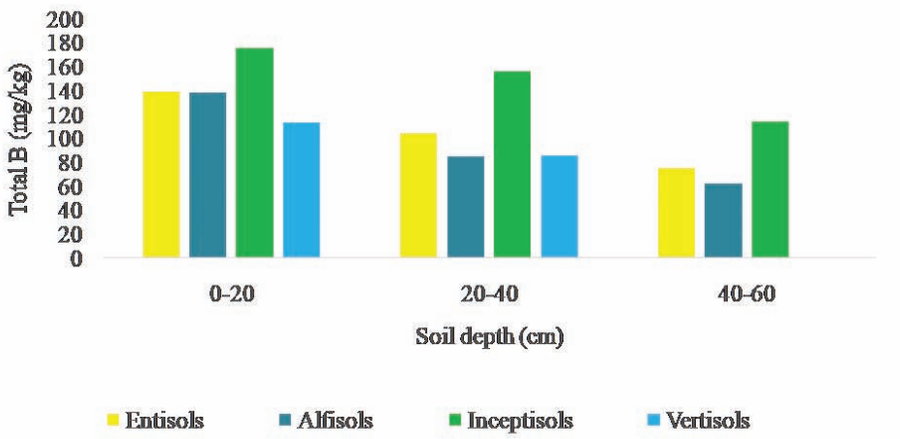


Fig. 25: Total Boron content in different soil types

negatively correlated with SOC & positively correlated with sesquioxides. The correlation matrix between soil properties and B fractions in alfisols is furnished in Table10.

Boron adsorption and desorption pattern in different soil types: Adsorption and desorption behaviour of B is studied with varying concentration *viz.*, 0, 2.5, 5.0, 7.5, 10.0, 12.5, 25, 50, 75, and 100 mg L^{-1}. The adsorption characteristics of B in different soil types is shown in Fig.26. The adsorption of B is maximum in vertisols and minimum in entisols irrespective of the concentration of B solution. B adsorption in soils followed the order: Vertisols> Alfisols> Inceptisols> Entisols. It shows that an increase in B adsorption with increase in the clay content of the soil. Adsorption behaviour of nutrients in the soil and its availability to the plant have been described by various adsorption models such as Freundlich, Langmuir, Temkin and Van Hany isotherms (Fig. 27). From the correlation coefficients obtained from all models, the Freundlich adsorption isotherm model explained the B sorption in a better way than other adsorption isotherms invertisols. This model assumes the multilayer adsorption of B on heterogeneous adsorption sites. The Freundlich constant 1/n refers to the adsorption intensity or surface heterogeneity and their values less than unity in all soil types indicates the favorable adsorption. The Langmuir adsorption model fitted well for alfisols, entisols and inceptisols. Highest B adsorption capacity is found in vertisols whereas it is lowest in entisols.

Boron adsorption kinetics: The kinetics of B adsorption decides the fixation and release of applied B and thus controls the efficiency of B

Table 9: Yield and growth parameters as influenced by different plant geometries

Treatments	Plant Height (cm)	Stem girth (cm)	No of leaves	Number of Bunches / palm	Bunch Weight/ palm	FFB yield (t/ha)
T1 -11 m Hexagon	605.5	272.6	40.17	7.09	46.10	4.38
T2 -9 m Hexagon	674.5	292.4	40.3	5.22	39.08	5.59
T3 -10 m Square	647.6	273.9	38.8	6.39	49.19	3.92
T4 -11 m Square	620.1	291.2	38.7	6.95	57.06	4.74
T5- 10 m Hexagon	603.9	277.7	37.8	6.02	48.51	5.63
T6- 9 m Square	633.9	290.2	38.1	6.42	44.63	5.53
T7 -10X7 m Rectangle	631.8	303.1	49.8	5.83	46.29	6.62

Table10: Correlation matrix among soil properties and Boron fractions

	pH	SOC	$CaCO_3$	Sesquioxides	Fe_2O_3
Readily soluble B	0.377*	0.163	-0.205	-0.612**	-0.443*
Specifically adsorbed B	-0.126	0.787**	-0.297	-0.154	-0.236
Oxide bound B	-0.238	-0.324	0.015	0.407*	0.510**
Organically bound B	0.159	0.388*	-0.141	-0.275	-0.200
Residual B	-0.263	-0.491**	-0.083	0.367*	0.258
Total B	-0.249	-0.440*	-0.107	0.345	0.252

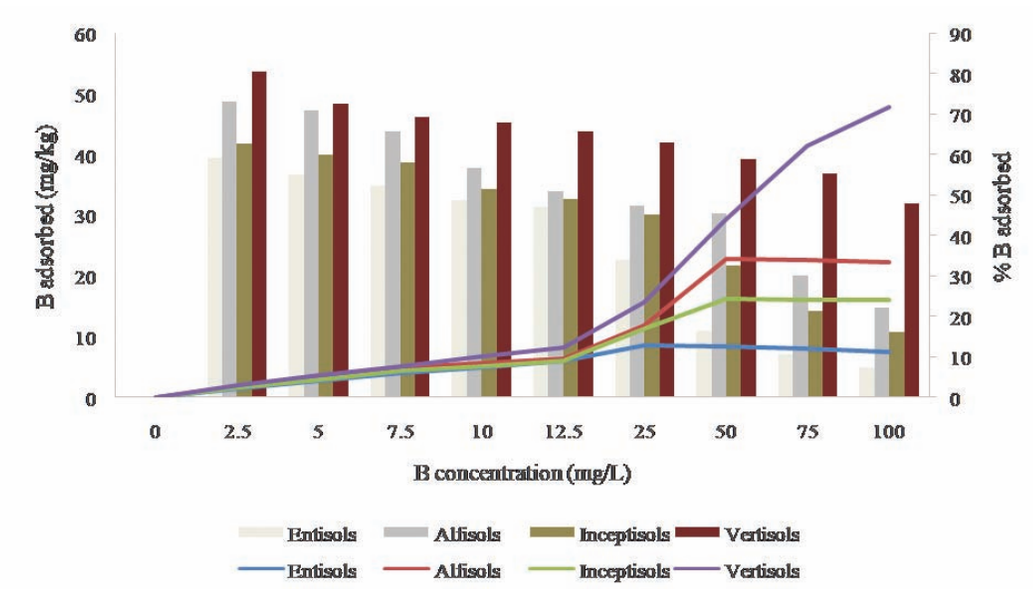


Fig. 26: Comparison of Boron adsorption in different soil types

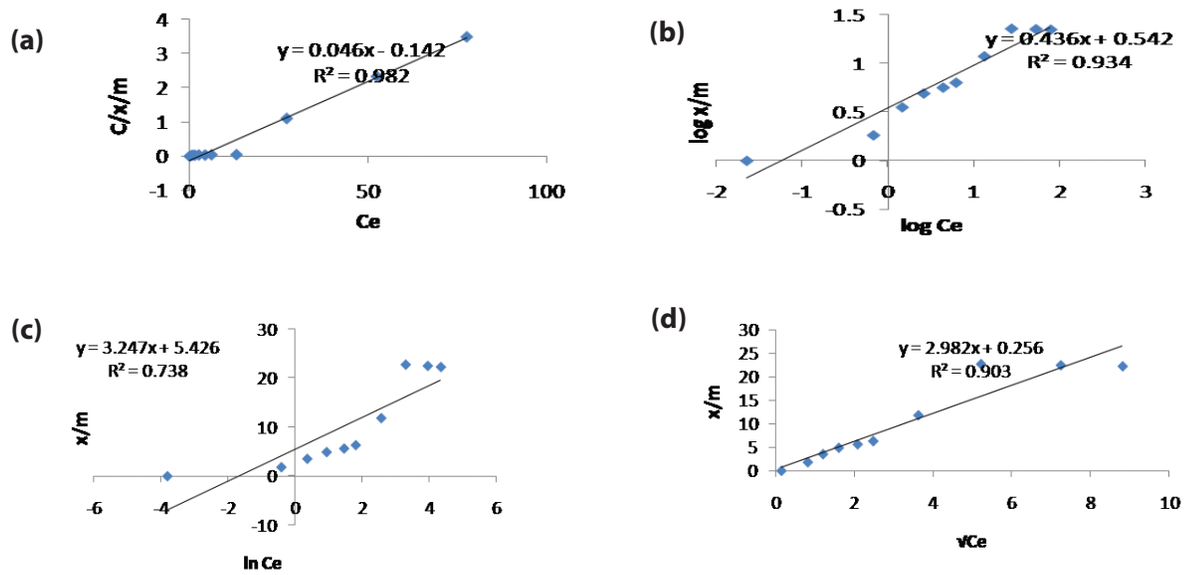


Fig. 27: Comparison of linear plots of (a) Langmuir, (b) Freundlich, (c) Temkin and (d) Van Hany isotherms for alfisols

fertilization. B adsorption by different soils is studied in varying time intervals ranging from 30 minutes to 72 hours. The kinetic equations (zero order, first order, second, elovich, intra particle diffusion, and power function) are used for describing the B adsorption in soils (Fig. 28). The B equilibrium attained in 24 hrs in alfisols and inceptisols, 12 hrs in entisols, whereas in vertisols, the equilibrium is not completed until 72 hours. From the correlation coefficients obtained from all models, the second order kinetic model explained the B sorption in a better way followed by elovich and power function kinetic models in different soil types.The second order kinetic model describes the chemisorption which involves sharing of electrons between soil and boron. To obtain valid information pertaining to process involved in the adsorption mechanism, the data were further examined by intra particle diffusion model (Fig. 28e). The multi linear plots (mostly three) were obtained from diffusion model which shows that three stages were associated with the sorption of B onto the soil. Desorption of B is higher in entisols in most of the added B concentrations (Fig. 29).

Weed dynamics in oil palm plantations

Oil palm being grown under irrigated conditions in peninsular India, facilitates growth of a large variety of weed species. Among them, if dominant species are identified through relative dominance, relative frequency and importance values, their control becomes more effective. With this objective, a study has been initiated in 2021 by conducting survey in existing oil palm plantations and estimation of weed frequency and dry matter production through quadrate method. The data generated from sole crop of oil palm is presented in figure 30. Among 39 weed species identified in oil palm basins, *Parthenium hysterophorus* was found to be more predominant with highest count of plants and *Acalypha indica* is having high frequency. The most dominant weed species in oil palm plantations of West Godavari Dt., Andhra Pradesh are given in Table 11.

Project No. 1000763003: OIL PALM BASED FARMING SYSTEMS

Oil palm based cropping systems

Experiment on introduction and evaluation of ornamental gingers in mature oil palm plantation has been initiated in September 2021 to identify the best performers. Ornamental gingers are speciality or premium cut flowers which are perennial in nature and mostly seasonal in flowering. The ornamental gingers under trial are

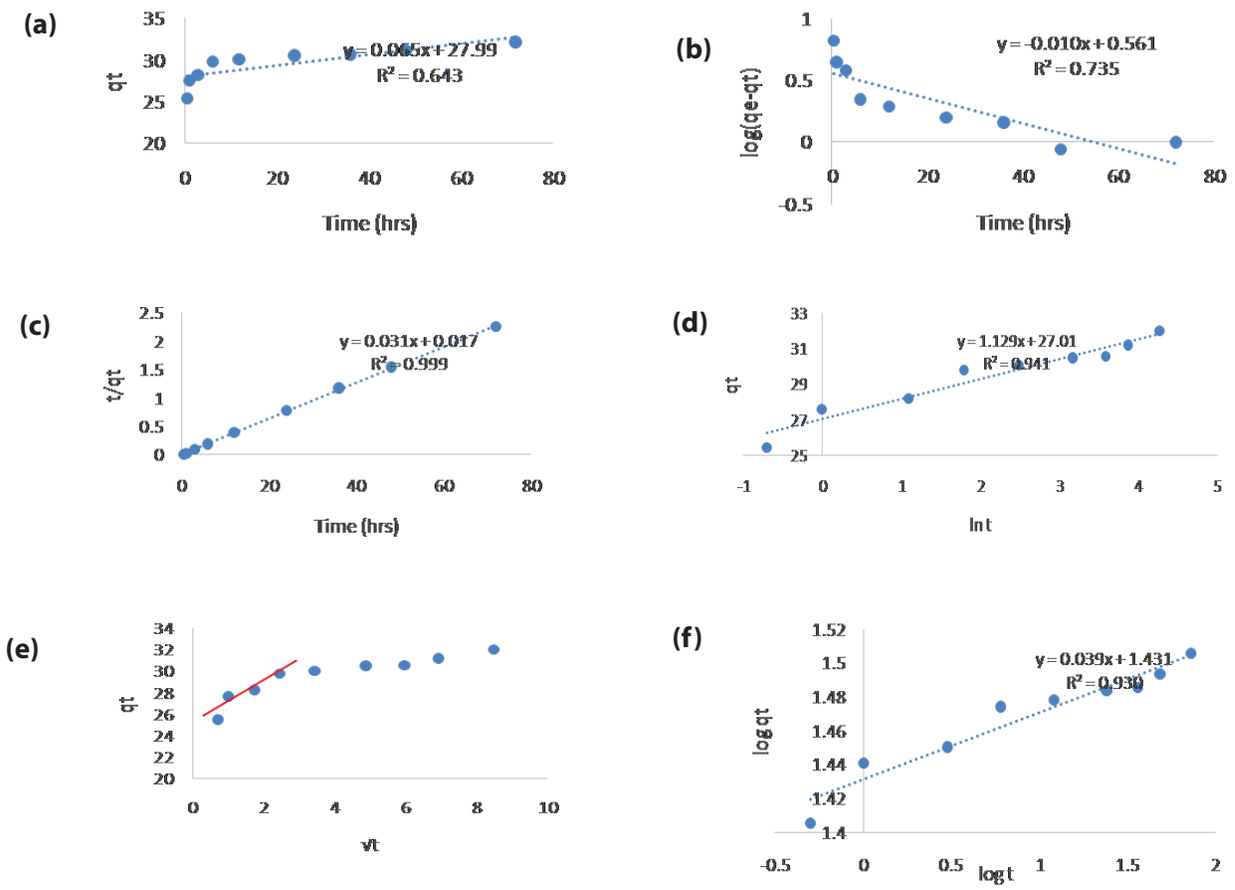


Fig. 28: Comparison of plots of (a) zero order, (b) first order, (c) second order (d) elovich, (e) intra particle diffusion, (f) power function kinetic models for vertisols

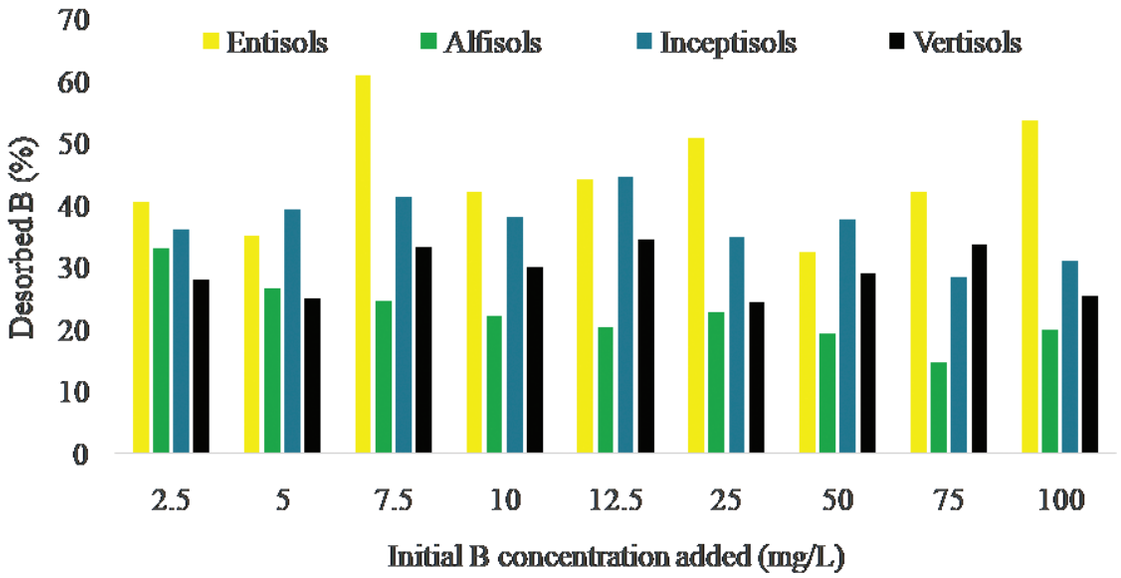


Fig. 29: Desorption of Boron at varying initial Boron concentrations added in different soil types

Table 11: Indices of weed species in oil palm plantations

Weed species	Rde	RF	Rdo	IVI
Parthenium hysterophorus	19.77	3.31	6.90	9.99
Acalypha indica	8.78	9.27	11.88	9.98
Corchorus spp	5.42	7.95	7.70	7.02

(Rde: Relative density; RF: Relative frequency; Rdo: Relative dominance; IVI: Importance value index)

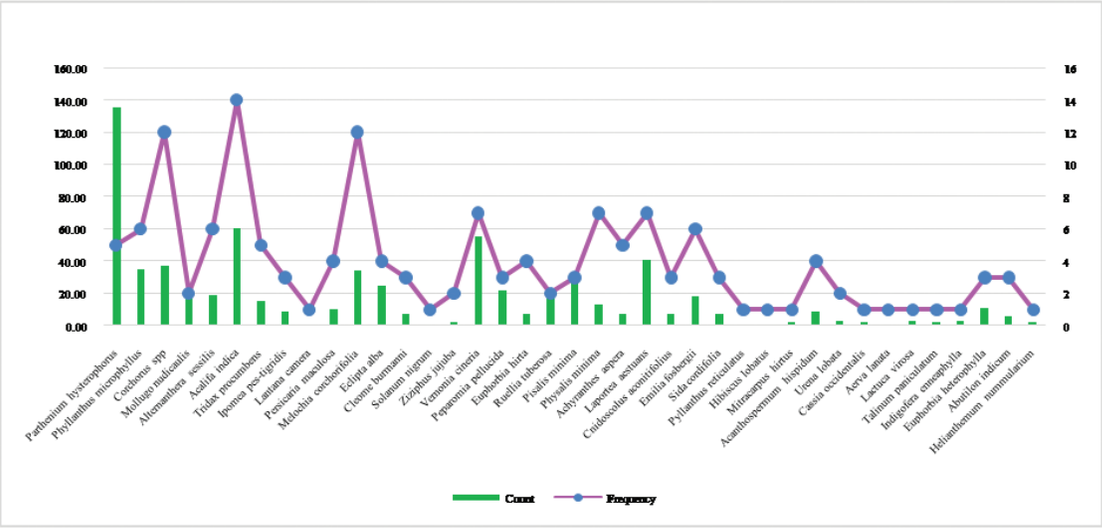


Fig. 30: Weed count vs frequency in oil palm plantations

Torch ginger (*Etlingera elatior*), Andaman Torch ginger (*E. fenzlii*), Siam rose (*E. cornerii*), Malay rose (*E. venusta*), Shampoo ginger (*Zingiber zerumbet*), Shell ginger (*Alpinia zerumbet*), Beehive ginger (*Z. spectabile*), Red button ginger (*Costus woodsonii*), Pine apple ginger (*Tapeinochilos ananasae*), Orange tulip ginger (*C. curvibracteatus*), Red ginger (*A. purpurata*), Red tower/spiral ginger (*C. camosus*) and Painted spiral ginger (*C. pictus*).

Observations were recorded on the vegetative and flowering parameters *i.e.*, plant height, number of shoots/clump, number of leaves/shoot, leaf length & width, chlorophyll content in leaves, shoot girth, days to flowering and flower characters in above mentioned plants. Time taken for reaching flowering phase was about 4 months in red button ginger, 8 months in painted spiral ginger and orange tulip ginger, 9 months in red ginger, 12 months in red tower/spiral ginger and beehive ginger, 16 months in shampoo ginger and 17 months in shell ginger and torch ginger. Rest of the specieswere still in vegetative phase. Thick shade (about 76 %) of oil palm plantation prolonged the vegetative phase.

Nursery management in oil palm

Study on growth of seedlings of doublets and triplets *vis a vis* singles during nursery stage

Ovary in oil palm is tri-carpellary which has the potential to produce two/three sprouts in some varieties though single sprout is a predominant and preferred character in most of the varieties. Normally two out of three ovules in tri-carpellary

ovary aborts and only one sprout will emerge from the seed in oil palm. Emergence of two or three sprouts from the seed is called doublet and triplet, respectively. The current practice is removal of weaker sprout in doublet and retaining the best one in triplet prior to planting of sprouts in bags. Experiment was taken up to observe the growth and vigour of seedlings from doublets and triplets in comparison with singles during the primary nursery stage.Results were found significant among the treatments for all the parameters except seedling height after the completion of primary nursery stage (4 months). Better growth *i.e.*, leaf and root production, leaf area, stem girth, root length and biomass production were recorded in seedlings from single seed sprouts rather than seedlings from doublets and triplets. Results of the study reflect that doublets and triplets have more or less equal growth and vigour providing opportunity for separation and raising them in secondary nursery.

After completion of 4 months, primary seedlings were separated from doublets and triplets and planted individually in secondary bags. Significant improvement in all the growth characters *i.e.*, seedling height, leaf and primary root production, petiole width and depth, 3rd leaf area, stem girth and dry matter production in seedlings developed from singles were observed when compared with seedlings from doublets and triplets in secondary nursery stage. Doublets and triplets in oil palm are generated from dizygotic and trizygotic embryos, respectively and they develop independently by taking water and nutrients from growing medium with separate root system. Doublets and triplets can be separated easily by hand without any damage and planted in secondary bags after completion of primary stage. What they need is extra care and nutrient management in order to catch up the growth of other seedlings during the secondary stage of nursery. In most of the times, growth of both the seedlings in doublets and two seedlings in triplets is almost on par with seedlings from singles. The present results indicate for further studies on improved nutrition for separated seedlings of doublets and triplets to catch the growth and vigour of seedlings rose from singles.

Effect of *jeevamrutham* on growth and vigour of oil palm seedlings during secondary nursery: Study was taken up to observe influence of *jeevamrutham* on growth of oil palm seedlings and standardize the dose for raising oil palm seedlings. Significantly better seedling height, leaf and primary root production, stem girth and biomass were recorded at 20% *ghanajeevamrutham* when compared with control. Similarly, higher seedling height, leaf and primary root production, leaf area, stem girth, biomass of seedlings were observed with 1.5L *drava jeevamruatham* which is significantly higher as compared with control. However, the trial can be repeated for confirmation of present results.

Effect of oil palm mill waste-boiler ash on growth of oil palm seedlings during secondary nursery: Boiler ash is a waste generated from oil palm mill and it is quite rich in potassium content (21%).Results indicated that boiler ash @ 500 g/bag had markedly increased oil palm seedling height, leaf and primary root number, leaf area, stem girth and biomass when compared with the control.

Project No. 1000766001: PHYSIOLOGICAL AND BIOCHEMICAL BASIS FOR GROWTH AND YIELD IN OIL PALM

Development of InfoCrop - Oil palm model for Agro-ecological zoning and Resource conservation

Growth and yield performance of oil palm crosses under two planting times: Two sets of crosses (10 crosses planted from July nursery and 11 crosses planted from December nursery) were compared for growth parameters (*viz.,* plant height, stem girth, number of leaves and area of 9th leaf) and the data are presented in Table 12. Plant height, stem girth and number of leaves and leaf area of 9th leaf were more in July planting in comparison with that of December planting. Plant height ranged between 288 to 348 cm under July planting where as the range is from 212 to 287 cm in

December planting. The range of stem girth is 295 to 333 cm under July planting and it is between 277 to 327 cm under December planting. Number of leaves did not vary under two planting dates but leaf area of 9th leaf was 6.3 and 5.4 square metres, respectively in July and December plantings. A clear-cut comparison of growth parameters under two planting dates can be visualized in figure 31. In the radar, the inner shape representing December planting indicates lower values for all the parameters *viz.,* plant height, stem girth, leaf number and area of 9th leaf in comparison with July planting which is represented by outer shape in blue colour. Planting the seedlings in July helped in quick establishment and robust growth due to monsoonal rains and the early initial growth has continuously resulted in better performance both in growth parameters as well as yield attributes (Table 13). Bunch number ranged between 6 to 11 in July planting and between 3 to 9.5 in December planting. Bunch yield (kg/palm) ranged between 60 to 150 in July planting and between 33 to 110 in December planting. Correlations estimated between growth and yield parameters indicated that bunch number followed by plant height and stem girth at breast were more influential in increasing FFB yield of crosses (Table 14).

Screening of oil palm seedlings for drought and salt tolerance based on physiological and biochemical traits

The screening of oil palm seedlings (14months old) for drought and salinity tolerance was conducted on 13 oil palm crosses. Five treatments were imposed for drought tolerance (Fig. 32) *i.e.,* T1 (900ml/Plant), T2 (450ml/Pl), T3 (225ml/Pl), T4 (112.5ml/Pl) and T5 (Complete drought/No water) along with control T0 (1.8L/Pl). Four treatments were imposed for salinity tolerance (Fig. 33) *i.e.,* 0.2%, 04 %, 0.6% and 0.8% Sodium chloride salt solution along with control. Photosynthetically active leaf (3rd leaf) was collected for undertaking the observations. Various physiological and biochemical characters were analyzed at weekly intervals and the crosses were classified based on their tolerance. Gradual reduction was observed in the parameters like chlorophyll content, sugars, protein, relative water content and Membrane Stability Index (MSI), whereas an increase in the accumulation of Super Oxide Dismutase (SOD), Melanoldehyde (MDA) content, Nitrate Reductase Activity and Proline was observed. Among the 13 crosses, five crosses (2DEX2DE, 44DEX74DE, 13DEX2DE and 410CDX410 CD)

Table 12: Growth parameters under two different dates of planting

Cross ID	July planted				Cross ID	December planted			
	Plant Height (cm)	Stem girth (cm)	No of Leaves	9th leaf Area		Plant Height (cm)	Stem girth (cm)	No of Leaves	9th leaf Area
226DX17P	338.3	310.0	37.00	6.43	**187DX2266RJY**	257.5	317.5	41.5	6.07
234DX17P	288.3	301.7	43.33	6.67	**118DX110P**	287.5	327.5	38.5	5.75
164DX17P	336.7	315.0	40.00	6.39	**118DX195P**	287.5	325.0	37.5	5.67
469CDX17P	306.7	295.0	34.00	5.55	**32DX110P**	245.0	300.0	38.0	5.38
448CDX17P	308.3	308.3	36.67	5.80	**78DX195P**	262.5	292.5	39.0	5.14
250CDX195P	298.3	296.7	34.67	6.49	**32DX17P**	267.5	300.0	33.0	4.80
208CDX17P	330.0	333.3	34.67	6.12	**234DX17P**	287.5	315.0	38.0	6.09
208CDX76P	348.3	311.7	38.00	6.73	**32DX195P**	235.0	277.5	35.5	4.77
203CDX195P	313.3	313.3	38.67	6.54	**118DX17P**	212.5	292.5	32.5	5.77
230DX17P	298.3	316.7	39.33	6.39	**164DX17P**	217.5	315.0	35.0	5.36
					121DX110P	245.0	295.0	37.5	4.73

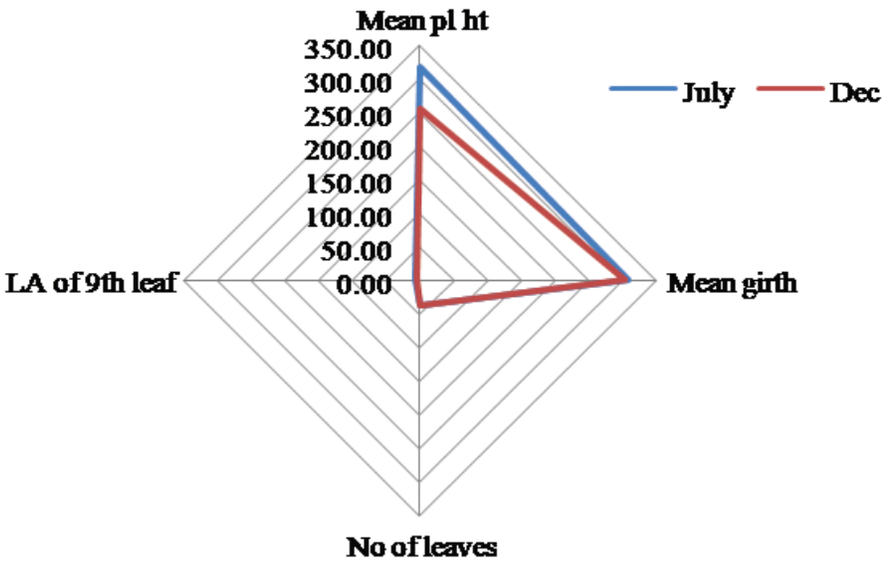


Fig. 31: Comparison of effect of two planting dates on growth parameters

Table 13: Effect of two planting dates on yield parameters of different crosses

Cross ID	July planted		Cross ID	December planted	
	Bunch Number	Bunch Weight (kg/palm)		Bunch Number	Bunch Weight (kg/palm)
226DX17P	9.33	96.56	**187DX2266RJY**	7.5	71.08
234DX17P	4.33	52.24	**118DX110P**	4	28.80
164DX17P	6.00	101.77	**118DX195P**	9.5	69.26
469CDX17P	8.00	97.76	**32DX110P**	6.5	46.23
448CDX17P	10.33	142.41	**78DX195P**	3	110.72
250CDX195P	10.67	150.99	**32DX17P**	12	102.43
208CDX17P	10.00	131.33	**234DX17P**	7.5	77.89
208CDX76P	7.33	114.76	**32DX195P**	6.5	33.47
203CDX195P	11.00	133.70	**118DX17P**	7.5	54.06
230DX17P	6.00	60.77	**164DX17P**	9.5	69.26
			121DX110P	3	46.23

Table 14: Relationship between growth parameters and yield attributes

	Plant Height	Girth	Leaf Area	Number of Bunches	Bunch Weight
Plant Height	1				
Girth	0.391514	1			
Leaf area	0.202591	0.08621	1		
Number of Bunches	0.105171	0.173394	0.06802	1	
Bunch Weight	0.388364	0.203408	0.087322	0.737035	1

Fig. 32: Screening of oil palm seedlings for drought tolerance

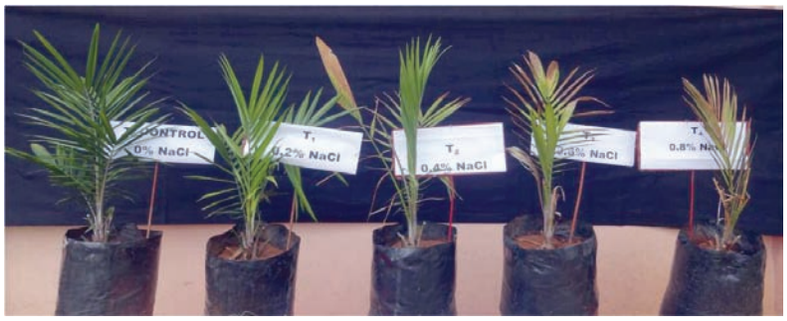


Fig. 33: Screening of oil palm seedlings for salinity tolerance

expressed variation in all the physiological and biochemical traits studied and showed significant tolerance to drought and salinity (Fig.34).

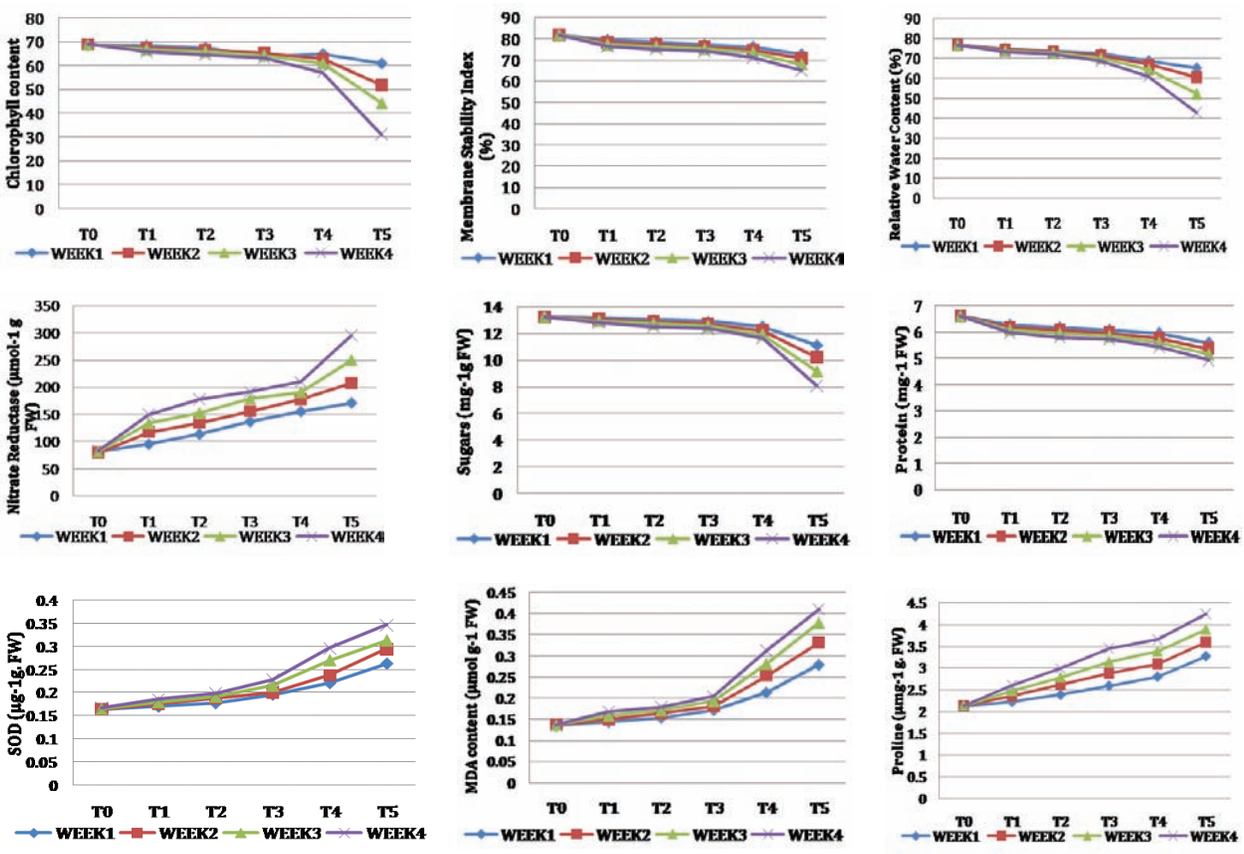


Fig. 34: Variation in physiological and biochemical traits in oil palm seedlings under salinity and drought stress

Project No. 1000765001: INTEGRATED PEST MANAGEMENT

Monitoring of insect pests and their natural enemies

Amongst the insect pests of oil palm both Rugose Spiraling Whitefly (RSW) and Bondar Nesting Whitefly (BNW) are found to be predominant and coexisting in oil palm. Highest incidence of both the species (RSW and BNW) was found during January, 2022 amounting to an average of 7.62 and 17.17 colonies/leaflet, respectively. After February2022, due to the intermittent rains, both the populations were reduced drastically. During 2022, no natural parasitizationof RSW with the parasitoid, *Encarsia guadeloupae* was observed. Low incidence of both whiteflies was also observed in farmer fields. During the year, BNW was found to be prominent and in due course may replace RSW. During the year, very low incidence of leaf eating caterpillars like bagworm, webworm *etc,* were observed in both IIOPR campus and farmers' fields. During June-August months, low incidence of Rhinoceros beetle was observed.

Spatial and temporal variation in populations of invasive whiteflies (RSW and BNW) in oil palm

The recent invasion by alien species *viz.,* rugose spiralling whitefly (RSW), *Aleurodicus-rugioperculatus* Martin and bondar nesting whitefly (BNW), *Paraleyrodes bondari* Peracchi posing great threat to cultivation of palm species in India, especially, coconut and oil palm. Although both the pest species are coexisting, the distribution patterns and population biology are unique to each other. In this context, species delimitation of both the species on four fronds at four directions (North, South, East and West) and at three locations per frond (base middle and tip) taken over four months (February, March, April and May) on 36 palms of oil palm garden was studied. The results revealed that the population of RSW in middle and tip leaflets was 2.47±2.07 and 2.22±2.83, whereas BNW was 4.2±2.05 and 3.49±1.93 nymphs+adults per leaflet, respectively. Both the species preferred tip leaflets of frond with no significant difference between middle and tip leaves in case of RSW and a clear significant preference of top most leaves in case of BNW (Fig 35, 36a & 36b). The average nymph+adult population of RSW and BNW for the data period were 1.88±1.82 and 2.84±1.42, respectively. In general, the population of both the species was high during February month. During this peak population time nymphs+adults of both RSW and BNW are at par with each other (4.25±2.89 and 4.26±4.41 per leaflet) whereas the seasonal average showed significantly (CD 5% - 0.125) higher population of BNW (2.84 per leaflet) than RSW (1.88 per leaflet). The average nymphs+adult population of RSW for the targeted four months on base, middle and tip leaflets was 0.92±1.28, 2.22±2.83 and 2.47±2.07, respectively. With respect to different months, the average number of RSW colonies per leaflet during February was 2.02 which was decreased to 0.79 per leaflet by May, whereas colonies of BNW decreased from 4.31 to 3.25 per leaflet. Similarly, nymphs+adult population of RSW decreased from 4.26 to 0.36 and BNW from 4.25 to 1.38 per leaflet (Fig 37). This reduction in population of colonies and nymphs+adults of RSW accounts to 61.0% and 91.6%, respectively, whereas with respect to BNW it was 24.57% and 67.6% respectively. The population of BNW (Nymphs+adults) was comparatively high in all the tested time intervals (months) which indicated its domination over RSW or replacement in due course of time.

Isolation of Entomopathogenic fungi (EPF) against bondar nesting whitefly

The newly developed modified insect baiting technique was used for isolation of entomopathogenic fungi against BNW from soil samples. Screening of a total of 49 soil samples collected from IIOPR fields and adjoining oil palm plantations resulted in isolation of 20% fungal strains(Fig.38) with pathogenicity against BNW. All these isolates were further evaluated under laboratory, semi-field and potent isolates in field conditions as conidia solutions obtained by culturing on PDA plates. The 20 isolates are initially

Fig. 35: Co-existence of Rugose Spiralling Whitefly and Bondar Nesting Whitefly on oil palm

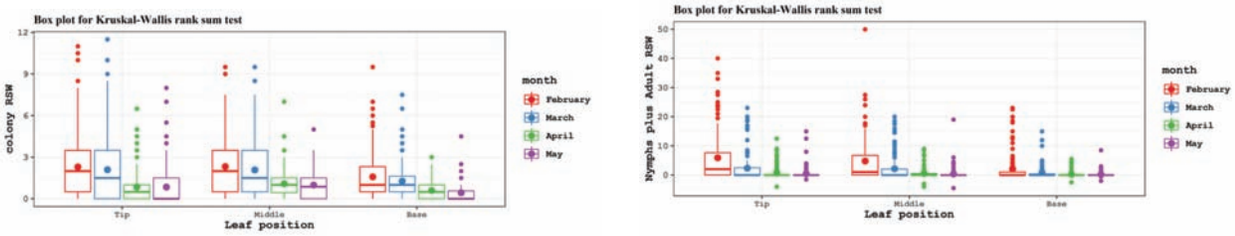


Fig 36a: Wilcox test graph of distribution of Rugose Spiralling Whitefly colony and nymphs+adults at different locations of leaf

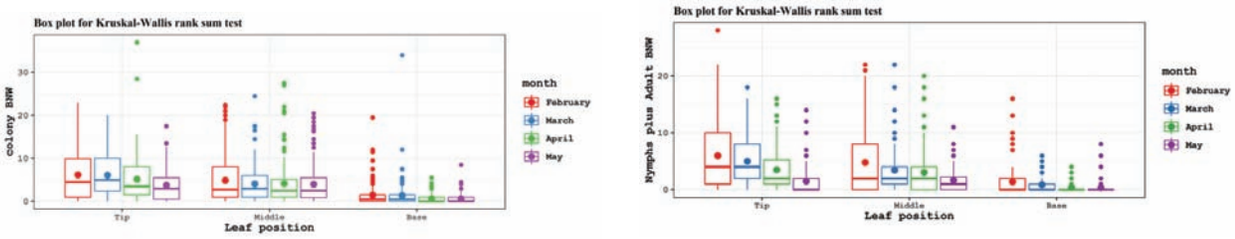


Fig. 36b: Wilcox test graph of distribution of Bondar Nesting Whitefly colony and nymphs+adults at different locations of leaf

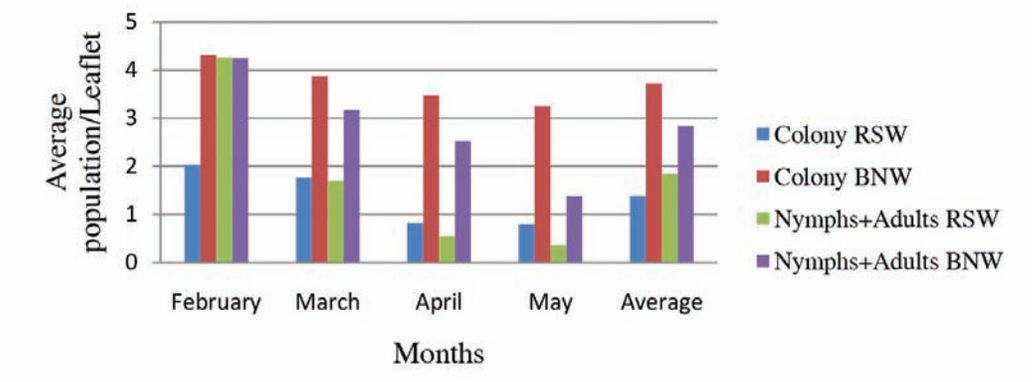


Fig. 37: Average population of life stages of Rugose Spiralling Whitefly and Bondar Nesting Whitefly over months

screened against adults of RSW which led to identification of two prominent isolates 41A and 55B with 93.5 and 94.74 mortality. All the isolates are also tested against the BNW population of five selected leaflets by spraying the culture at 5ml/L concentration. The results also showed a clear reduction in pest population over 15 days after treatment which accounts to 96.7 and 89.77% in 41A and 55B isolates, respectively (Table 15, Fig 39).

Field evaluation of these potent isolates along with R38 and *Cladosporium* (from HRA, Ambajipeta**)** was done by spraying the isolates on trees with mixed populations of both the whiteflies and data was collected from ten randomly selected leaflets. The data clearly showed that the isolates, 41A, 55B and Cladosporium were found to be effective in reducing pest population to an extent of 91.3, 87.7 and 88.4% over control, respectively with no significant difference. Moreover, the isolate 41A significantly reduced the BNW colonies to 3.6 per leaflets in comparison with the control (24.8 per leaflet). However, in case of RSW significantly highest control was recorded in 55B to a tune of 91% over control (Table 16, Fig.40).

Management of invasive whiteflies using papaya leaf extract

Preliminary evaluation of leaf extracts of papaya showed promising results against RSW.

Table 15: Semi-field evaluation of entomopathogenic isolates against Bondar Nesting Whitefly

	Number of adults / leaflet					Percent reduction over PTC			
Isolates	**PTC**	**3DAT**	**5DAT**	**10DAT**	**15DAT**	**3DAT**	**5DAT**	**10DAT**	**15DAT**
3A (A)	32	19	17	14.33	15.67	40.63	46.88	55.22	51.03
3A (B)	62.33	53.33	41	37.67	59.67	14.44	34.22	39.56	4.27
3A (C)	43	38	31.67	35.33	45	11.63	26.35	17.84	-4.65
3C	43	26.67	23	23.67	32	37.98	46.51	44.95	25.58
4A	32	37.67	53	35.2	35	-17.72	-65.63	-10.00	-9.38
4C	47	36.33	51	77.67	50.33	22.70	-8.51	-65.26	-7.09
5A	34	37.67	27	25.67	26.67	-10.79	20.59	24.50	21.56
6A (C)	18.33	16	22.33	33	9	12.71	-21.82	-80.03	50.90
11C	19	15	14.33	18	16.67	21.05	24.58	5.26	12.26
13B (A)	19	15	14.67	8.33	15.33	21.05	22.79	56.16	19.32
18A (A)	15.33	16.33	12.67	10	11	-6.52	17.35	34.77	28.25
18A (B)	28.67	23	20.33	20.33	24.67	19.78	29.09	29.09	13.95
33A	13.67	14.67	17.67	17.33	19.67	-7.32	-29.26	-26.77	-43.89
34A(A)	22.33	25.33	20.67	31.67	27.33	-13.43	7.43	-41.83	-22.39
34A (B)	31.67	31.67	37	52.67	53.67	0.00	-16.83	-66.31	-69.47
38A	46.33	45.33	50.33	25	33.33	2.16	-8.63	46.04	28.06
R-38	27.67	30	27	40	18	-8.42	2.42	-44.56	34.95
41A (A)	20.33	6.33	8	7.3	0.67	68.86	60.65	64.09	**96.70**
42A (A)	18.67	18.33	14	12.33	18.33	1.82	25.01	33.96	1.82
55B	16.33	15	14.67	5.33	1.67	8.14	10.17	67.36	**89.77**
Water	43.33	11.67	43	49	36.67	73.07	0.76	-13.09	15.37

DAT : Days after treatment; PTC: Pre treatment count

Table 16: Field evaluation of potent entomopathogenic fungi against invasive whiteflies

Treatment	Bondars Nesting Whitefly		%R*	Rugose Spiralling Whitefly		%R*
	Colonies	Adults + nymphs		Colonies	Adults + Nymphs	
41A	3.6±1.14d	2.4 ±1.14c	91.3	2.2 ± 0.84b	5 ± 1.22bc	80
55B	6.8±0.84bc	3.4 ±1.4c	87.68	1.6 ± 0.55b	2.2 ± 1.3c	91
Cladosporium	5.4±1.52cd	3.2 ±1.3c	88.41	2.6 ± 0.55b	4.6 ± 2.3bc	81.6
R38	8.6±0.55b	11 ±1.22b	60.14	1.8 ± 0.84b	5.4 ± 0.55b	78.4
Control	24.8±3.11a	27.6 ± 1.14a		9.4 ± 1.67a	25 ± 4.18a	
F-stat	131.38	472.3		51.66	78.74	
CV	16.98	11.55		29.25	27.88	
CD (0.05)	2.24	1.48		1.38	3.16	

Data with similar alphabet had no significant difference. *Reduction in adults+nymphs

Fig. 38: Diversity in entomopathogenic fungi isolated against Bondar Nesting Whitefly

B41A infected BNW Healthy BNW B55 infected BNW

Fig. 39: Mycosis of potent isolates on dead cadavers of Bondar Nesting Whitefly (BNW)

Fig. 40: Field infestation of R55 on colony of Rugose Spiralling Whitefly

During the present year, bondar nesting whitefly (BNW) has also become predominant. A semi field evaluation of 5% papaya leaf extract was done on palms with mixed populations of both the whiteflies. The study revealed that, 5% leaf extract of papaya showed substantial reduction of RSW nymphs+adults to a tune of 72.53% whereas, BNW reduction was 45.45% over pretreatment count. Moreover, this reduction is observed up to 10 days after treatment. Further data on counts of life stages at 15 DAT showed a slight increase in populations of both RSW and BNW necessitating further management (Table 17).

Supply of *Isaria fumosorosea* pfu5 cultures for management of invasive whiteflies in oil palm

Isariafumosorosea pfu5 (ICAR-NBAIR, Bengalore) was found to be the most effective isolate in managing the RSW population in palms, especially oil palm and coconut. The simple and cost-effective mass production technology developed by ICAR-IIOPR, Pedavegi is well accepted by the farming community and is popular amongst the oil palm growers. With the financial assistance from Farmers First Project and Department of Horticulture, Andhra Pradesh the local farmers weresupplied with the 500ml mother culture of *I. fumosorosea* pfu5 along with *insitu* mass production technology for large area coverage and management of invasive RSW. Till date ICAR-IIOPR, Pedavegi supplied a total of 5803 mother culture bottles (500 ml each) and 3575L of ready to use culture to farmers and horticulture department for distribution and management of the pest (Table 18). This volume of mother culture is sufficient to cover an area of 0.81 lakh ha of oil palm plantations.The mother culture distribution and management of the pest with IIOPR technologies led to successful curb of the pest in different districts of Andhra Pradesh including East Godavari, West Godavari, Eluru, Krishna, Guntur, Srikakulam, Vijayanagaram, Nellore, Chittoor etc.

Table 17: Management of rugose spiralling whitefly and bondar nesting whitefly using papaya leaf extracts

Whitefly	Colonies				Nymphs+Adults			
species	PTC	10DAT	15DAT	% R	PTC	10DAT	15DAT	% R
RSW	9.8±2.56	7.8±3.52	9.2±1.94	6.12	27.3±3.93	7.5±0.67	8.3±0.9	72.53
BNW	32.5±2.23	28.75±3.52	31.9±1.56	11.54	31.35±3.93	17.1±1.94	18.5±2.13	45.45

DAT (Days After Treatment), PTC (Pre Treatment Count), R (Reduction in pest population)

Table 18: Details of *Isaria fumosorosea* pfu5 culture distribution for management of invasive RSW

Year	Mother culture supplied (L)		Ready to use culture supplied to farmers (L)
	Department of Horticulture Govt. of Andhra Pradesh	Farmers	
2019-20	1306	918	3321
2020-21	2402	240	214
2021-22	601	192	18
2022-23	0	144	22
Total	**4309**	**1494**	**3575**

Studies on trapping efficiency of different colours for weevils visiting female inflorescence

With a view to identify the seasonal variation in weevil population visiting the female inflorescence, a study was conducted to identify the attraction efficiency of different colours. Amongst the eight colours tested, only blue and yellow are found to be most attractive and were further evaluated by keeping 5x5cm size glued sheets above the anthesizing female inflorescence. The data from 50 female inflorescences revealed a sex ratio of 3.85 and 3.66 weevils in yellow and blue sticky traps, respectively with an average trap catch of 250.81 and 234.15 weevils/trap/3 day, respectively. There is no significant difference with respect to total catch and sex ration of the weevils between both the colours as detailed in Table 19.

Studies on weevil populations visiting male inflorescence

The visits of pollinating weevils on male inflorescence during anthesis are studied by collecting spikelets with weevils. The sex ratio of the weevils visiting during 1st, 2nd and 3rd day of anthesis was found to be 3.88, 2.14 and 2.22, respectively. This indicated a significant amount of high female weevil visits on 1st day. The total number of weevils was found to be non-significant between three days of anthesis. Male weevils are significantly higher on the second day of anthesis (Table 20).

Table 19: Pollinating weevil catch on two colored sticky trap in female inflorescence

Days	Weevil catch in yellow sticky trap				Weevil catch in blue sticky trap			
	Female	Male	Sex ratio	Per day	Female	Male	Sex ratio	Per day
1st	22.30±2.59	7.70±2.59	3.74±3.21	126.42±72.5 (10.69)[a]	22.15±2.08	7.85±2.08	3.15±1.38	122.42± 73.5 (10.56)[a]
2nd	23.46±2.57	6.46±2.60	4.40±2.34	79.08±52.8 (6.66)[b]	23.23±2.55	6.77±2.55	4.77±4.18	68.31± 36.6 (7.90)[b]
3rd	23.23±2.17	7.31±1.70	3.41±1.23 F (cal) CD (5%)	45.31±35.3 (7.12)[b] 4.93 2.90	21.85±2.61	8.15±2.61	3.08±1.45	43.42± 25.1 (6.27)[b] 10.73 1.93

Figures in parenthesis are square root transformed values

Table 20: Details of pollinating weevil visiting male inflorescence

Days	Female weevils	Male weevils	Sex ratio	Weevils/Spikelet
Day 1	22.58±3.04[a]	7.42±3.04[b]	3.88±2.37[a]	196.32±147.05
Day 2	19.95±2.70[b]	10.05±2.70[a]	2.14±0.62[b]	305.42±216.27
Day 3	19.26±5.09[b]	9.26±3.66[ab]	2.22±1.15[b]	272.68±190.16
F-statistic value	4.12	3.47	7.54	NS
P-value	0.02	0.04	0.00	
CD (0.05)	2.62	2.07	1.10	

Project No. 1000765002: INTEGRATED DISEASE MANAGEMENT

Evaluation of *Trichoderma* isolates against *Ganoderma boninensis*

The native *Trichoderma* isolates collected from different locations (Table 21) of India are evaluated against *G. boninensis* for inhibition in radial growth and dry weight. A multiphasic evaluation was adopted where in the isolates in the form of mycelia disc, conidia suspension and cell free culture filtrate are used in estimating the inhibition in growth. Amongst the tested seven isolates, preliminary evaluation using dual culture technique using mycelia discs showed four potent isolates (Tl, Ta, Up1 and Up3) which were further evaluated for their efficacy of conidia suspension and cell free filtrate. This evaluation led to identification of two potent isolates, *T. longibrachiatum*(Tl) from Jodhpur and Up3 isolate from Mau (Fig.41) with more than 70% reduction in *G. boninensis* mycelia and dry weight. Conidia production by the *Trichoderma* isolates in dual culture plates also revealed highest conidia production of 16.4 x 10^8conidia/plate in isolate *T. longibrachiatum*.

Compatibility of *Trichoderma* with commercial pesticides

Compatibility of *Trichoderma* isolate, *T. asperellum* was tested with the two commercially available fungicides *viz*., Propiconazole and Hexaconazole which are widely recommended against Ganoderma dry rot. Both the fungicides were tested at three different concentrations (250,500,1000 ppm) using poison food technique where the fungicide was spread on a PDA plate followed by inoculating an actively growing mycelia disc at the center of the plate. The results

Table 21: Multiphasic evaluation of *Trichoderma* isolates against *G. boninensis*

Isolate	Location	Inhibition in radial growth of fungus (%)			Conidia strength x 10^8
		Mycelia disc	Cell suspension	Cell free culture filtrate	
T. longibrachiatum Tl	Jodhpur, RJ	84.22	86.11	77.00	16.4
*T. asperellum*Ta	Pedavegi, AP	75.11	70.86	68.00	14
*T. asperelloides*Tad	Andaman	69.88	ND	ND	ND
T. asperellum Up1	Mau, UP	89.22	66.11	50.00	7.8
T. asperellum Up2	Mau, UP	83.12	ND	ND	ND
T. afroharzialum Up3	Mau, UP	90	77.22	77.88	12.8
ChB2	Chintalapudi,AP	68.33	ND	ND	ND

showed that both the fungicides are compatible with *Trichoderma* except the propiconazole at 1000ppm where 40% reduction in radial growth was observed. Moreover, there is no negative impact on the conidia production by *Trochoderma* isolate at 96 h. of incubation which is ranging between 23-32 x 10^5 in comparison to control, 34 x 10^5 conidia/ml. Propiconazole at 1000 ppm had only 15 x 10^5 conidia/ml.

Studies on use of locally available agro wastes in restricting the spread of *G. boninensis*

A preliminary study on the use of agro wastes (Table 22) in restricting the spread of *G. boninensis* was studied under pot conditions (Fig. 42). In a horizontal pot (21 cm L X 8cm W X 9 cm H) three oil palm seedlings are transplanted longitudinally in which one of the cornered plants is root inoculated with conidia solution of *G. boninensis*. Between the treated and untreated plants around one inch space is filled with agro wastes and observed for disease progression in treated and untreated plants. Although in no treated plants showed symptoms of *Ganoderma* infection, there is a clear variation in symptom expression and death of *Ganoderma* treated plants. Interestingly cow dung treated with fungicides did not have any impact on the *Ganoderma* infection and more over the disease progression is rapid in comparison to control *i.e,* only Ganoderma treatment. The best treatments with respect to reduced foliar severity are Rice husk + Rice straw + Crustacean waste and *Trichoderma* + neem cake. In case of delay in death of the palms, the best treatment was rice straw with palm survival of 52.3 days.The second-best treatments are rice husk and rice husk in combination with straw and crustacean waste. This delay in death of the palms and disease progression in rice waste may be attributed to the silica content which is having negative impact on mycelia development. So, further studies are planned on adult plantations with basin application.

Evaluation of commonly used fungicides against Ganoderma

Fungicide applications are commonly used management strategies against pathogenic infections and are the only options under high incidences. Ganoderma stem rot is a disease of oil palm with no visible symptoms of infection in early stages, thereby necessitating application of fungicides upon symptom appearance which coincides with the advanced stages of infection. With a view to identify effective fungicide, seven commercially available fungicides are tested under laboratory conditions by estimating the reduction in dry weight of the mycelia by Ganoderma in potato dextrose broth infused with fungicide at two different concentrations.The data clearly showed that Chlorothalonil, Tricyclazole and M40 had no impact on the growth of Ganoderma. The best fungicide was a combi product of Tebuconazole + Trifloxystrobin with more than 92 % reduction in dry weight of the fungus at recommended dose. Propiconazole was also found to be effective with 92% reduction in dry weight but at double the recommended dose. Hexaconazole and combi product, Azoxystrobin+ Difenconazole was also found to reduce the mycelia dry weight at around 50% (Table 23).

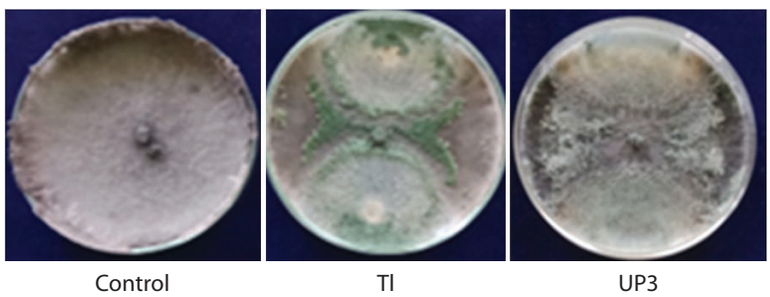


Fig. 41: Coverage and disintegration of *Ganoderma* by *Trichoderma* isolates

Fig. 42: Experimental setup of using agro-wastes for managing Ganoderma

Table 22: Use of agro-wastes in managing the Ganoderma disease progression

Treatment	Foliar Severity at 14 DAT (%)	Death of the palm (days after treatment)
Rice husk	50.00^{de}	48.0±1^{b}
Rice straw	53.33^{cde}	52.3±2.5^{a}
Crustacean waste	63.33^{bc}	48.0±1^{b}
Rice husk + Rice straw + Crustacean waste	37.67^{f}	48.0±1^{b}
Trichoderma + Neem cake	43.33^{ef}	41.0±1^{c}
Kernel fiber + *Trichoderma*	56.67^{bcd}	30.7±1.5^{d}
Cow dung + Fungicide	76.67^{a}	20.7±0.6^{e}
Only Ganoderma	65.00^{b}	29.7±0.6^{d}
F-cal	14.24	234.62
CD(0.05)	10.08	1.95

Values with similar alphabet are not significant different as per RBD test

Table 23: Evaluation of different fungicides against control of Ganoderma

Fungicide	Trade name	Company	Dose (g or ml/L)	Ganoderma dry weight (g)	Percent reduction over control
Hexaconazole 5EC	Contaf	Tata	2	0.72±0.08 (0.23)b	43.54
Hexaconazole 5EC			4	0.57±0.23 (0.19)bc	55.35
Propiconazole 25EC	Tilt	Crystal	2	0.3±0.1 (0.11)de	76.38
Propiconazole 25EC			4	0.1±0.1 (0.04)f	92.13
Chlorothalonil 75WP	Kavach	Syngenta	2	1.17±0.06 (0.34)a	8.11
Chlorothalonil 75WP			4	1.13±0.06 (0.34)a	10.79
Tricyclazole 75WP	Beam	Dow	1	1.23±0.12 (0.35)a	2.91
Tricyclazole 75WP			2	1.23±0.12 (0.35)a	2.91
Tebuconazole 50WG + Trifloxystrobin 25WG	Nativo	Bayer	1	0.1±0 (0.04)f	92.13
Tebuconazole 50WG + Trifloxystrobin 25WG			2	0.09±0.01 (0.04)f	92.68
Azoxystrobin 18.2% + Difenconazole 11.4% SC	Amistar Top	Syngenta	1	0.47±0.23 (0.16)cd	63.23
Azoxystrobin 18.2% + Difenconazole 11.4% SC			2	0.27±0.12 (0.1)e	78.98
Mancozed 75WP	M40	Indofil	1	1.27±0.12 (0.36)a	0.24
Mancozed 75WP			2	1.1±0.1 (0.32)a	13.39
Control				1.27±0.05 (0.36)a	

Values with similar alphabet are not significant differencet as per CRD test.
Figures in parenthesis are log transformation values

Project No. 1000769001: DISSEMINATION OF TECHNOLOGY AND INFORMATION COMMUNICATION TECHNOLOGY (ICT) APPLICATIONS IN OIL PALM SECTOR

Training of extension, research workers and farmers involved in oil palm production

Officers training programmes organized

A total of 11 training programmes organized on oil palm technologies to the officers of state department of agriculture, staff of oil palm processing units, Scientists & technical staff of SAU's/ICAR institutes.

S. No.	Training programme	Date	Number of participants
1	Soil and leaf nutrient analysis in oil palm	January 04-06, 2022	09
2	Oil palm cultivation practices to field staff of TS oilfed at IIOPR, Pedavegi	June 21, 2022	70
3	Nursery management in oil palm to the staff of RSILs online from ICAR-IIOPR, Pedavegi	July 05-06, 2022	12
4	Oil palm production technology	August 01-06, 2022	24
5	Oil palm cultivation to technical staff Malkangiri, Odisha at ICAR-IIOPR, Pedavegi	September 02, 2022	10
6	Stakeholders meet with officers of state department of agriculture on oil palm plantation management at Dimapur, Nagaland	September 02, 2022	100
7	Skill development programme on Oil palm hybrid seed production at IIOPR, RC, Palode	September 13-15, 2022	10
8	Skill development programme on Oil palm bunch analysis and selection of parental lines at ICAR-IIOPR, RC, Palode	September 16-17, 2022	5
9	Skill demonstration on collection of soil & leaf samples for analysis and providing soil health cards to the field staff of 3F oil palm, Nallajerla	September 17, 2022	80
10	Oil palm plantation health management	October 11-13, 2022	04
11	Nursery management in oil palm	November 15-17, 2022	24
	Total		**348**

Farmers training programmes organized

A total of 16 farmers training programmes organized to 5727 farmers. Farmers from Andhra Pradesh, Telangana, Arunachal Pradesh and Odisha participated in the training programmes.

S. No.	Training Programme	Venue	Date	Number of participants
1	Oil palm cultivation	Thorur division, Mahabubabad Dt., Telangana	January 19, 2022	50
2	Oil palm cultivation practices	Ranga nayaksagar, Siddipet Dt.,, Telangana	March 17, 2022	425
3	Growers awareness campaign on oil palm cultivation	Narmetta, Nanganur Mandal, Siddipet Dt., Telangana	April 04, 2022	4000
4	Mechanization in oil palm harvesting - Training cum demonstration (TSP)	Datlavarigudem, Jeelugumilli Mandal, Eluru Dt., A. P.	April 28, 2022	100
5	Oil Palm growers awareness campaign (TSP)	Pasighat, Arunachal Pradesh	June 16, 2022	120
6	Oil Palm growers awareness campaign (TSP)	Roing, Arunachal Pradesh	June 17, 2022	100
7	Oil palm cultivation to farmers of Malkangiri, Odisha	IIOPR, Pedavegi	August 29, 2022	30
8	On farm training on oil palm cultivation	Remalle, NTR Dt., A. P.	September 08, 2022	78
9	Oil palm cultivation and harvesting of oil palm bunches to farmers from Jeelugumilli Mandal, Eluru Dt., A. P. (TSP)	IIOPR, Pedavegi	September 21, 2022	40
10	Oil palm cultivation	Nareda, Kuravi Mandal, Mahamubabbad Dt., Telangana	September 30, 2022	139
11	Oil palm cultivation & skill demonstration on harvesting of oil palm bunches and recycling of bio mass with chaff cutter (TSP)	Datlavarigudem, Jeelugumilli Mandal, Eluru Dt., A. P	October 17, 2022	125
12	Oil palm cultivation practices (TSP)	KVK Pandirimamidi, AP	October 20, 2022	80

13	World Soil day celebrations - Awareness program on soil and leaf nutrient analysis in oil palm	Yernagudem, A.P	December 05, 2022	200
14	Oil palm cultivation practices for DAESI Program trainees	IIOPR, Pedavegi	December 09, 2022	40
15	On- farm training program on oil palm cultivation practices	Kothapeta, Warangal Dt., Telangana	December 21, 2022	50
16	Technological interventions to enhance oil palm productivity on the occasion of National farmers day & swachtha pakwada week	Yernagudem, A. P.	December 23, 2022	150
	Total			**5727**

Design and development of database applications in oil palm technology

- In the intranet application of Hybridization in oil palm, 165 parent palms data along with Cross ID's were updated in the database. Issues raised during data entry / viewing / editing / deleting of bagging and pollination data for the year 2022 were addressed during the implementation process.
- Designed and developed data entry screens in intranet application for Data Management in Oil Palm Tissue Culture for storage, retrieval and editing of oil palm tissue culture data. Data entry screens for inoculation data, sub culture data were designed and developed (Fig. 43, 44, and 45).

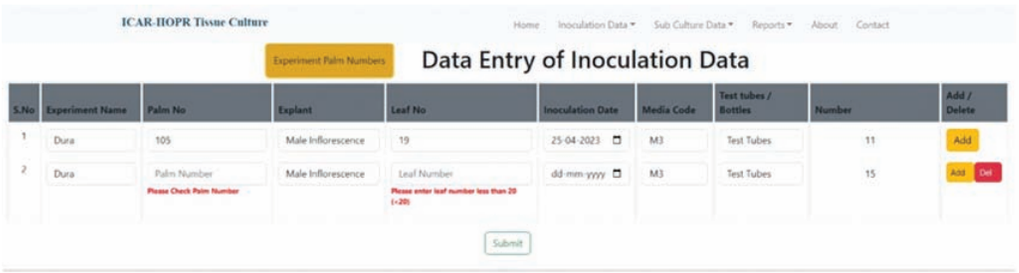


Fig. 43: Data entry screen for inoculation data of oil palm tissue culture

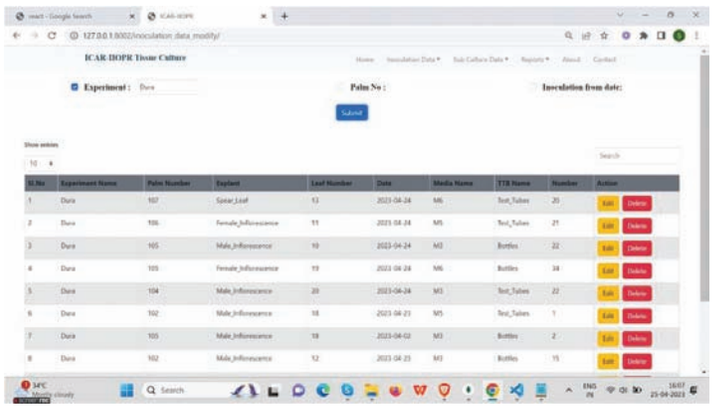


Fig. 44: Screen to modify / delete tissue culture inoculation data

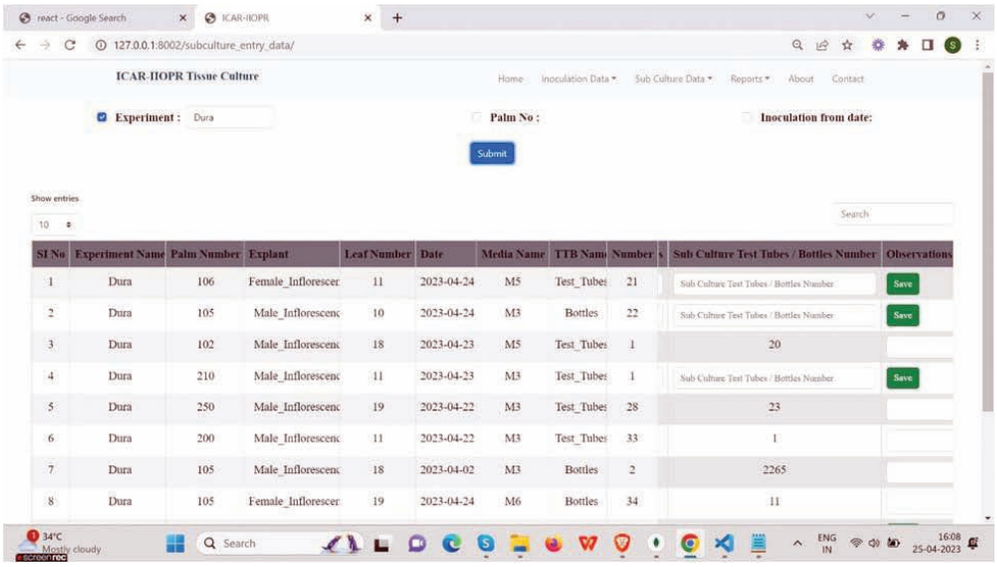


Fig. 45: Data entry screen of sub culture data

Application of ICT for dissemination of oil palm technology

- Updated contents of institute website regularly. Pages of E-Procurement, Opportunities, Cadre Strength, Staff, Farmers Corner etc. were updated along with latest publications and technologies developed.
- Uploaded oil palm advisories in English and vernacular languages, Hindi, Telugu, Kannada, Tamil and Malayalam
- About 50 queries received from website and Oil Palm Crop Doctor users were answered. These queries were categorized as per different topics and it was found that most queries were on General Aspects, followed by queries on fertilizer, disease, nutrient disorders and seedlings (Fig. 46).
- About 60 virtual sessions were organized / facilitated participation in various of virtual programs.

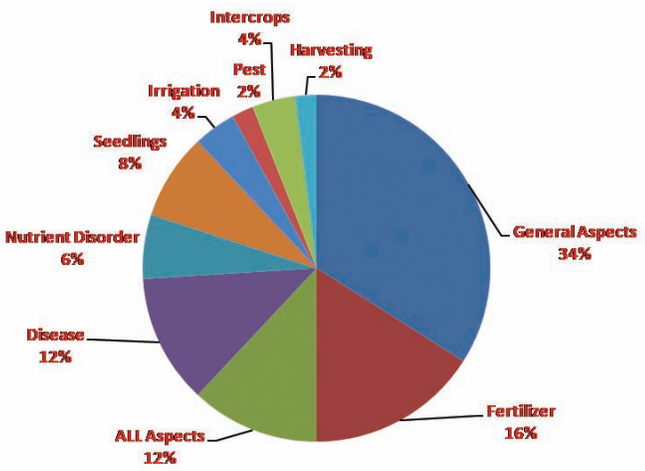


Fig. 46: Queries addressed using Website and Oil Palm Crop Doctor

5. TRANSFER OF TECHNOLOGY AND EDUCATION

Feasibility studies conducted

- Dr. K. Manorama visited a new site at Harangi in Kushal Nagar, Karnataka for evaluating its suitability to establish a new seed garden and found that it is not suitable as its soil type was clayey.
- Drs. K. Suresh, G. Ravichandran, K. Ramachandrudu and G. Somasundaram conducted feasibility studies for establishment of a new oil palm seed garden in Karnataka and submitted Report to State Horticulture Department, Karnataka.

Expert committee

- Dr. K. Ramachandrudu acted as Chairman, Technical Team constituted by Govt. of Telangana for monitoring commercial oil palm nurseries in Telangana State and provide technical guidance to nursery managers. Submitted the status report to the Secretary, Dept. of Agriculture and Co-operation, Govt. of Telangana State during February, 2022.

Training courses organised

- Online training program on "Production and marketing of oil palm" during August 23-25, 2022 in collaboration with MANAGE, Hyderabad.

Participation in Exhibitions

- Exhibition Udyana sandarshana of Dr YSR Horticultural University, VR Gudemon February 24, 2022
- Exhibition at Raipur, Chhattisgarh during November 1-3, 2022

Participated in the Exhibition at Raipur, Chhattisgarh
Hon'ble CM visited IIOPR stall on 01.11.2022

- Exhibition at 3rd National Conference on oil palm "Oil palm the way forward for increasing vegetable oil pool through AatmaNirbhar for doubling the income and providing social security to farmers" at Vijayawada, Andhra Pradesh during November 23-25, 2022.
- Farmers Meet cum Agri. Expo organized at ICAR-CPCRI, Research Centre, Kidu, Karnataka during November 19-23, 2022. The stall of ICAR-IIOPR, RC, Palode received Second Best Stall Award.

Diagnostic field visits

- Dr. M.V. Prasad conducted diagnostic field visits in Andhra Pradesh (25), Telangana (12), Arunachal Pradesh (8) and Manipur (3).

- Drs. K. Suresh, K. Manorama and G. Ravichandran visited Taraka and Kabini oil palm seed gardens in Karnataka during May 10-14, 2022 and provided advisory for better management of seed gardens.
- Drs.G. Ravichandran, K. Ramachandrudu, B.Kalyana Babu and ARNS Subbanna conducted diagnostic field visits to Gopannapalem seed garden, Andhra Pradesh on July 16, 2022 to give suitable recommendations for strengthening of the seed garden.

- Dr.G.Somasundaram conducted six diagnostic field visits to oil palm farmers' field at Athirapally, Kulathupuzha in Kerala and Kamalanagar and Bungtlang South in Mizoram. Demonstrations on basin management, fertilizer application, leaf pruning and bunch harvest were conducted.
- Dr. P. Anitha conducted diagnostic field visits to Pandiramamidi, Rampachodavaram, Rajanagaram, Dwarapudi mandals of East Godavari Dt., Andhra Pradesh.
- Dr.ARNS Subbanna carried out diagnostic field visits to Chintalapudi, Andhra Pradesh (January 4, 2022), Mehabubabad, Telangana (September 19-20, 2022) and suggested management practices for various insect pests and diseases especially the invasive whiteflies, rhinocerous beetle, ganoderma dry rot.

Farmers'awareness programmes/workshops

Dr. M. V. Prasad participated in

- Oil palm growers' awareness campaign at College of Horticulture & Forestry, Pasighat, Arunachal Pradesh and delivered lecture on "Oil palm cultivation practices" on June 16, 2022.
- Oil palm growers' awareness campaign at Roing, Arunachal Pradesh and delivered lecture on "Management oil palm plantations to improve productivity" on June 17, 2022.
- Oil palm growers' awareness campaign at KVK, Pandirimamidi, Dr.YSRHU and delivered lecture on "Recommended practices for oil palm cultivation" on October 20, 2022.

Dr. K. Manorama participated as a resource person in a state level workshop organized at Shimoga, Karnataka by AICRP (Palms) centre and Government of Karnataka on July 29, 2022.

Dr. K. Ramachandrudu delivered talks on

- "Good agricultural practices of cocoa in oil palm" during the District Level Seminar on Cocoa organized by Dr.YSRHU at HRS, Vijayarai on March 3, 2022
- "Improved crop production practices in oil palm" during training program on "Improved production technology in oil palm" organized by HRS, Vijayarai, Dr.YSRHU on May 28, 2022.

Dr. P. Anitha organised training cum demonstration programme on "Harvesting and pruning of oil palm" at Jambuga, Adilabad on March 28, 2022 to 45 farmers.

Dr. A.R.N.S. Subbanna delivered lecture on "Improved crop protection practices in oil palm" during training program on "Improved production technology in oil palm" organized by HRS, Vijayarai, Dr.YSRHUon May 28, 2022.

Exposure visits

Farmers

- Farmers (19) from Kollodu, Mylakkara villages of Thiruvannathapuram Dt., Kerala visited

ICAR-IIOPR, RC, Palode on January 24, 2022.

- As part of ATMA SCPSC (2021-22), 20 farmers from Aruvikara and Vembayam areas visited ICAR-IIOPR, RC, Palode on February 22, 2022. They were explained about oil palm cultivation, processing, etc.

Students

Students from Andhra Pradesh, Karnataka and Kerala visited IIOPR, Pedavegi and Research Centre, Palodeon study tour / field visit /educational tour. They were shown experimental fields, explained cultivation practices, shown video film on oil palm cultivation and provided literature.

S. No.	Programme	Students from	Date	No of participants
Pedavegi				
1	Field visit	Andhra Loyola college, Vijayawada, A.P.	March 28, 2022	108
2	Educational tour	Kadiri Babu Rao college of Horticulture, C.S.Puram, PrakasamDt., A.P	March 30, 2022	49
3	Study tour	College of Horticulture, Bagalkot, Karnataka	May 05, 2022	41
4	Study tour	College of Horticulture, Bagalkot, Karnataka	May 20, 2022	41
5	Study tour	SRR and CVR College, Vijayawada,A.P	June 07, 2022	42
6	Study tour	KRC College of Horticulture, Arabavi, Karnataka	June 22, 2022	76
7	Industrial visit	Mary Stella college, Vijayawada, A.P.	October 21, 2022	64
8	Study tour	College of Horticulture, Aaantarajupeta, A.P.	October 26, 2022	78
9	RHWEP	College of Horticulture, Venkataramannagudem, A.P.	November 07, 2022	31
10	Study tour	College of Horticulture,Bangalore, University of Horticultural Sciences,Karnataka.	December 06, 2022	18
11	Study tour	Sidhartha Mahila Kalasala, Vijayawada, A.P	December 21, 2022	45
Palode				
12	Study tour	Rubber Research Institute of India, Kottayam	March 24, 2022	20
13	Study tour	Botany students fromN.S.S. College, Pandalam	April 04, 2022	12
	Total			625

Academic activities

Memorandum of Understanding: ICAR-IIOPR entered into MOU with Siddartha Mahila Kalasala, Vijayawada for facilitating staff and post graduate research.

Dr. M. V. Prasad

- Co-Chairman for Ph. D student (Ag. Extn.), Mr. N. Nagendra Babu of Agricultural College, Bapatla, ANGRAU, Guntur, Andhra Pradesh.
- Evaluated M. Sc. (Ag. Extn.) thesis "Impact of tribal Farmer Producer Groups (FPGs) on livelihood of Tribals of Visakhapatnam Dt." ANGRAU, Guntur, Andhra Pradesh.
- Evaluated Ph. D (Ag. Extn.)thesis "Sustenance of women labourers in agriculture – A case study approach". ANGRAU, Guntur, Andhra Pradesh.

Dr. K. Ramachandrudu

- Guided one M. Sc. Student and one Ph.D student of Dr.YSR Horticultural University, VR Gudem,Andhra Pradesh.
- Evaluated thesis of two M.Sc students of Dr.YSR Horticultural University, VR Gudem, Andhra Pradesh.
- Evaluated thesis of one Ph.D (Hort.) student of University of Horticultural Sciences, Bagalkote,Karnataka.
- External Examiner for conducting thesis viva-voce of Ph.D student, University of Horticultural Sciences, Bagalkote, Karnataka on July 10, 2022.

Dr. ARNS. Subbanna

- Guided two M.Sc students (Ms. Gedda Meenakshi, VHM/18-14 and Ms S. Sai Tejasri, VHM/20-03) as Co-chairman from Dr. YSR Horticultural University, VR Gudem, Andhra Pradesh.

Mera Gaon Mera Gaurav

The following oil palm technology transfer programmes were conducted in Mera Gaon Mera Gaurav villages in Eluru district, Andhra Pradesh

S. No.	Name of activity	No. of activities conducted	No. of farmers benefitted (Male)			No. of farmers benefitted (Female)			Beneficiaries (No) Grand Total (M+F)
			SC/ST	others	Total	SC/ST	others	Total	
1.	Visit to village by teams	23	—	455	455	—	30	30	485
2.	Interface meeting/ *Goshties*	01	—	06	06	—	—	—	06
3.	Trainings conducted	—	—	—	—	—	—	—	—
4.	Demonstrations conducted	10	—	240	240	—	—	—	240
5.	Mobile based advisories	—	—	—	—	—	—	—	—
6.	Literature support provided	04	—	145	145	—	—	—	145
7.	General Awareness created	03	—	65	65	—	30	30	95
	Total	41	—	911	911	—	60	60	971

Farmers FIRST Programme

Enhancing profitability of oil palm based cropping system through resource use efficient technologies with Farmer - Scientist and stakeholder's interface

Programmes organized at Makkinavarigudem, A.P.

S. No.	Date	Programme	No. of participants
1.	January 10, 2022	Skill demonstration of Pole harvesting	30
2.	January 10, 2022	Demonstration on Bush pepper planting and management	5
3.	March 08, 2022	Demonstration on Bush pepper planting and management	10
4.	April 12, 2022	Demonstration and distribution of Aluminium poles, fertigation units and vermicompost beds	30
5.	April 12, 2022	Monthly advisories in form of Calendars provided to the farmers	100
6.	May 06, 2022	Demonstration and distribution of new mobile pump starters to farmers	15
7.	June 07, 2022	Demonstration and distribution of chaff cutters to farmers of Makkinavarigudem at IIOPR	15
8.	June 09, 2022	Skill demonstration on power sprayer, weed cutters and chaff cutters	30
9.	August 17, 2022	Skill demonstration on backpack power sprayers for the pest management in oil palm	20
10.	Sept. 23, 2022	Skill demonstration on pest management with Turbo sprayer	20
11.	Sept. 29, 2022	Demonstration of mobile pump starters for irrigation	05
12.	Oct. 18, 2022	Field visit for distribution of fish fingerlings to the empty farm ponds	05
13.	Dec. 21, 2022	Field visit for observation and data collection from vermicompost beds & fodder grass of farmers.	10
	Total		**295**

Programmes organized at Challachintalapudi, Andhra Pradesh

Sl. No.	Date	Programme	No. of participants
1.	Jan. 20, 2022	Awareness on Release of fish fingerlings Catla: Rohu: Mrigala	10
2.	Mar. 07, 2022	Training on fish rearing	09
3.	Apr. 18, 2022	Skill demonstration on Turbo sprayer in oil palm plantation for spraying against RSW	30
4.	Apr. 19, 2022	Skill demonstration and distribution of poles, ventures and vermibeds	30
5.	May 07, 2022	Demonstration of mobile pump starters	10
6.	May 20, 2022	Demonstration on battery operated bush cutter of sprayer in oil palm gardens	25
7.	July 11, 2022	Field visit for distribution of fish feed to the farmers	10
8.	Aug. 02, 2022	Awareness programme on vegetable seed production unit with FFP village farms	50
9.	Sept. 19, 2022	Field visit for observation of mobile starters condition	05
10.	Oct. 10, 2022	Field visit for checking of mobile starters condition in farmers field	05
11.	Oct. 31, 2022	Field visit for distribution of pepper cuttings to the farmer	05
12.	Nov. 18, 2022	Field visit for the distribution of injector and bio control agent (*Isaria fumosorosea*) to the farmers.	05
13.	Dec. 07, 2022	Interface meeting of SPIG&IAC Meeting on Farmers First Programme	30
	Total		**224**

Exposure visits organized to farmers

Sl. No.	Date	Programme	No. of participants
1.	May 18, 2022	Awareness and exposure visit to HRS, Kovvur and vermicompost units	25
2.	August 26, 2022	Awareness programme on weather-based irrigation scheduling at Achyutapuram, Telangana	20
3.	July 11, 2022	Celebrated national aqua culture day at Challachintalapudi	10
4.	Aug. 02, 2022	Exposure visit to vegetable seed production unit, Challachintalapudi	50
	Total	**105**	

Mobilization of Groups and their capacity building

- **Biomass recycling with chaff cutters:** Six groups were formed in Challachintalapudi village with 56 farmers and 7 groups were formed in Makkinavarigudem with 112 farmers for use of chaff cutters.
- **Petrol operated power sprayer:** Four groups were formed in two villages for spraying of pesticides and fungicides in oil palm plantations.
- **Turbo Sprayer:** Two groups were formed one each in Makkinavarigudem and Challachintalapudi villages (consisting of 10 farmers) for spraying of pesticides on tall oil palm plantations.
- **Jet sprayers:** Two groups were formed in two villages (consisting of 20 farmers) for spraying operation in oil palm plantations.

Module wise farmers' feedback on technology characteristics and socio-economic parameters

S. No.	Module	Intervention	Feedback on technology characteristics and socio-economic parameters
1	Crop based module	Weather based irrigation scheduling in oil palm	Saved irrigation, fertilizer quantity and reduce labour cost and obtained higher FFB yield. Electricity consumption was reduced.
2	Crop based module	Nutrient application to oil palm through fertigation	Saved excessive application of fertilizers, reduced labor cost and gave higher FFB yield. Saved fertilizer transport cost
3	Crop based module	Integrated pest management of rugose spiralling whitefly, leaf eating caterpillar and bag worm	Saved the crop from pests during October – February.
4	Crop based module	Integrated disease management of Basal Stem Rot (*Ganoderma sps.*) in oil palm	Managed to stop further spread of disease.
5	Crop based module	Mechanization of harvesting of bunches in oil palm	Initiated harvesting of bunches with pole harvesting instead harvesting by climbing, could minimise the drudgery and labour cost. Harvesters could harvest 50% more tones of bunches. Time saving, safe to harvester.
6	Horticulture based module	Coconut and oil Palm based cropping system	Introduced intercrops like Heliconia, Red ginger, and Bush Pepper in empty space to get more income. Could create employment generation during lock down period.
7	Livestock based module	Fodder grass for live stock	Could harvest fodder 5-10 days earlier than previously growing fodder. Feed intake (quantity) of cattle was increased and Milk quality is also increased.
8	NRM based module	Recycling of biomass obtained from oil palm plantation	5-7 tonnes of fronds are cut and kept as mulch, could save irrigation water, weeds were controlled, upon decomposition added organic content there by reduced fertilizers use. Biomass was used as composting material in vermicompost beds and after decomposition vermicompost is being used in plantations.
9	Livestock Based module	Doubling farm income by introducing fish in unused farm ponds in coconut / oil palm cropping system	Unused farm ponds were efficiently used and net income of 2, 25,000/- per hectare. Could use available resources efficiently.

Sri. L. Pradeep Kumar, a progressive farmer from ICAR-IIOPR FFP village,Challachintalapudi received Innovative Farmer award 2020-21 from ICAR-National Academy of Agricultural Research Management (NAARM), Hyderabad.

भाकृअनुप - राष्ट्रीय कृषि अनुसंधान प्रबंध अकादमी
राजेन्द्रनगर, हैदराबाद-५०००३०, तेलंगाणा, भारत
ICAR-National Academy of Agricultural Research Management
(ISO 9001 2015 Certified)
Rajendranagar, Hyderabad-500030, Telangana, India

FOUNDATION DAY 46th

Innovative Farmer 2020-21

L Pradeep Kumar
(Andhra Pradesh)

who was associated with NAARM, is felicitated for his outstanding performance and significant innovations in farming systems

On the occasion of
46th Foundation Day of ICAR-NAARM
1st September 2021

(G. Venkateshwarlu)
Chairman, Selection Committee

(Ch. Srinivasa Rao)
Director, NAARM

NEH, SCSP and TSP activities

The following programs were organized by ICAR-IIOPR under TSP, SCSP and NEH components:

Tribal Sub Plan (TSP)/ Scheduled Tribe Component (STC)

Nine capacity building programmes on oil palm cultivation practices were organised under TSP in the states of Andhra Pradesh and Arunachal Pradesh. Skill demonstrations were organised on harvesting of oil palm bunches, brush cutter for weed management in oil palm and coconut plantations, recycling of biomass from oil palm fronds by using chaff cutter in Vankavarigudem and Datlavarigudem villages Eluru Dt., Andhra Pradesh. Inputs like chaff cutters, brush cutters and aluminium poles with harvesting sickles were distributed to 134 beneficiaries.Oil palm harvesting tools and ablation tools were distributed to 800 beneficiaries in Pasighat, East Siang Dt., and Roing, Lower Dibang Valley Dt., of Arunachal Pradesh.

Scheduled Caste Sub Plan (SCSP)

On-farm demonstration on basin making in oil palm plantations for better utilization of water and fertilizers was organized to 23 SC farmers at Koppulavarigudem. A demonstration program on use of chaff cutter for efficient utilization of oil palm biomass was organized to 16 SC farmers of Koppulavarigudem at ICAR-IIOPR, Pedavegi. An amount of Rs. 20.59 lakhs were disbursed to a total of 130 SC beneficiaries.

North East Hill (NEH)

- Awareness programs on oil palm cultivation were organized at Kamala Nagar II, Bungtlang South and Marpara South, Mizoram during March 4-8, 2022.
- Demonstrations to farmers on fertilizer application, fertigation and harvesting of FFBs were organized during March 10-12, 2022 at oil palm seed garden, West Serzawl, Mamit Dt., Mizoram.
- Two exposure visits to oil palm seed garden, West Serzawl, Mamit Dt., and oil palm processing mill, Buckvennei, Kolasib Dt., were organized during March 14-18, 2022 and March 28-31, 2022 to the farmers of Kamala Nagar II and Bungtlang South villages.
- Training on oil palm cultivation and Demonstration on FFB harvesting were organized to 26 farmers at Kamala Nagar II – Chhwangte on May 4, 2022. Ten knapsack sprayers, 4 brush cutters, 26 aluminium harvesting poles and sickles and chisels were provided to the farmers.

Training cum Farm implements distribution at Kamala Nagar II, Mizoram

Swachh Bharat Activities

Swachhta Pakhwada was organised at the Institute during December 16-31, 2022. Cleanliness and sanitation drives were organised within the campus and surrounding residential colonies, schools, villages, common market places etc. Programmes like organising webinars, converting waste to wealth, planting trees, awareness on reducing use of plastics etc., were taken up during this period as detailed below.

Activities undertaken during SwachhtaPakhwada (December 16-31, 2022)

S.No.	Date	Activities	Coordinators
1.	December 16, 2022	Display of banner at prominent places	Shri. NV Ganesh
		Swachhata pledge and briefing of the activities to be organized during the Pakhwada Display Swachhata message on the website	Dr. P. Anitha
2.	December 17, 2022	Stock taking on digitization of office records/ e-office implementation	Mr. Rakesh Dubey Mr. S. Sivarama Krishna Mrs. Y. Chaitanya
		Cleanliness drive including cleaning of offices, corridors and premises	Mr. V.V.S. Krishna Murthy
		Review of progress on weeding out old records, disposing of old and obsolete furniture's, junk materials	Mr. J. Prabu Kumar Mr. T.V. Rama Krishna
3.	December 18, 2022	Cleanliness and sanitation drive in the adopted villages	Dr. M.V. Prasad and Dr. A.R.N.S. Subbanna
4.	December 19, 2022	Cleanliness and sanitation drive within campuses and surroundings including residential colonies, common market places	Dr. R.P. Premalatha and Mr. Mohammed Ashhar Hayat
		Stock taking of biodegradable and non-biodegradable waste disposal status and providing on the spot solutions	Mr. N.V. Ganesh and Mr. P. Sai Kishore
5.	December 20, 2022	Utilization of organic wastes/ generation of wealth from waste, polythene free status, composting of kitchen and home waste materials. Promoting clean & green technologies and organic farming practices in kitchen gardens of residential colonies and at least one nearby village and proving on the spot technology solutions.	Dr. K. Ramachandrudu and Dr. P. Anitha
6.	December 21, 2022	Campaign on cleaning of sewerage & water lines, awareness on recycling of waste water, water harvesting for agriculture/ horticulture application/ kitchen gardens in residential colonies/ 1-2 nearby villages.	Mr. V.V.S. Krishna Murthy
7.	December 22, 2022	Debate on Swachhata	Dr. B. Kalyana Babu and Mrs. A. Bhanusri
		Webinar on Swachhata	Dr. A.R.N.S. Subbanna and Dr. R.P. Prema latha

S.No.	Date	Activities	Coordinators
		Use of Social Media (Facebook, Twitter, Instagram, YouTube etc.) to generate awareness	Mr.T.V. Rama Krishna
8.	December 23, 2022	Celebration of Special Day- Kisan Diwas. Experience sharing on Swachhata initiatives by farmers and civil society officials. Felicitating farmers/ civil society officials for exemplary initiatives on Swachhata.	Dr. M.V. Prasad
9.	December 24, 2022	Swachhata Awareness at local level (organizing Sanitation Campaigns involving and with the help of the farmers, farm women and village youth in new villages not adopted under any schemeby Institutes/ establishments.	Dr. A.R.N.S. Subbanna and Dr. P. Anitha
10.	December 26, 2022	Competition: Selection of best office room/ residential area (based on cleanliness)	Dr. B. Kalyana Babu and Mr. Mohammed Ashhar Hayat
11.	December 27, 2022	Awareness on waste management & other activities including utilization of organic wastes/ generation of wealth from waste, polythene free status. Composting of kitchen and home waste materials, promoting clean & green technologies and organic farming practices in new area.	Dr. K. Ramachandrudu and Dr. A.R.N.S. Subbanna
12.	December 28, 2022	Campaign on cleaning of sewerage & water lines, awareness on recycling of waste water, water harvesting for agriculture/ horticulture application/ kitchen gardens in residential colonies, outside campuses/ nearby villages with the involvement of local/ village communities.	Dr. A.R.N.S. Subbanna and Mr. V.V.S. Krishna Murthy
13.	December 29, 2022	Visits of community waste disposal sites/ compost pits, cleaning and creating awareness on treatment & safe disposal of bio-degradable/ non-bio-degradable wastes by involving civil/ farming community.	Dr. G. Ravichandran Dr. R.P. Premalatha
14.	December 30, 2022	Publicity on Swachhta Pakhwada (Involvement of VIP/VVIPs)	Dr. K.L. Maryrani and Dr. A.R.N.S. Subbanna
15.	December 31, 2022	Organization of press conference for highlighting the activities of Swachh Bharat Pakhwada by involving all stake holders including farmers/ VIPs/ press and electronic media.	Dr. M.V. Prasad Dr. B. Kalyana Babu

ICAR-IIOPR organised "Parthenium free IIOPR campus" programme on April 11, 2022 as a part of Swachhta campaign.

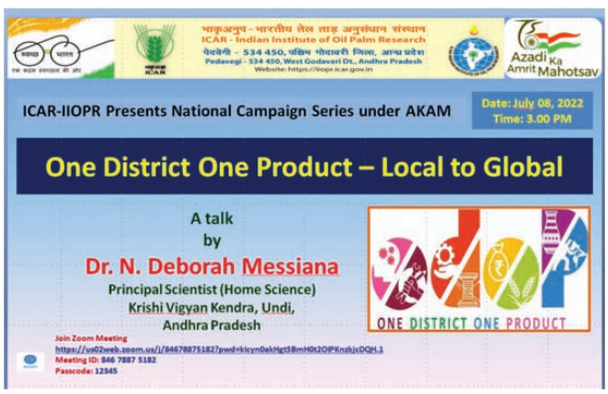
ICAR-IIOPR organized National Farmers Day under "Swachatha Pakhwada Campaign" on December 23, 2022 at Yernagudem, East Godavari Dt., Andhra Pradesh. A Growers Awareness Campaign on oil palm was organized on this occasion. The highest yielding oil palm growers were felicitated by ICAR-IIOPR. Soil health cards were provided to oil palm growers. Nearly 150 stakeholders consisting of oil palm growers, staff of oil palm processing units and State Department of Horticulture participated in the programme.

Aazadi Ka Amrit Mahotsav activities

Under Aazadi Ka Amrut Mahotsav celebrations, ICAR-IIOPR organized a series of lectures by eminent speakers and also organised national and regional campaigns on various topics.

National campaigns, Regional campaigns and Lecture series organised

S. No.	Date	Campaign/Lecture	Organisers
1.	January 11, 2022	Campaign for farmers on'Clean milk – Better health and pricing'Dr. Aparna, Veterinary Surgeon, State Institute of Animal Health and Veterinary Biology, Palode, Trivandrum delivered a talk.	Ms. S.N. Rahana & Mr. Sunil Dut
2.	January 24, 2022	National girl child day	Dr. H.P. Bhagya
		Regional campaign on "High Tech Horticulture for Higher Productivity and Income"	Dr. G. Somasundaram
3.	February 10, 2022	National Campaign for farmers on "Fresh water Aquaculture – Diversified source of Income" Dr. Ramesh Rathod, Senior Scientist, Regional Res. Centre of ICAR- CIFA, Vijayawada delivered a talk.	Dr. G. Ravichandran & Dr. B. Kalyana Babu
4.	March 08, 2022	International Women's Day:Empowering Women Farmers with Skill and Knowledge	Dr. K.L. Mary Rani Dr. P. Anitha Dr. H.P. Bhagya Dr. R.P. Premalatha & Ms. M. Amrutha Lakshmi
5.	March 11, 2022	Lecture on "Application of Artificial Intelligence in Agriculture"	Dr. A.R.N.S. Subbanna
6.	April 18, 2022	Outreach program on "Import substitution of edible oils through enhancing production and productivity of oil seeds"	Dr. B. Kalyana Babu & Dr. A.R.N.S. Subbanna
7.	May 06, 2022	Harnessing potential of pulses for import substitution Dr. M.V. Ramana, Principal Scientist, RARS (ANGRAU), Lam, Andhra Pradesh delivered a talk.	Dr. K. Suresh & Dr. G. Ravichandran
8.	July 03, 2022	Balanced use of fertilizers for Soil Health	Dr. K. Manorama & Dr. R.P. Premalatha
9.	July 08, 2022	One District One Product – Local to Global Dr. Deborah Messiana, Principal scientist, KVK, Undi, Andhra Prdaesh delivered a talk	Dr. P. Anitha & Mrs. A. Bhanusri



6. AWARDS AND RECOGNITIONS

Dr. K. Suresh

- Awarded Fellow by Confederation of Horticulture Association of India.
- Best oral presentation award for research paper entitled "Seasonal Variation in Oil Content and Fatty Acid Composition in Oil Palm Hybrids" during the National Conference on Climate Resilient and Sustainable Development of Horticulture held at Kanpur, Uttar Pradesh during May 28-31, 2022.

- Member / IPR Expert, Institute Technology Management Committee (ITMC) of ICAR-CTRI, Rajahmundry.

Dr. M. V. Prasad

- Expert committee member, Scrutiny of applications to present the endowment awards of ANGRAU.
- Technical expert, 51st meeting of Research & Extension Advisory Council of ANGRAU.
- Invited judge, Committee for evaluating Best KVK and Best DAATTC of ANGRAU for the years 2020-21 and 2021-22.

Dr. K. Ramachandrudu

- Reviewer for national journal "Indian Journal of Horticulture".
- Reviewer for "ANGRAU Research Journal".

Dr. G. Somasundaram

- Member (IPR Expert), Institute Technology Management Committee (ITMC), ICAR-CTCRI, Trivandrum.
- Received "second best oral presentation award" during 2nd Indian Horticulture Summit 2022 organised at Navasari Agricultural University, Navasari, Gujarat during April 27-29, 2022.

Dr. P. Anitha

- Received "Best oral presentation award" during 3rd National Conference on "Oil palm – The way forward for increasing vegetable oil pool through AatmaNirbhar Bharat for doubling farm income and providing social security to farmers" held at Vijayawada, Andhra Pradesh during November 23-25, 2022.

Dr. A.R.N.S. Subbanna

- Received Edita David Memorial Award-2022 for a research publication entitled"Gut microbial diversity across five important species of white grubs: An unculturable analysis of beetles of Anomala and Holotrichia (Scarabeidae:Coleoptera)" during 18th AZRA international conference on "Advances in applied zoological researches towards food, feed and nutritional security and safer environment" held at Bhubaneswar from November 10-11, 2022.
- Received "Best oral presentation award" in 7th National conference on Biological Control held at Bengalore during December 15-17, 2022.
- Awarded "Fellow of the Society of Biocontrol Advancement".
- Received "SBA-Dr TN Manjunath Young Scientist award for significant contributions to biological control research" in 7th National conference on Biological Control held at Bengalore during December 15-17, 2022.

Dr. S. N. Rahana

- Conferred Ph.D in Plant Breeding and Genetics from the Kerala Agricultural University during January, 2022.
- Received the "Best oral presentation award" in the Virtual National Conference on "Underutilized Horticultural Genetic Resources: Conservation and Utilization" (NCUHGR-2022) organized by Andaman Science Association, Port Blair in collaboration with ICAR-Central Island Agricultural Research Institute, Port Blair and Department of Biotechnology, Government of India during June 3-4, 2022.

7. LINKAGES AND COLLABORATION

ICAR-Indian Institute of Oil Palm Research, Pedavegi is maintaining linkages with the following National level Institutions for the promotion of oil palm research and development:

- ICAR-Central Institute of Agricultural Engineering, Bhopal
- ICAR-Central Plantation Crops Research Institute, Kasaragod
- ICAR-Indian Institute of Horticultural Research, Bangalore
- ICAR-National Bureau of Plant Genetic Resources, New Delhi
- ICAR- National Bureau of Soil Survey and Land Use Planning, Nagpur
- ICAR-Central Tobacco Research Institute, Rajahmundry
- Department of Science and Technology (DST)
- Department of Agriculture & Farmers Welfare (DA&FW), Ministry of Agriculture & Farmers Welfare, Govt. of India
- State Departments of Agriculture/ Horticulture, Govt. of Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Goa, Gujarat, Chhattisgarh, Maharashtra, Odisha, Mizoram, Tripura, West Bengal
- State Agricultural/ Horticultural Universities of oil palm growing states
- Entrepreneurs involved in oil palm development

ICAR-IIOPR is implementing the following externally funded projects and inter-institute collaborative research projects:

DST funded projects

- DST – Women scientist scheme - Genetical and functional analysis for phosphorus and zinc efficiency of microbiome associated with rhizosphere of oil palm in India
- DST-SERB/STAR project– "Genomic Selection for Enhancement of Oil Quality and Yield Traits for their Use in Oil Palm (*Elaeis guineensis*) Breeding Programmes using Whole Genome SNP Markers.

ICAR funded projects

- National Agricultural Innovation Fund - Intellectual Property Management and Technology Transfer/ Commercialization.
- Farmers first programme (under KVK scheme of ICAR)-Enhancing profitability of oil palm based cropping system through resource use efficient technologies with Farmer-Scientist and Stakeholders Interface.
- Challenge research project under LBS Outstanding young scientist award (Crop and Horticultural sciences -2017)-Integrated genomics approaches for identification of genes for dwarf trait and genes expressed during callus and somatic embryogenic stages in oil palm.

Inter-institute collaborative research activities

- Long term conservation of oil palm germplasm (ICAR-NBPGR, New Delhi).
- Evaluation of African oil palm germplasm (*Elaeis guineensis*) for cold tolerance (ICAR-CPCRI, Kasaragod).
- Microbe-mediated dormancy breaking and enhanced germination in seeds of oil palm (ICAR-NBAIM, Mau)
- Field testing of virulent strains of *Trichoderma* species on managementof Basal stem Rot of oil palm caused by *Ganoderma boninense* (ICAR-CAZRI, Jodhpur)
- Elucidating the mechanism of bio-control agents against Basal Stem Rot (BSR) pathogen (ICAR-NBAIM, Mau)

Oil Palm Development Programme

ICAR-IIOPR is providing technical guidance to DA & FW and State Agriculture/ Horticulture Departments of oil palm growing states on various aspects of oil palm cultivation. Director, IIOPR is a member of the Project Management Committee (PMC) and FFB Price Fixation Committee (PFC) of the Oil Palm Development Programme implementing states. Director and Scientists of ICAR-IIOPR were involved in various oil palm development activities.

A research programme entitled "Enhancing production, productivity and profitability of oil palm through novel technological interventions" with a total outlay of Rs. 2742.26 lakhs was approved by DA&FW (under NMEO-OP scheme) for funding during 2022-23 to 2026-27.

The following eleven projects were approved:

S. No.	Projects and Principal Investigators	Budget (Rs. in lakhs)
1	Enriching the oil palm germplasm in India to identify high oil yielding, disease resistant oil palms for commercial cultivation. **Dr. G. Somasundaram (PI), Dr. G. Ravichandran, Dr. P. Anitha, Dr. S.N. Rahana and Dr. B. Kalyana Babu**	208.44
2	Generation of parental material, support for establishing new seed gardens, strengthening existing seed gardens and research on increasing the germination percentage of planting material. **Dr. G. Ravichandran (PI), Dr. G. Somasundaram, Dr. P. Anitha and Dr. S.N. Rahana**	1265.00
3	Development and evaluation of next generation dwarf and high oil yielding oil palm hybrids. **Dr. P. Anita (PI), Dr. G. Ravichandran, Dr. B. Kalyana Babu and Dr. G. Somasundaram**	71.04
4	Early generation selection indices for high oil yield, disease and pest resistance. **Dr.A.R.N.S. Subbanna (PI), Dr. B. Kalyana Babu, Dr. P. Anitha, Mrs. M. Amrutha Lakshmi (on study leave), Dr. G. Somasundaram, Dr. S.N. Rahana and Dr. G. Ravichandran**	
	Sub Project I - Selection of high oil yielding palms through marker assisted selection and utilization for breeding. **Dr. B. Kalyana Babu**	46.20
	Sub Project 2 - Marker Assisted selection of oil palm germplasm resistantto basal stem rot and development of tool for managing Rugose Spiralling Whitefly. **Dr. A.R.N.S. Subbanna and Mrs. M. Amrutha Lakshmi (On study leave)**	50.10
5	Development of clonal seed garden through mass multiplication of high yielding elite oil palms using tissue culture. **Dr. B. Kalyana Babu(PI), Dr. K. Suresh, Dr. G. Ravichandran, Dr. S.N. Rahana and Dr. G.B. Patil**	
	Centre I IIOPR, Pedavegi. **Dr. B. Kalyana Babu**	154.70
	Centre 2 IIOPR, RC, Palode. **Dr. S.N. Rahana**	51.36
	Centre 3 Anand Agricultural University, Gujarat. **Dr. G.B. Patil**	31.56
6	Influence of climate change on regulatory processes involved in oil synthesis of oil palm mesocarp. **Dr. K. Suresh(PI) and Dr. P. Anita**	178.74
7	Efficient utilization of available space, light and biomass for making oil palm plantation as productive and self-sustainable system. **Dr. K. Ramachandrudu (PI), Dr. K. Suresh and Dr. R.P. Premalatha**	93.60
8	Enhancing resource use efficiency in oil palm through sensor based IOT applications in irrigation and fertigation. **Dr. K. Manorama (PI)**	64.10
9	Studies on insect pollination of oil palm under changing climate with special emphasis to pollinating weevil, *Elaeidobius kamerunicus* Faust. **Dr. A.R.N.S. Subbanna (PI)**	24.42
10	Development of suitable post-harvest technologies and value-addedproducts in oil palm. **Er. S. Shivashankar (PI) (on study leave), Dr. P. Anita and Dr. K. Suresh**	274.00
11	Design and development of machinery for harvesting of oil palm bunches. **Er. S. Shivashankar(PI) (on study leave), Dr. M.V. Prasad, Dr. V.K. Tewari, Dr. M. Rajendra and Dr. Ravindra Naik**	229.00
	Total	**2742.26**

8. AICRP/CO-ORDINATION UNIT

The ICAR-Indian Institute of Oil Palm Research is offering the required technical support for the implementation of research programmes of the All India Coordinated Research Project on Palms at six centres namely: Pattukottai (Tamil Nadu), Bavikere (Karnataka), Mulde (Maharahstra), Pasighat (Arunachal Pradesh) and Vijayarai (Andhra Pradesh).

Monitoring AICRP trials on oil palm

Dr. K. Manorama

- Visited AICRP (Palms) centers at Mulde (Maharashtra) and Bavikere (Karnataka) during July 26-30, 2022 to monitor the progress of crop production field trials being conducted over there on oil palm.
- Participated as a resource person in a state level workshop organized at Shimoga, Karnataka by AICRP (Palms) centre and Government of Karnataka on July 29, 2022.

Dr. G. Ravichandran

- Visited AICRP (Palms) centers at Mulde and Shimoga to monitor the trials under oil palm crop improvement and crop production during July 2022.

Dr. G. Ravichandran and Dr. A.R.N.S Subbanna

- Attended 31st Annual Group Meeting on AICRP (Palms) during September 16-18, 2022 at ICAR-CPCRI, Kasaragod, Kerala.

9. PUBLICATIONS

Research papers

Behera, S.K. Shukla, A.K., Suresh, K., Manorama, K., Mathur, R.K.andMajumdar, K. (2022). Yield variability in oil palm plantations in Tropical India is inûuenced by surface and sub-surface soil fertility and leaf mineral nutrient contents. *Sustainability*, 14; 2672. https://doi.org/10.3390/su14052672.

Manorama, K., Mathur, R.K., Suresh, K. and Behera, S.K. (2020).Influence of weather parameters on fresh fruit bunch yield of oil palm (*Elaeis guineensis*Jacq.). *International Journal of Oil palm*. 12 (1 & 2): 7-15.

Manorama, K., Behera, S.K., Suresh, K., Ramachandrudu, K. and Premalatha, R.P. (2021).Geospatial technologies for precise nutrient management in oil palm (*Elaeis guineensis* Jacq.) plantations. *International journal of Oil palm*. 13 (1 & 2): 24 - 32.

Mary Rani, K.L., Prasad, M.V., Shivashankar, S. and Anitha, P. (2022). Training need assessment of extension officers on oil palm. *The Andhra Agricultural Journal* 69 (1): 100-104.

Prasad, M. V., Madhuridevi, T., Rajesh, K., Mahesh, S. S. N. M., Srikanth, K., Siva, M. and Mathur, R. K. (2022). Perception of farmers on the impact of lockdown due to Covid-19 on agriculture and oil palm cultivation in the state of Andhra Pradesh, India. *Journal of Plantation Crops*. 50: 20-25.

Tejasri, S. S., Chinnabbai, C.H., Subbanna, A.R.N.S., Emmanuel, N., and Umakrishna, K. (2022). Influence of biochemical constituents of oil palm (*Elaeis guineensis* Jacq.) leaves on the incidence of invasive whitefly species, Rugose spiraling whitefly (*Aleurodicus rugioperculatus*) and Bondar nesting whitefly (*Paraleyrodes bondari*). *The Pharma Innovation Journal*. 11(8): 1220-1222.

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Kalyana Babu, B. 2022. Doubling the income of oil palm farmers through inter-cropping. Agriculture and Food. 04 (1): 248-249.

Kalyana Babu, B., P. Anitha, H. P. Bhagya, A.R.N.S. Subbanna. 2022. Fertigation in oil palm. Agriculture and Food. 04 (2): 322-323.

Manorama K, Suresh K, Ravichandran G, Mathur R K and Lakshmi Ambika. 2022. Irrigation management is crucial in oil palm. Annadata, April 2022. Pp: 50 – 51.

Prasad, M. V., Manorama. K., and Mathur R. K. 2022. Tel tad me sinchayiprabhandan (Irrigation management in Oil Palm). Unnat krishi. Published by Ministry of Agriculture, Government of India, New Delhi. Issue 55. No 1. January - March 2022. Pp 13-16.

Premalatha, R.P., Manorama, K., Suresh, K., Mathur, R.K. 2022. Ennai Panaiyil man maathirigal saegaripatharkana thuleyamaana muraigal– Tamil (Precise method of collecting soil samples in Oil Palm plantations). Krishi Jagran (Monthly magazine), 8(1): 30-32.

Book chapters

Kalyana Babu, B. and Mathur, R.K. 2022. Role of "Omics" approaches in sustainable development and improvement of oil palm (*Elaeis guineensis* Jacq)". In: Omics in Horticultural crops. G R Rout and K V Peter (Eds.). Academic Press, Elsevier, pp205-213.

Kalidas, P., and Subbanna, A.R.N.S. 2022. Pests and their management in oil palm. In: Trends in Horticultural Entomology, 1457-1475.

Technical publications

- Souvenir and Abstracts - 3rd National Conference on Oil palm – The way forward for increasing vegetable oil pool through AatmaNirbhar Bharat for doubling farm income and providing social security to farmers. 2022. P. Rethinam, K. Suresh, V. Krishnakumar (Eds.). November 23-25, 2022, Vijayawada, Andhra Pradesh. Pp 87.
- Summary Proceedings Vijayawada Declaration on Indian Oil palm-II. 3rd National Conference on Oil palm – The way forward for increasing vegetable oil pool through AatmaNirbhar

Bharat for doubling farm income and providing social security to farmers. 2022. P. Rethinam, K. Suresh, V. Krishnakumar, P. Anitha, H. Hameed khan, A. Bhanusri (Eds.).November 23-25, 2022, Vijayawada, Andhra Pradesh. Pp 28.

Oil palm crop calendars

- Prasad, M. V. and Mathur, R. K. (2022) Oil palm crop monthly advisory. ICAR-Indian Institute of Oil Palm Research. Pedavegi. A. P. P-6.
- Prasad, M. V. and Mathur, R. K. (2022) Oil palm panto lo nelavarisuchanalu (Telugu). ICAR-Indian Institute of Oil Palm Research. Pedavegi, A. P. P-6.

Abstracts in Conference, Seminars, Symposia

- Anitha Pedapati, R.K. Mathur, G. Ravichandran, S. Somasundaram, B. KalyanaBabu, HP Bhagya and SN Rahana.2022. Selection of Genetically Super elite Dura Mother Palms for Production of Promising Dwarf Oil Palm Seedlings. In: Souvenir & Abstracts of 3rd National conference on Oil Palm Oil Palm - The way forward for increasing vegetable oil pool through AatmaNirbhar Bharat for doubling the income and providing social security to farmers. (Eds.: P. Rethinam, K. Suresh and V. Krishna Kumar) held at Vijayawada, Andhra Pradesh during November 23-25, 2022. pp 62.
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10. TRAINING AND CAPACITY BUILDING

i. Trainings attended

The following training programmes were attended by the scientists of ICAR-IIOPR:

Dr. K. Manorama

- Webinar on "Use of AI and ICT in agriculture Information Access and Dissemination" on 14th March 14, 2022, organized by Centre for Development of Advanced Computing, Noida In association with CDAC Kolkata, Bihar Animal Science University Patna Birsa Agriculture University (BAU), Ranchi.
- IP Awareness/Training program under "National Intellectual Property Awareness Mission" on August 5, 2022 organized by Intellectual Office, India (virtual).
- Training Workshop on "Response Surface Methodology" (online) organized by ICAR-NAARM, Hyderabad during August 18-20, 2022.

Dr. G. Ravichandran

- Training on "National Intellectual Property Awareness Mission" on August 5, 2022 organized by Intellectual Property Office, India (online).
- Training on "Post Entry Quarantine for Imported Planting Material of Horticultural Crops" on September 7,2022 organized by ICAR-NBPGR, New Delhi.
- NABL Assessors Training organized by NABL, New Delhi at ICAR-NAARM, Hyderabad during December 19-23, 2022.

Dr. S. N. Rahana

- Seven days online training programme on "Transforming Food Processing from Laboratory to Industry" organized by Society of Krishi Vigyan in collaboration with College of Community Science CSKHPKV, Palampur during November 26 - December 2, 2022.

Mr. S. Shiva Shankar

- Training program on "Analysis of experimental data" conducted by ICAR-NAARM Hyderabad during January 17-22,2022 (virtual).

ii. Seminar/Symposium/Conferences attended

- Dr. K. Suresh, Dr. M.V. Prasad, Dr. K. Manorama, Dr. K Ramachandrudu, Dr. K.L. Mary Rani, Dr. B. Kalyana Babu, Dr. P. Anitha, Dr. A.R.N.S. Subbanna and Dr. R.P. Premalatha organized and attended 3rd National Conference on oil palm "Oil palm the way forward for increasing vegetable oil pool through AatmaNirbhar for doubling the income and providing social security to farmers" held at Vijayawada, Andhra Pradesh during November 23-25, 2022.

Dr. M. V. Prasad

- National Conference on Tribal Horticulture held during October 17-18, 2022 at Dr YSR Horticultural University, V.R. Gudem, Andhra Pradesh.
- National workshop on "Self sustainability in edible oils in India" organized by ICAR-NAARM, Hyderabad on April 20, 2022.
- National workshop on "Promotion of oil palm in Manipur" on June 14, 2022 at Imphal.

Dr. K. Suresh

- National Conference on "Climate Resilient and Sustainable Development of Horticulture" at CSAUA&T, Kanpur, Uttar Pradesh during May 28-31, 2022.

Dr.B. Kalyana Babu

- "International Conference on Biotechnological initiative for Climate Resilient Agriculture (BICRA)-2022" at Pusa, Samastipur, Bihar during January 07-09, 2022 and presented a paper (oral).
- "3rd International Conference on Environmental, Agricultural, Chemical and Biological Sciences" organized by voice of Indian concern for environment (VOICE) on January 22, 23, 26, 2022.
- Webinar organized by ISPC and Bionivid Technology Pvt Ltd during January 18-20, 2022 (Virtually) and delivered a keynote lecture on "Plantation Crops Genomics: An Overview of Current Research".
- "International Conference on Biotechnology

Trends and Future Prospects (BTFP-2022)" (online) organized by UAS, Bangalore during September 13-15, 2022 and presented a poster.

- "National Conference on Climate Resilient and Sustainable Development of Horticulture" at CSAUA & T, Kanpur, Uttar Pradesh during May 28-31, 2022 and presented a paper (oral).

Dr. G. Somasundaram

- Meeting (virtual) with Oil Palm India Ltd., Kottayam to establish a new oil palm seed garden at Kulathupuzha estate, Kerala on February 9, 2022.
- 2nd Indian Horticultural Summit 2022 held at Navsari Agricultural University, Navsari, Gujarat during April 27-29, 2022.Presented two papers (oral) on 1. Oil palm kernel germination – a potential alternate to conventional seed germination for enhancing oil palm planting material production.2. Oil palm planting material production and supply in India: Challenges and strategies in view of National Mission on Edible Oils – Oil Palm.
- Meeting (virtual) of researchers working on plant genetic resources organised by ICAR-NBPGR, New Delhi on August 5, 2022.
- Meeting with Director of Agriculture, Govt. of Kerala to discuss about oil palm area expansion in Kerala on October18, 2022.

Dr. P. Anitha

- National Conference on "Climate Resilient and Sustainable Development of Horticulture" at CSAUA&T, Kanpur, Uttar Pradesh during May 28-31, 2022. Presented paper on "Mapping of Quantitative Trait Loci (QTLs) for bunch traits using SSRs in African oil palm (*Elaeisguineensis* Jacq.)"

Dr.ARNS Subbanna

- On-line meeting on "Policy Document for Promotion of Oil Palm" by ICAR-NAARM, Hyderabad on January 13, 2022.
- Meeting on "National Network of Plant Health Experts" organized by NIPHM, Hyderabad on January 25, 2022.
- Online National Workshop on SCSP program organized by ICAR-NAARM, Hyderabad on August 18, 2022.
- 18th AZRA International conference on "Advances in applied zoological researches towards food, feed and nutritional security and safer environment" held at Bhubaneswar from November10-12, 2022. Presented paper (oral) on "Gut microbial diversity across five important species of white grubs: an unculturable analysis on beetles of Anomala and Holotrichia (scarabaeidae: coleoptera)"
- 7th National conference on biological Control held at Bengalore during December 15-17, 2022.Presented a paper (oral) on "Economics of mass production and impact of pest management by *Isaria fumosorosea* pfu5 against rugose spiralling whitefly in oil palm: An ICAR-IIOPR Recommendation".

Dr. R.P. Premalatha

- International webinar on "Climate Change & Soil Health" organized by Sri Sri University, Cuttack, Odisha on January 18, 2022.
- Webinar on "Technology to Drive Future Horticulture in India" organized by Prof. Brahma Singh Horticulture Foundation, New Delhi on July 10, 2022.
- Symposium on "Soils: Where Food Begins" organized by ICAR- IARI, New Delhi and ISSS-Delhi chapter on November 30, 2022.

Mr. S. Shivashankar

- Webinar on "Indian standards for Aqua feed" organized by Bureau of Indian standards on February 17, 2022
- International conference on "Key Enabling Technology for Sustainable Agri-Food Chain" organized by the Department of Food Process Engineering, National Institute of Technology, Rourkela, Odisha during December 09-11, 2022.
- International Conference on "Vision 2047: Sustainable Development Towards AtmaNirbar Bharat (VSANB-2022)" Jointly organized by Society for Science and Nature, FDDI, ICFRE & OURA Prakashan during December 23-24, 2022.

11. LIST OF ONGOING PROJECTS

S. No.	ProjectNo.	Title of the Project	Project Leader and Associates
I	1000761001	Collection, conservation, cataloguing and evaluation of oil palm germplasm	G. Somasundaram, G. Ravichandran, P. Anitha, H. P. Bhagya (upto Aug. 12, 2022), S. N. Rahana, K. L. Mary Rani
II	1000761002	Genetic enhancement in oil palm	G. Ravichandran, R. K. Mathur, K. Suresh, B. Kalyana Babu, P. Anitha, H. P. Bhagya (upto Aug. 12, 2022), G. Somasundaram, S. N. Rahana, K.L.Mary Rani
III	1000761003	Biotechnological studies in oil palm	B. Kalyana Babu, R. K. Mathur, K. Suresh, G. Ravichandran, P. Anitha, S. N. Rahana
IV	1000763002	Efficient resource management strategies in oil palm production system	K. Manorama, K. Suresh, R. P. Premalatha
V	1000763003	Oil palm based farming systems	K. Ramachandrudu, R. P. Premalatha, M. Amrutha Lakshmi (upto April 4, 2022)
VI	1000766001	Physiological and biochemical basis for growth and yield in oil palm	K. Suresh, K. Manorama, P. Anitha, R. P. Premalatha
VII	1000767001	Development of farm machineries and post harvest technologies in oil palm	S. Shivashankar (upto March 21, 2022), M.V. Prasad, K. Suresh, P. Anitha
VIII	1000765001	Integrated pest management	A.R.N.S. Subbanna
IX	1000765002	Integrated disease management	A.R.N.S Subbanna, H. P. Bhagya (upto Aug. 12, 2022), M. Amrutha Lakshmi (upto April 4, 2022)
X	1000769001	Dissemination of technology & ICT applications in oil palm sector	M.V. Prasad, K.L. Mary Rani, K. Suresh, K. Manorama, G. Ravichandran, K. Ramachandrudu, B. Kalyana Babu, A.R.N.S. Subbanna, H. P. Bhagya (upto Aug. 12, 2022), G. Somasundaram, P. Anitha, S. N. Rahana, S. Shivashankar (upto March 21, 2022), R. P. Premalatha, M. Amrutha Lakshmi (upto April 4, 2022)

12. CONSULTANCY, PATENTS AND COMMERCIALIZATION OF TECHNOLOGY

ICAR-Indian Institute of Oil Palm Research offers the following training programmes, consultancy services, contract research and contract services.

1. Training programmes (National and International)

- Oil palm nursery management
- Oil palm production and processing technology
- Harvesting of oil palm FFB
- Oil palm hybrid seed production
- Plant protection in oil palm
- Soil and leaf nutrient analysis in oil palm

2. Consultancy services

- Oil palm hybrid seed production
- Production of quality planting material
- Setting up of oil palm nurseries and their management
- Designing of experiments and data analysis
- Oil palm crop feasibility studies/surveys
- Techno - advisory services
- Project preparation, evaluation and management
- General consultancy for oil palm development
- Agronomic aspects of plantation management
- Intercropping in oil palm plantations
- Soil and nutrient management
- Assessment of soil fertility status and advisory services on nutrient disorders
- Plant health centre for pest & disease management
- Molecular and biochemical characterization of plants, fungi, bacteria
- PCR based detection of oil palm diseases
- Pollinating weevils
- Maturity, harvest, post harvest management
- Oil quality analysis
- Value addition of palm oil and EFB fibre
- Management of oil palm plantation and mill wastes
- Impact studies, socio economic studies, SWOT analysis, case studies, diffusion studies, constraint analysis in oil palm
- Management of Rugose Spiraling Whitefly in Oil Palm

3. Contract Research

- Testing of Agro-chemicals, Fertilizers, Bio-Fertilizers, Bio-Pesticides and Growth regulators suitable for oil palm
- Projects on all aspects of Water, Nutrient, Pest and Disease Management in oil palm /oil palm based cropping system

4. Contract services

- Analysis of water and soil to test the suitability for oil palm
- Leaf nutrient analysis
- Lab and field evaluation of fertilizers, herbicides, agro-chemicals/plant protection against fungi, bacteria and insect pests of oil palm
- Diagnosis of damages caused by insect pests and diseases in oil palm plantations and suggest control measures
- Oil analysis
- Bunch analysis

Consultancy proposals/Contract trainings taken up

Consultancy projects

- Technical guidance in management of oil palm seed garden for identification of mother palms in oil palm seed garden at Gopannapalem, W.G.Dt., Andhra Pradesh (Department of Hort., Govt. of Andhra Pradesh)

- Technical guidance in management of oil palm seed garden and identification of mother palms in oil palm seed garden at Taraka and Kabini, Karnataka. (Department of Hort., Govt. of Karnataka)

Contractual training

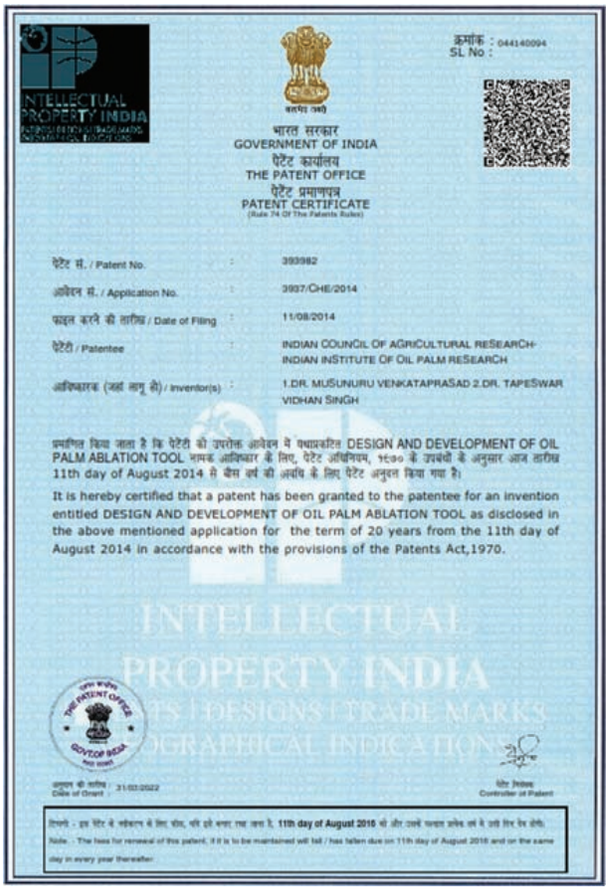
The following contractual training programmes were takenup with M/s Patanjali Foods Ltd.

- Nursery Management in Oil Palm during July 5-6, 2022.
- Nursery Management in Oil Palm during November 15-17,2022.

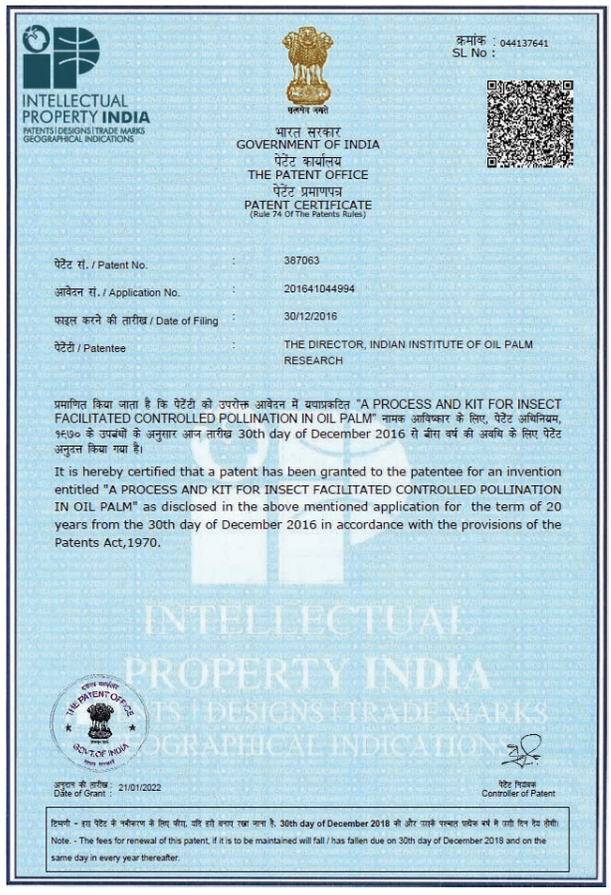
Institute Technology Management Unit

Patents obtained

S. No.	Title of Patent	Patent No.	Date of Patent Granted
1.	A process and kit for insect facilitated controlled pollination in oil palm	387063	21-01-2022
2.	Design and development of oil palm ablation tool	393982	31-03-2022



Design and development of Oil Palm Ablation tool" with IPO no: 393982



A process and kit for insect facilitated controlled pollination in oil palm with IPO no. 387063

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S. No.	Diary Number	Title of the Work	Registered Number
1.	28102/2021-CO/L	Pests, Diseases, Nutrient Deficiencies and Disorders of Oil Palm	Registered **L-114228/2022**
2.	28167/2021-CO/L	An Enchiridion of Oil Palm Cultivation in North East India	Registered **L-114239/2022**
3.	28806/2021-CO-L	Best Management Practices for Growing Irrigated Oil Palm in India	Registered **L-112369/2022**
4.	6055/2022-CO/L	Annual Report 2017 – 18 ICAR – Indian Institute of Oil Palm Research Pedavegi – 534 450, West Godavari Dt., Andhra Pradesh, India	Registered **L-115950/2022**
5.	6052/2022-CO/L	Annual Report 2019 ICAR – Indian Institute of Oil Palm Research Pedavegi – 534 450, West Godavari Dt., Andhra Pradesh, India	Registered **L-115949/2022**
6.	6043/2022-CO/L	Annual Report 2020 ICAR – Indian Institute of Oil Palm Research Pedavegi – 534 450, West Godavari Dt., Andhra Pradesh, India	Registered **L-115946/2022**
7.	6155/2022-CO/L	Smarika Evam VistrutSaramsh - Rastriya Sangosti, Tel Tad Anusandhan Evam Vikas Chunowthiya Aur Sambhavanaye	Registered **L-115961/2022**
8.	4893/2022-CO/L	Research Highlights (2015-2020)	Registered **L-115580/2022**
9.	6150/2022-CO/L	Oil Palm Sagulo Tarachuga Adige Prashnalu – Samadhanalu	Registered **L-116397/2022**
10.	5969/2022-CO/L	Methodology for Evaluation of Morphological, Phenological and Bunch Components in Oil Palm	Registered **L-116521/2022**
11.	5854/2022-CO/L	Systems Approach in Oil Palm for Higher Productivity and Profitability	Registered **L-116686/2022**
12.	6125/2022-CO/L	Technologies, Methodologies, Concepts and Products Developed by ICAR-IIOPR (1995-2020)	Registered **L-116684/2022**
13.	6059/2022-CO/L	Annual Report 2016 – 17 ICAR – Indian Institute of Oil Palm Research Pedavegi – 534 450, West Godavari Dt., Andhra Pradesh, India	Registered **L-116685/2022**
14.	6143/2022-CO/L	Frequently Asked Questions in Oil Palm	Registered **L-116693/2022**
15.	1025/2022-CO/L	Irrigation Management in Oil Palm	Granted
16.	1030/2022-CO/L	Nutrient Management in Oil Palm	Granted

Digital publications-Copy right

- Oil Palm Crop Doctor - Hindi.
- Oil Palm Crop Doctor - Telugu.
- Oil Palm Crop Doctor - Kannada.
- Oil Palm Crop Doctor - Tamil.
- Oil Palm Crop Doctor - Mizo.

Technology Commercialized

The patented technology entitled "Design and Development of Oil Palm Ablation Tool" was licensed to M/S. M.N.R. Sasyaveda, West Godavari Dt., Andhra Pradesh on Non-Exclusive basis on October 8, 2022.

Licensing of oil palm ablation tool technology to M/S. M.N.R. Sasyaveda

13. QRT, RAC, IRC, IMC MEETINGS

Institute Research Committee (IRC)

The 25th Institute Research Committee meeting was held during March 24-25, 2022 at ICAR-IIOPR, Pedavegi to review and finalize the technical programme (2022-23) of ongoing research projects at the Institute. The committee was chaired by Director, ICAR-IIOPR with all the scientific staff as members of the committee.

Research Advisory Committee (RAC)

The 21stResearch Advisory Committee meeting of ICAR-Indian Institute of Oil Palm Research was held on March 22, 2022 through online mode. The Chairman and members of RAC and scientists of ICAR-IIOPR participated in the meeting.

Dr. B. M. C. Reddy	Chairman
Dr. Manavindra Singh Gill	Member
Dr. (Prof.) Rekha Chaudhury	Member
Dr. S. Chander Rao	Member
Dr. P. M. Haldankar	Member
Dr. R. K. Mathur	Member
Dr. B. K. Pandey	Member
Dr. M. V. Prasad	Member Secretary

Institute Management Committee (IMC)

The 32ndmeeting of Institute Management Committee of ICAR-IIOPR was held on February 25, 2022. Following members were present:

Director, ICAR-IIOPR	Chairman
Dr. T. Janaki Ram	Member
Director of Agriculture, Mizoram	Member
Commissioner of Horiculture Govt. of Andhra Pradesh	Member
Asst. Director General (HS-II), ICAR	Member
Dr. B. Srinivasulu	Member
Dr. V. Dinesh Kumar	Member
Dr. (Mrs) V. Niral	Member
Dr. M.V. Prasad	Member
Sri K. Kranthi Kumar Reddy	Non-Official Member
Sri M. Durgarao	Non-Official Member
Sri Rakesh Dubay	Member Secretary

14. WORKSHOPS, SEMINARS, SUMMER INSTITUTES/ FARMERS' DAY AND OTHER MEETINGS ORGANIZED

Interface Meet with oil palm Stakeholders was organised on February 19,2022 on the occasion of ICAR-IIOPR Foundation Day.

National science day was organised on February 28, 2022.

PM Kisan Bhagidhari – PradhamikataHamari campaign was organised on April 28, 2022 at Datlavarigudem, West Godavari Dt., Andhra Pradesh.

Hon'ble Prime Minister's Nationwide Interaction Programme with beneficiaries of government schemes and programmes("Garib Kalyan Sammelan")was held on May 31, 2022.The programme was live telecasted and webcasting was organised at Rajamahendravaram jointly by ICAR-CTRI and ICAR-IIOPR. About 2000 members participated in the programme. ICAR-IIOPR, Research Centre, Palode, mobilised more than 200 farmers from Palode, Nanniyode, Peringamala, etc. villages and participated in Live Web Telecast & State Level Stakeholders Interface cum Farmers' Fair organised at ICAR-CTCRI, Thiruvananthapuram.

World bicycle day was celebrated on June 3, 2022

Yoga day was organized on June 21, 2022.

Hon'ble Prime Minister inaugurated the PM Kisan Samman Sammelan on October 17, 2022 at Mela Ground of ICAR - IARI, Pusa, New Delhi. The program was live telecasted. All the participants viewed the webcasted programme and release function at ICAR-IIOPR, Pedavegi. Scientists of ICAR-IIOPR briefed the importance of the program.

World Soil Day was organised on December 5, 2022. About 200 farmers and other oil palm stakeholders participated in the programme.

National Conference on Oil Palm (2022)

The third National Conference on Oil Palm (2022) with theme "Oil palm – The way forward for increasing vegetable oil pool through Aatma Nirbhar Bharat for doubling the income and providing social security to farmers" was held during November 23-25, 2022 at Vijayawada, Andhra Pradesh, India. The Conference was attended by oil palm growers, processors, officials from State Agriculture/Horticulture Departments of oil palm growing States, Scientists from ICAR-IIOPR & other ICAR institutes and State Agriculture/ Horticulture Universities, policy makers, students and experts from Malaysia and France. A total of around 250 delegates participated in the Conference. During the Conference there were seven Technical Sessions, in which, 13 Keynote lectures and 5 Status papers were presented along with16 oral presentations and 13 poster presentations, which were included in Souvenir and Abstracts. The proceedings of the Conference were brought out in the form of Summary Proceedings Vijayawada Declaration on Indian Oil palm-II.

15. OFFICIAL LANGUAGE IMPLEMENTATION COMMITTEE

Hindi Fortnight was celebrated from September 14-28, 2022 and conducted various competitions in Hindi. The staff members enthusiastically participated in the seven competitions during the Fortnight period. All the prize winners were given cash prize and certificate in the closing ceremony organized on September 30, 2022. The closing ceremony was chaired by Shri V.Venkataswamy, Principal, Hindi Pandit Training College, Eluru. He addressed the staff and briefed on the usage of Hindi in all official activities.

GENERAL ACTIVITIES

Constitutional day

Ekta diwas

Foundation day

ICAR Foundation day

Independence day

Republic day

Vigilance awareness week

Women's day

16. DISTINGUISHED VISITORS

The following officials visited ICAR-IIOPR during the calendar year 2022.

S. No.	Name of the visitor	Date of visit
1.	Ms. Surya Chakraveni, Women and Child Department, Govt. of Andhra Pradesh, Eluru	Jan. 24, 2022
2.	Sri M.Raghunandan Rao, IAS, Secretary (Agriculture), Govt. of Telangana	Feb. 01, 2022
3.	Sri G.P.Sharma, Director (Finance), ICAR, New Delhi	Feb. 26, 2022
4.	Sri T. Anilkanth, Manager DDM, National Bank for Agriculture and Rural Development, Eluru	May 09, 2022
5.	Sri S Ranganath - AP RO (HYD), National Bank for Agriculture and Rural Development, Hyderabad	May 09, 2022
6.	Ms. B Santhini - AP RO (HYD), National Bank for Agriculture and Rural Development, Hyderabad	May 09, 2022
7.	Dr.V. Praveen Rao, Vice-Chancellor, PJTSAU, Hyderabad	May 09, 2022
8.	Sri Rajender Kumar Kataria, IAS, Principal Secretary to Govt. (Dept. of Horticulture & Sericulture)	July 21, 2022
9.	Sri K.Nagendra Prasad, IAS, Director of Horticulture	July 21, 2022
10.	Dr.Prakash M Sobarad, Additional Director of Horticulture, Dept. of Horticulture, Govt. of Karnataka	July 21, 2022
11.	Sri M.V.S.Nagi Reddy, Vice Chairman, A.P.State Agriculture Mission, Govt. of A.P.	Sep. 02, 2022
12.	Smt. Suseela Chintala, CGM, NABARD, Telangana	Oct 21, 2022

Visit of Officials of Dept, of Horticulture, Govt. of Karnataka on July 21, 2022

Visit of M.V.S. Nagi Reddy, Vice Chairman, A.P. State Agriculture Mission on September 02, 2022

Visit of NABARD Team to ICAR - IIOPR on October 21, 2022

17. PERSONNEL

RMP

Dr. R. K. Mathur, Director, (Till November 25, 2022)

STAFF POSITION AT HEAD QUARTERS, PEDAVEGI

Scientific Staff

Dr. M. V. Prasad, Principal Scientist (Agril. Extension)
Dr. K. Suresh, Principal Scientist (Plant Physiology)
Dr. K. Manorama, Principal Scientist (Agronomy)
Dr. K. Ramachandrudu, PrincipalScientist(Horticulture)
Dr. G. Ravichandran, Principal Scientist (Seed Technology)
Dr. K. L. Mary Rani, Principal Scientist(Computer Applications)
Dr. B. Kalyana Babu, Senior Scientist (Agril. Biotechnology)
Dr. P. Anitha, Senior Scientist (Plant Breeding)
Dr. A.R.N.S. Subbanna, Senior Scientist (Agril. Entomology)
Dr. Bhagya H.P., Scientist (Plantation, Spices, Medicinal & Aromatic Plants) -Transferred to ICAR-DCR, Puttur and relieved on August 12, 2022
Ms. M. Amrutha lakshmi, Scientist (Plant pathology) - On study leave from April 04, 2022
Dr. R. P. Premalatha, Scientist (Soil Science)
Mr. S. Shivashankar, Scientist (Agril. Structures & Processing Engineering) - On study leave from March 21, 2022

Administrative Staff

Mr. Rakesh Dubey, Administrative Officer
Mr. J. Prabu Kumar, Asst. Admn. Officer
Mr. T. V. Rama Krishna, PS to Director
Mr. Asif Mohammed, Asst. Finance & Accounts Officer -Promoted as FAO and relieved on June 10, 2022
Mr. P. Sai Kishore, Personal Assistant
Mr. S. Sivarama Krishna, Personal Assistant
Mr. Mohammad Ashhar Hayat, UpperDivision Clerk
Mr. G.S.N. Babu, Lower Division Clerk (superannuation on June 30, 2022)
Ms. Y. Chaitanya, Lower Division Clerk

Technical Staff

Mrs. A. Bhanusri, Asst. Chief Technical Officer
Mr. N. V. Ganesh, Asst. Chief Technical Officer
Mr. P. R. L. Rao, Technical Officer (Driver)
Mr. E. Perayya, Technical Officer (Driver)
Mr. V. V. S. Krishna Murthy, Technical Officer (Library)
Mr. Ch. Subba Raju, Technical Officer (Driver)
Mr. A. Papa Rao, Technical Officer (Tractor Driver)
Mr. M. Rambabu, Senior Technical Assistant
Mr. K. Ananda Rao, Senior Technician

Mr. A. Dhana Raju, Technician (Tractor Driver)

Skilled Support Staff

Mr. G. Raju, SSS
Mr. G. Venkateswara Rao, SSS
Mr. A. Ganga Raju, SSS
Mrs. N. V. V. S. Lakshmi, SSS
Mr. K. Satyanarayana, SSS
Mr. Ch. Venkata Durga Rao, SSS
Mr. M. Appa Rao, SSS

STAFF POSITION AT RESEARCH CENTRE, PALODE

Scientific Staff

Dr. G. Somasundaram, Senior Scientist (Seed Technology)
Dr. S. N. Rahana, Scientist (Plant Breeding)

Administrative Staff

Mr. K. Ravindran, Assistant

Technical Staff

Mr. A.S. Sabu, Chief Technical Officer
Mr. V. Sunilduth, Technical Officer (Superannuation on July 31, 2022)
Mr. B. Muralidharan Pillai, Senior Technical Assistant

Skilled Support Staff

Mr. P. K. Rethnakaran, SSS
Mrs. P. Rema, SSS

18. METEOROLOGICAL DATA

ICAR-IIOPR, Research Centre, Palode, Kerala

Month	Temperature			Relative Humidity (%)
	Max^0(C)	Min^0(C)	Avg.^{0}(C)	
January, 2022	32.2	28.0	29.0	78.0
February	32.7	25.3	28.1	78.3
March	32.7	26.3	28.1	74.5
April	32.7	26.5	28.2	75.5
May	33.2	28.5	30.0	76.1
June	31.1	27.6	29.0	78.8
July	31.8	27.2	29.4	78.0
August	32.2	26.1	29.0	76.5
September	31.8	27.0	29.2	74.0
October	32.0	26.7	29.1	74.6
November	31.8	26.7	28.1	74.1
December	32.0	26.2	27.6	74.1

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भाकृअनुप – भारतीय तेल ताड़ अनुसंधान संस्थान
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