ICAR-AICRP on Palms

ANNUAL REPORT 2022

वार्षिक प्रतिवेदन

भा.कृ.अनु.प. - अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना
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कासरगोड़, केरल, भारत - 671 124

ICAR- ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS
ICAR-CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
KASARAGOD, KERALA, INDIA - 671 124

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Director & Project Coordinator (Palms)
ICAR - Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
Kasaragod, Kerala, India – 671 124
Phone: 04994 – 232733; Fax: 04994 – 232614
E mail: pcpalms.cpcri@icar.gov.in
Website: http://www.cpcri.gov.in

Compiled and edited by
Dr. Ravi Bhat
Dr. Sumitha S

Hindi Translation
Dr. Alka Gupta

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PREFACE

Plantation crops play a major role in agriculture sector which contributes to the employment both directly and indirectly through its forward and backward linkages. In an open economy, competitiveness of a product is not only important from export point of view, it is equally important to survive in the domestic market. Given the nature of the plantation crop with a long gestation period supply responsiveness is rigid, it is important to analyse the changes in the area, production and productivity of plantation crops to understand the impact of globalization on these crops to suggest policy measure. More than 25 million people in rural areas are engaged in the production, processing and marketing the products of these crops. The long term nature of research on these crops, the prospects of higher returns from research investment and the likely distribution of research benefits to the small holders and economically disadvantaged sections of the society, make it imperative to strengthen the research programme on these crops.

The All India Coordinated Research Project on Palms started functioning from 1972 with the objective of conducting location-specific research in the mandate crops. At present the project has coconut, oil palm, arecanut, palmyrah and cocoa as mandate crops and it is implemented in 28 centres, which are located in 14 states and one union territory covering 13 SAUs/SHUs, one CAUs and four ICAR institutes. The achievements made during 2021 under the project are briefed in this annual report.

At Ambajipeta centre, among the varieties/ hybrids evaluated for a period of 2014-2021Godavari Ganga recorded significantly higheryield/palm/year (144nuts) followed by VHC-2(135 nuts) and Kera Ganga (133 nuts) with thehighest fruit weight (1393 g).

A total of 6600 numbers of Braconhebetor, 1,77,050 numbers of G. nephantidis, 17100 numbers of P. imbrues, 242 Tricho cards and 32,61,100 number s of P. astureggs were supplied to the farmers of East Godavari, West Godavari, Visakhapatnam and Srikakulam districts of Andhra Pradesh, BhadradriKothagudem, Medchal and Khammam districts of Telangana for black headed caterpillar management. Coconut fronds or leaflets containing parasitized puparia were collected from the affected ecosystem and released in newer areas of infestation. At Aliyarnagar centre, a total of 12,561 packets of Encarsiaparasitoid were distributed to 4000 farmers. A multilocationtrial (MLT) of cocoa clones under palms is in progress at different AICRP centres *viz*., Aliyarnagar, Arsikere, Kahikuchi, Ratnagiri and Vijayarai. Under evaluation of performance of cocoa varieties/hybrids as intercrop in coconut garden, at Ambajipeta, VTLCH-2 recorded higher dry beans/ plant (2.1 kg) and was at par with VTLCC-1 and VTLCH-4 (1.8 kg/tree).

In respect of transfer of technology front, different centres were involved in conducting on-farm, off-farm trainings, kisanmelas, and participation in exhibition, diagnostic field visits and coverage through press and media. The schedule caste Sub plan (SCSP) was implemented to benefit and improve their livelihood security in different states.

I consider it a privilege to express my sincere gratitude to Dr.TrilochanMohapatra and Dr. Himanshu Pathak, Secretary, DARE and Director General, ICAR for his constant support given for the project. I am grateful to Dr.Anand Kumar Singh, Deputy Director General (Hort. Science)Dr. B.K. Pandey, ADG (Hort. Science-II) and staff of Horticulture Science Division, ICAR for their support and necessary guidance. The technical guidance and help in implementation of technical programmes by Dr. Anitha Karun, Acting Director and staff of ICAR-CPCRI, Kasaragod and Dr. R. K. Mathur, Director and staff of ICAR-IIOPR, Pedavegi are gratefully acknowledged. The efforts made by all the staff of the centres during execution of various programmes is well appreciated. The help rendered by Dr.Alka Gupta in Hindi translation is acknowledged with gratitude. The support and coordination of Dr.Sumitha S, Scientists, Smt. K. Narayani, Private Secretary, Mr. Karunakara, and Mr. Shankar, of AICRP Cell for bringing out this report is appreciated.

May, 2023 (Dr. Ravi Bhat)

कार्य सारांश

अखिल भारतीय समन्वित अनुसंधान परियोजना ने 1972 से लक्षित फसलों में ताड़ पर स्थान-विशिष्ट अनुसंधान करने के उद्देश्य से कार्य करना शुरू किया । वर्तमान में इस परियोजना में नारियल, तेल ताड़, सुपारी, पामेरा और कोको मुख्य फसलों के रूप में है, जिन्हें २८ केंद्रों में लागू किया गया है। अभासअप (ताड़) के तहत नारियल पर 15, तेल ताड़ पर 6, सुपारी पर 4, पामेरा पर 4 शोध करने वाले केंद्र हैं और कासरगोड़ में स्थित भाक्ट अनुप-केराफसआ के मुख्यालय समेत कोको पर शोध करने वाले 7 केंद्र है। 14 राज्यों और 1 केन्द्रशासित प्रदेश में समन्वय केंद्र स्थापित किये गए हैं जिनमें 13 राज्य कृषि विश्वविद्यालयों/राज्य बागवानी विश्वविद्यालयों, एक केंद्रीय कृषि विश्वविद्यालय और चार भा.कृ.अनु.प संस्थानों में स्थित हैं। वर्ष 2021 (जनवरी-दिसंबर) का बजट 669.35 लाख रूपये था और यह योजना संम्बंधित राज्य कृषि/बागवानी विश्वविद्यालयों के माध्यम से 75:25 के आधार पर लागू की गई जिसमे भा.कृ.अनु.प. को 75% और राज्य कृषि/बागवानी विश्वविद्यालयों को 25% हिस्सा आबंटित हूआ। केंद्रीय विश्वविद्यालयों और भा.कृ.अनु.प. संस्थानों के केन्द्रों में 100% वित्त पोषण भा.कृ.अनु.प. द्वारा होता है।

अनुसंधान उपलब्धियाँ

नारियल

फसल सुधार

अम्बाजिपेट केंद्र में 2014-2020 की अवधि में मूल्यांकित की गई किस्में/संकरों में से गोदावरी गंगा से उच्चतम उपज/ताड़/वर्ष 144 गुठली दर्ज की गई और वी एच सी-2 से 135 गुठली और केरा गंगा से 133 गुठली और उच्चतम गुठली भार 1393 ग्राम पाया गया।

रत्नगिरी में वर्ष २०११ में रोपित बौनी x बौनी संयुक्त के मूल्यांकन के अधीन जीबीजीडी x एम ओ डी संकर पूर्व पुष्पित देखा गया और संकर सीओडी x एम वाई डी से उच्चतम मृदुफल (डाब) उपज (76.7 गुठली) दर्ज की गई। सीओडी x एम वाई डी में डाब पानी अधिक (602 मि.ली./प्रति गुठली) जबकि टी एस एस अधिकतम जीबिजीडी x एम ओ डी संकर में 5.7^0 ब्रिक्स पाया गया।

फसल उत्पादन

तटीय रेतीली मिट्टी में नारीयल आधारित बहु-प्रजाति फसल प्रणालियों के मूल्यांकन से अनुशंसित पोषक तत्वों के साथ अधिकतम गुठली उपज के संकेत मिले हैं। नारियल + *गार्सिनिया इंडिका* + हरी स्वाद के साथ सब्जी फसल प्रणाली + जैव उर्वरक + जैविक पुनर्चक्रण + उर्वरक (आर डी एफ) की 100% अनुशंसित स्वुराक में सब्जी (स्नेक गाई) की उपज अधिकतम पाई गई। नारियल + *गार्सनिया इंडिका* + अनानास फसल प्रणाली में हरी स्वाद + जैव उर्वरक + जैविक पुनर्चक्रण + मृदा परीक्षण आधारित पोषक के अनुप्रयोग के साथ अनानास कयू जाति की अधिकतम उपज दर्ज की गई। *गार्सनिया इंडिका* की अधिकतम ऊंचाई व विस्तार नारियल + गार्सिनीया इंडिका + हरी स्वाद + जैव उर्वरक + जैविक पुनर्चक्रण + 100% आर डी एफ के साथ सब्जी फसल प्रणाली में दर्ज किया गया।

चारागाह फसलों के साथ नारियल का एकीकरण (कुम्बु नेपियर संकर + डेसमन्यस), चारे के पेड़ (*सेस्बेनिया ग्रेंडिफ्लोरा* + *ल्युकैना स्यूकोसेफेला* + ग्लैरिसिडिया) और टेलिचेरी नस्ल की बकरियों ने अलियार नगर केंद्र में, नारियल की एक फसल में प्रति हेक्टेयर 2.25 के बीसी अनुपात के साथ 1,51,312/- रूपये की तुलना में, प्रति हेक्टेयर 3.16 के बीसी अनुपात के साथ 2,54,206/- रूपये की शुद्ध आय दर्ज की।

स्थान विशेष पोषक तत्व प्रबंधन के साथ द्वितियक रूप में ($CaSO_4$ $2H_2O$-1 कि.ग्रा. और $MgSO_4$-500 ग्राम प्रति ताड़ प्रति वर्ष) + सूक्ष्म पोषक मिश्रण (FeSO4, MnSO4, CuSO4, ZnSO4, बोरेक्स और अमोनियम मोलिब्डेट) @ 1 कि.ग्रा. प्रति ताड़ प्रति वर्ष + नारियल फ्रोड मल्विंग + एजोस्पिरिलम - 100 ग्राम + फास्पोबैक्टीरिया-0 ग्राम + वी ए एम-0 ग्राम प्रति ताड़ के अनुप्रयोग से प्रति वर्ष चौघाट आंरेज बौनीर्फ किस्म (डाब के लिए उपयुक्त) में किसानों के उत्पादन में 32% तक की वृद्धि दर्ज की गई। किसानों को शुद्ध रिटर्न औ लाभ लागत अनुपात में 3.10 लाख प्रति हेक्टेयर और आई एन एम फैकेज 2.66 लाख रूपये के मुकाबले क्रमशः 4.38 लाख प्रति हेक्टेयर और आई एन एम 2.99 लाख रूपये की बढ़त दर्ज की गई।

फसल सुरक्षा

रोग प्रबंधन

100, 250 और 500 पी पी एम के कृत्रिम वातावरण *गैनोडेरेमा* जाति की वृद्धि के विरुद्ध 13 नए फंफूदनाशी का परीक्षण किया गया। परीक्षण में यह देखा गया कि अन्य फंफूदनाशी की तुलना में 4% हेक्साकोनेजोल + 16% एस सी कारबेन्डाजिम + 5% हेक्साकोनेजोल की आवरोधन क्षमता श्रेष्ठ पाई गई।

नारियल के तना स्त्रवन रोग के विरुद्ध कॉपर ऑक्सीक्लोराइड के लेपन की तुलना में टी. हर्जियानम और टी. रिर्से केक फोरमूलेशन से रोग प्रभावित ताड़ को पूर्ण रूप से रोग मुक्त किया जा सकता है। अम्बाजिपेट केंद्र में ट्रैकोडेरेमा हर्जियानम

केक (केरोफअसं केक) और ट्रैकोडेरेमा रिर्स केक फोरमुलेशन के प्रयोग के 50 दिनों के अंदर रोग सूचकांक 7.96 और 6.95 को 0.0 प्रतिशत तक कम किया जा सकता है।

पत्रा क्षयरोग प्रबंधन

जनवरी, अप्रैल, जुलाई और अक्तूबर में तिमाही के उन्तराल पर 100 मि.ली. पानी में 5 मि.ली. प्रोपीकोनाजोल के साथ मिलाकर 36 महीने तक जड़ो में डाल कर उपचार करने के बाद पत्तों के क्षयरोग की घटनाओं में 27.0% तक की कमी दर्ज की गई। इस उपचार के परिणामस्वरूप 138 गुठली/ताड़/वर्ष की उच्चतम उपज और अनुपचारित नियंत्रण में 97 गुठली/ताड़/वर्ष के मुकाबले बीःसी अनुपात 3.7 दर्ज किया गया।

कीट प्रबंधन

अम्बाजिपेट केंद्र में आंध्राप्रदेश के पूर्व गोदावरी और पश्चिम गोदावरी, विशाख्रापट्टनम, श्रीकाकुलम और तेलंगाना के भद्रादी कोतगुदम मेडचाल और ख्रम्मम जिलों के किसानों को कुल 6600 ब्राकोन हेबेटोर, 1,77,050 जी. निफान्टिडिस, 17,100 पी. इम्ब्रस, 242 ट्राईकोकार्ड्स और 32,61,100 पी.एस्टूर अण्डों का वितरण किया गया परजिव्याभ्य प्यूपेरिया निहित पर्णक या पणागि संग्रहित किए गए। अलियार नगर केंद्र में एन्कार्सिया परजीव्याभ के कुल 12,560 पैकेट 4000 किसानों को वितरित किए गए।

रुगोस सर्पिल सफेद मक्स्वी के लिए समीकृत कीट प्रबंधन रणनीतियाँ शुरु की गई जिसके तहत बगीचे में पीले चिपचिपे जाल को लगाया गया, 15 दिनों के अन्तराल पर 0.05% नीम के तेल के तीन धिड़काव और नीम के तेल के 10 दिन बाद जोट वाटर स्प्रे के तीन राउंड लगाए गए। अलियार नगर केंद्र में 15 वर्ष आयू के सी ओ डी ताड़ में परीक्षण से यह देख्रा गया की समीकृत कीट प्रबंधन रणनीतियाँ स्वीकृत प्लाट में प्राकृतिक नियंत्रण की तुलना में रोग लक्षण 52.2% से 22.5% कम और 48.2% से 20.5% कम दर्ज किया गया। लेकिन लक्षण प्रतिशत और कीट तीक्ष्णता में क्रमशः 45.2 से 56.2% और 50.5 से 58.8% वृद्धि दर्ज की गई।

तेल ताड़

पाट्टूकोट्टाई में 10 संकरों की वृद्धि और उपज के प्राचल मूल्यांकन से संकर एन आर सी ओ पी 4 से उच्चतम ताड़ लम्बाई 5.27 मी. पाई गई। प्रति वर्ष उत्पादित पत्तों की संख्या एन आर् सि ओ पि 2 में उच्चतम 25.6 और उच्चतम गुच्छ भार 173.2 कि.ग्रा./ताड़ और प्रति हेक्टेयर उपज 24.78 टन प्रति हेक्टेयर एन आर सि ओ पि 9 में दर्ज की गई।

मुल्डे तेल ताड़ बाग़ में सात विभिन्न अंतर फसलों का मूल्यांकन किया गया। तेल ताड़ + ताल अदरक + काली मिर्च अंतर फसलन से 166.2 कि. ग्रा./ताड़ का गुच्छ भार देख्रा गया। बुश काली मिर्च से अधिकतम उपज 0.726 ग्रा. प्रति पौध और सुख्रे फल की अधिकतम उपज 1.05 की. ग्रा./ प्लाट दर्ज की गई।

सुपारी

बर्मी धनिया अंडमान और निकोबार द्विप समूह में उगाई जाने वाला एक सोकप्रिय शाक है। इस शाक को दक्षिण अंडमान द्वीप के गर्म आर्द्र उष्णकाटिंबधिय परिस्थितियों में सुपारी ताड़ की 'समृधि' किस के साथ इस शाक की लाभ प्रदता का अध्ययन करने के लिए एक अंतर फसल के रूप में उगाया गया। परिणामों से पता चला की इंटरस्पेस में वर्मी धनिया उपजाने से वह अकेली सुपारी की फसल के 9,59,600/ - रूपये की तुलना में 13,03,065/- रूपये उच्च शुद्ध रिटर्न दे सकती है। इस फसल का बिः सी अनुपात 3.19 पाया गया और इसलिए इसे द्वीप किसानों के लिए अनुशंसित किया जा सकता है।

कोको

भारतीय समन्वित ताड़ अनुसंधान परियोजना के पश्रिमी तट, पूर्वी तट और पूर्वोतर को कवर करने वाले सातों केंद्रों में कोको दिनोटाइप और सुपारी, नारियल व तेल ताड़ के बगानों सहित विभिन्न फसल प्रणालियों का परीक्षण किया जा रहा है। कासरगोड (केरल), अम्बाजिपेट (आंध्र प्रदेश) और वोप्पनकुलम (तमिलनाडु) स्थित संस्थानों में 12 वर्ष पुरामे परीक्षण में नारियल वाले क्षेत्रों में वि टि एल सि एच-2 और वि टि एल सि एच-1 के प्रदर्शन को क्रमशः सबसे बेहतर बाया गया। मूल्यांकन के प्रारंभिक आठ वर्षों में यह देख्रा गया कि अलियार नगर (तमिलनाडु) रत्नगिरी (महाराष्ट्र) और काहीकुची (असम) में क्रमशः वि टि एल सी पी-16 वि टि एल सि-20 पेड़ों में सर्वश्रेष्ठ प्रदर्शन पाया गया जबकि तेल ताड़ के तहत विजयराय (आंध्र प्रदेश) में वि टी एल सी-57 अधिक उपज देने वाला पाया गया।

पामैरा

ताजा नीरा से बना शक्कर पाउडर (सि पि सि आर् आई संग्रहण तरीके के अनुसार) अच्चा रंग और एक वर्ष तक का जीवन काल देता हौ, लेकिन पास्मपरिक विधि से बनाने से शक्कर का रंग गहरा हो जाता है और साधारण पैकिंग में कमरे के तापमान पर तीन महीने के भितर ही ख्रराब हो जाती है। सि आई एई द्वारा विकसित पामैरा मृदु फल प्रक्रमण यंत्र का मूल्यांकन किया गया और पाया गया कि यह ब्रूणपोष निकालने का समय और परिश्रम को कम करता है। यह भी देख्रा गया कि कुटीर स्तर पर भ्रूणपोष बेचने के लिए, और अकुशल व्यक्तियों दारा प्रयोग के लिए यह बहुत उपयोगी है। निर्जलीकृत कंत और कंदचूर्ण वाणिज्यिकरण के लिए तैयार है जिसे गैर सरकारी संस्था (आशा चिन्तूरु, आंन्ध्र प्रदेश) द्वारा ब्रिटेन भेजा गया जो जनजातीय लोगों के लिए आय का साधन साबित हुआ।

II. EXECUTIVE SUMMARY

The All India Coordinated Research Project on Palms started functioning from 1972 with an objective of conducting location-specific research in the mandate crops. At present the project has coconut, oil palm, arecanut, palmyrah and cocoa as mandate crops and it is implemented in 28 centres. The AICRP (Palms) has 15 centers conducting research on coconut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa with Headquarters at ICAR-CPCRI, Kasaragod. The coordinating centres are located in 14 states and one union territory covering 13 SAUs/SHUs, one CAU and four ICAR institutes. The budget for the year 2022 (January -December) was Rs. 669.35 lakhs and the scheme is implemented through the respective state Agricultural/Horticultural Universities on 75:25 basis, with 75% share from ICAR and 25% share from State Agricultural/Horticultural Universities. The centers of Central Agricultural Universities and ICAR Institutes have 100% funding from ICAR.

RESEARCH ACHIVEMENTS

COCONUT

CROP IMPROVEMENT

- At Veppankulam centre, the nut yield varied from 55.60 to 97.00 nuts in COD and GBGD x MOD respectively. The setting per cent varied from 21.59 % (COD) to 33.78% (CGD x MGD). The whole fruit weight varied from 766.00 g to 1180.33g. The average was 928.85g with deviation of 140.37g. The tender nut volume was higher in GBGD x MOD (603.83 ml /nut) and lower in COD (326.40ml/ nut). Assuming 175 palms per hectare, the tender nut yield was higher in GBGD x MOD (10,250 litres) and lower in COD (3,175.97 litres). The average yield of tender nut water was 6,336.87 litres.
- Among the Dwarf x Dwarf combinations planted during 2011 at Ratnagiri, hybrid GBGD x MOD is a promising cross for the earliness. The hybrid COD x MYD recorded the highest tender nut yield (76.7 nuts) followed by the hybrid GBGD x MOD (68.3 nuts) among the entire Dwarf x Dwarf coconut hybrids. The hybrid COD x MYD recorded maximum volume of tender nut water (602.7 ml/nut) whereas, the hybrid GBGD x MOD recorded maximum TSS with a score of 5.7 ^{0} Brix.

CROP PRODUCTION

- Integration of coconut with pasture crops (*Cumbu Napier hybrid + Desmanthus*), fodder trees (*Sesbania grandiflora + Leucaena leucocephala + Glyricidia)* and Telicherry breed of goats recorded net income of Rs. 2,18,650 per ha as compared to Rs. 1,17,600 per ha in the monocrop of coconut. Nutrient monitoring was done employing NUT MON Tool box. Under coconut monocropping system and cropping system – I with balanced fertilization (application of N, P and K), there was positive balance for P and K and negative balance for nitrogen whilst in cropping system – II with imbalanced fertilization, there was negative balance for N, P and K. Green House Gas (GHG) Emission was estimated in Integrated Farming System trial employing IFS – GHG Estimation Tool obtained from Project Directorate of Cropping Systems Research, Modipuram. GHG emission from Integrated Farming System was negative and hence it is environmentally safe.
- Evaluation of Coconut based multispecies cropping systems under coastal littoral sandy soil indicated maximum nut yield in Coconut + *Garcinia indica* + Pineapple cropping system

with recommended nutrient application. The vegetable (snake guard) yield was maximum in Coconut + *Garcinia indica* + Vegetable crops cropping system with Green manuring + biofertilizers + organic recycling +100% Recommended Dose of Fertilizer (RDF). The maximum pineapple (var. Kew) yield was recorded in Coconut + *Garcinia indica* + pineapple cropping system with Green manuring + biofertilizers + organic recycling + Soil test based nutrient application. Maximum height and girth of *Garcinia indica* was recorded in Coconut + *Garcinia indica* + Vegetable Crops cropping system with Green manuring + biofertilizers + organic recycling +100% RDF.

CROP PROTECTION

Management of leaf blight disease

- Root feeding with propiconozole @ 5 ml in 100 ml of water at three months intervals during Jan, April, July and October reduced the leaf blight incidence by 27.0 per cent after 36 months of treatment. This treatment also recorded the highest nut yield of 138 nuts/ palm/ year and the B:C ratio of 3.7 as against 97 nuts/ palm/year in the untreated control.

Pest Management

- The IPM strategies (Installation of yellow sticky traps in the garden, Three rounds of neem oil spray 0.5% at15 days interval and Three rounds of jet water spray 10 days after spraying neem oil)for the management of rugose spiralling whitefly was started during the month of November 2018, in the COD palms (15 years old) at Aliyarnagar centre. The results revealed that the application of IPM strategies significantly reduced incidence and intensity of rugose spiralling whitefly from 52.2% to 22.5% and 48.2 % to 20.5% respectively when compared to the natural control where the percent incidence and pest intensity was increased from 45.2 to 56.2% and 50.5% to 58.5% respectively.
- A total of 7000 numbers of *Bracon hebetor*, 1,87,050 numbers of *G. nephantidis*, 17100 numbers of *P. imbrues*, 275 Tricho cards and 32,61,100 number s of *P. astur* eggs were supplied to the farmers of East Godavari, West Godavari, Visakhapatnam and Srikakulam districts of Andhra Pradesh, Bhadradri Kothagudem, Medchal and Khammam districts of Telangana from Ambajipeta centre. Coconut fronds or leaflets containing parasitized puparia were collected from the affected ecosystem and released in newer areas of infestation. At Aliyarnagar centre, a total of 13,165 packets of *Encarsia* parasitoid were distributed to about 4000 farmers.

OIL PALM

- Seven different intercrops were evaluated in oil-palm garden at Mulde. The maximum yield of oil palm was recorded in treatment Oil Palm + Red Ginger + Black pepper with bunch yield of 166.2 kg /palm. The bush pepper recorded maximum yield of 0.726g per plant and maximum yield of dry berries was 1.05 kg/plot.

COCOA

- Cocoa genotypes are under evaluation in 8 AICRP (Palms) centres covering west coast, east coast and NE regions and different cropping systems including arecanut, coconut and oil palm gardens. From the 12 year old trial at Kasaragod (Kerala), Ambajipeta (AP) and Veppankulam (TN), VTLCH-2, VTLCH-2 and VTLCH-1 were identified as best performers respectively in the regions under coconut. From the initial years of evaluation, it was observed that among 8 year old trees of Aliyarnagar (TN), Ratnagiri (Maharashtra) and Kahikuchi (Assam), VTLCP-16, VTLC-17 and VTLC-20 were found to be best performing respectively, whereas VTLC-57

was high yielding at Vijayarai (AP) under oil palm.

PALMYRAH

- Jaggery powder prepared form fresh neera (collected as per CPCRI method) gives good colour and shelf life up to one year, whereas jaggery from traditional method turns into dark colour and spoil within 3 months under room temperature with normal packing. Palmyrah tender fruit processing machine developed by CIAE was evaluated and it reduces drudgery and time for endosperm separation. It was also observed that the machine is useful for both skilled and unskilled persons at cottage level selling of endosperm. Dehydrated tuber and tuber flour was commercialized and one consignment was sent to UK through an NGO (ASHA Chinturu, AP) and income generated to tribal people.

MEETINGS HELD:

'The 31st Annual Group Meeting of All India Co-ordinated Research Project on Palms was conducted at Central Plantation Crops Research Institute, Kasaragod from 16-18 September 2022, which coincided with the Golden Jubilee Year of AICRP (Palms). The meeting was inaugurated on 16th September 2022 by Dr. V. Geethalakshmi, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore. The formers Project Coordinators Dr.P.Rethinam, Former Executive Director, ICC (APCC), Jakarta, Dr.S.Arulraj, Former Director, IIOPR, Pedavegi, Dr.H.Hameed Khan Former Project Co-ordinator of AICRP (Palms) and Dr.H.P.Maheswarappa, Director of Research, UHS, Bagalkot were the Guests of honour. Dr.R.K.Mathur, Director, IIOPR, Pedavegi, Dr.V.S. Korikanthimath, Former Director, ICAR Research Complex for Goa and Dr. P. Chowdappa, Former Director, ICAR – CPCRI Kasaragod, also participated in the inaugural session.

Dr. Ravi Bhat, Acting Head (Crop Production) and Scientist in-charge, Project Co-ordinator Cell, CPCRI, Kasaragod welcomed the dignitaries and delegates in which he highlighted the yeomen service and spade work of the Former Project Co-ordinators of AICRP (Palms) in moulding the programme to hit several milestones in the Plantation Crops Sector. The Project Co-ordinator presented a brief note on the mission of the Project Directorate since its genesis in1972 on five mandate crops - Coconut, Oil palm, Palmyrah, Arecanut and Cocoa distributed across 28 AICRP centres of 14 States, 13 State Agricultural Universities, 4 ICAR institutes and one Central Agricultural University of the nation. He opined that the release of Oil plam variety NRCOP – 4, identification of the precocious coconut hybrid Godavari Ganga and Tall x Tall hybrid combinations of coconut, Coconut based multispecies cropping system models in transformation of unproductive ecosystems to vibrant environment, Integrated Nutrient Management for higher productivity and profitability of dwarf coconut, Development of location specific Integrated Farming System models, Integrated Pest and Disease Management modules for the management of stem bleeding, leaf blight and Rugose Spiraling Whtiefly in coconut stands testimony to the work of AICRP (Palms). Intercropping of Burmese Coriander in Arecanut System, multiplication of superior cocoa clones VTLCH 7 and 14 for planting material production to cater the need of North East India and export of a consignment of dehydrated tuber and tuber flour of Palmyrah to UK were underlined by him. Taking technology to the farmers' door steps and to the technologically deprived through series of trainings under SCSCP / TSP mission, supply of biocontrol agents to curb pest and disease menace, supply of elite seedlings of plantation crops remain added strength of the programme.

Dr.V.Geethalakshmi, Vice Chancellor, TNAU, Coimbatore in her Inaugural Address applauded AICRP (Palms) for the release of 21 varieties of coconut and 11 varieties of arecanut and a bouquet of crop production technologies towards

improving the standard of living of the plantation crop growers. Non scientific management and senile palms remain major impediments in achieving higher productivity. She also emphasized the need for developing varieties tolerant to pests, diseases and to weather extremities. She invited the palm researchers to enlighten the farmers on crop diversification and value addition to overcome the frequent depression in price chart of copra and also to devise strategies to enhance water use efficiency. She outlined the scope for oilpalm and palmyrah and hinted the need for Mechanization and Artificial Intelligence with robotics and sensors in the era of labour scarcity. Following the Inaugural Address, Dr.P.Rethinam, Founder Director, IIOPR, Pedavegi in his Golden Jubilee Lecture "Reminiscences on Research Imprints of AICRP (Palms)" listed the glorious achievements of AICRP (Palms) in its 50 years journey in terms of release of improved varieties catering to the demands of the farmers, path breaking research technologies like Cropping Systems Approach, Eradication of Tatipakka disease in Andhra Pradesh and effective management of Basal Stem Rot of Coconut. He set forth the need for establishment of Centre of Excellence in Palmyrah as this drought hardy crop provides livelihood security to the rural unemployed. He congratulated all the torch bearers of the AICRP (Palms) scheme for placing the programme in the pinnacle of grandeur.

Dr. H. Hameed Khan, Former Project Co-ordinator in his felicitation appreciated the rigorous efforts of palm scientists in addressing location specific problems and for improving the production base. He rolled out a red carpet to intensify research in value addition of coconut. Dr.S.Arulraj, Former Director, IIOPR in his felicitation expressively looked back the social concern of the palm scientists in overriding the emotional setbacks of the farmers in the events of natural disasters. Dr.H.P.Maheswarappa, Former Project Co-ordinator, AICRP (Palms) and Director of Research, University of Horticultural Sciences, Bagalkot attributed the accolades like Best AICRP Centre of ICAR during 2015 and 'OUTSTANDING' rank of Quinquennial Review Team of 2020 to the exemplary guidance of the predecessors together with the industrious efforts of the palm scientists garnished with enthusiasm across the nation.

Dr. Anita Karun, Director, CPCRI and Project Co-ordinator (Acting), AICRP (Palms) in the Presidential Address extended profuse gratitude to the entire palm scientists for the achievements of AICRP (Palms) which helped transform the lives of the palm growers towards economic prosperity. She also wished that all the palm scientists should join hands to take the AICRP (Palms) programme and plantation crops sector to greater heights in the nation. The inaugural session concluded with the formal vote of thanks by Dr. P. Subramanian, Principal Scientist (Agronomy), CPCRI, Kasaragod. About 100 participants from across different AICRP centres of the nation attended the Annual Group Meet. Navsari Centre, Gujarat received the Best AICRP (Palms) Centre Award for the year 2021. Bouquet of publications in terms of Technical Bulletins, booklets and folders prepared by the palm scientists were released in the event. The inaugural session was followed by technical sessions on Genetic Resources and Crop Improvement, Crop Production, Crop Protection and Post Harvest Technology.

III. PROFILE OF AICRP ON PALMS

Among the plantation crops, coconut (*Cocos nucifera* L.), arecanut (*Areca catechu* L.), oil palm (*Elaeis guineensis* Jacq.), palmyrah (*Borassus flabellifer* L.) and cocoa (*Theobroma cacao* L.) play a significant role in the sustainable livelihood of millions of small and marginal farmers in the country. The All India Co-ordinated Research Project on palms came into existence in the year 1972 to carry out the location specific research on mandate crops (coconut, arecanut, oil palm, palmyrah and cocoa) with the following objectives:

- Identification, conservation and utilization of elite genetic resources for useful traits in palms and cocoa from different agro-climatic regions.
- Evaluation of varieties/hybrids under different locations and to facilitate release of varieties/ hybrids of palms and cocoa through multi-location testing (MLT).
- To improve input use efficiency and develop location-specific palm based integrated farming systems to enhance the productivity per unit area.
- Evolving cost effective integrated insect-pest and disease management practices besides survey and surveillance of pests and diseases for forewarning.
- Development of post-harvest technologies in palmyrah.

List of Centres

The project is implemented in 28 centers with its headquarters at ICAR-CPCRI, Kasaragod and at present 15 centres are working on coconut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa. The coordinating centers are located in 14 states and one union territory covering 13 SAU's/SHU's, one Central Agricultural University and four ICAR institutes.

State	Center/Location	Area of Research	University/ Institution
Andhra Pradesh	Ambajipeta: Horticultural Research Station, Ambajipeta, East Godavari Dt. - 533 214 Phone: 08856-244436/243711	Coconut: Crop Improvement, Crop Production & Crop Protection	Dr. Y.S.R Horticultural University, West Godavari Dt., Andhra Pradesh - 534 101
	Pandirimamidi: Horticultural Research Station, Pandirimamidi, Ramapachodaram, East Godavari Dt. - 533 288 Phone : 08864-246577	Palmyrah: Crop Improvement, Crop Production & Post Harvest Technology	
	Vijayarai: Horticulture Research Station, Vijayarai, West Godavari Dt. - 534 475 Phone : 08812-225431	Oil palm: Crop Improvement & Crop Production Cocoa:Crop Improvement	
	Pedavegi: Indian Institute of Oil Palm Research, Near Jawahar Navodaya Vidyalaya, Pedavegi, West Godavari Dt. -534 450 Phone :08812-259409/259532	Oil palm: Crop Improvement & Crop Production	Indian Council of Agricultural Research

Andaman and Nicobar	Port Blair: Central Island Agricultural Research Institute, Port Blair - 744 101 Phone : 03192-250436	Coconut and Arecanut: Crop Improvement & Crop Production	Indian Council of Agricultural Research
Arunachal Pradesh	Pasighat: College of Horticulture & Forestry, Pasighat - 791 102 Phone : 0368-2224887	Oil palm: Crop Improvement & Crop Production	Central Agricultural University, P.O. Box 23, Imphal, Manipur - 795 004
Assam	Kahikuchi: Horticultural Research Station, Kahikuchi, Guwahati Kamrup Dt. - 781 017 Phone : 0361-2840232	Coconut: Crop Improvement & Crop Production Cocoa: Crop Improvement	Assam Agricultural University, Jorhat, Assam - 785 013
Bihar	Sabour: Bihar Agricultural College, Sabour, Bhagalpur Dt. - 813 210 Phone : 0641-2451001	Coconut: Crop Improvement & Crop Production Palmyrah: Crop Improvement & Post Harvest Technology	Bihar Agricultural University, Sabour, Bhagalpur, Bihar - 813 210
Chhattisgarh	Jagdalpur: Shaheed Gundadhur College of Agriculture & Research Station, Kumhrawand Farm, Jagdalpur - 494 005Phone : 07782-229360	Coconut: Crop Improvement & Crop Production	Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh - 492 012
Goa	Goa: Central Coastal Agricultural Research Institute, Ela, Old Goa Dt. - 403 402 Phone : 0832-2285448	Coconut and Arecanut: Crop Improvement & Crop Production	Indian Council of Agricultural Research
Gujarat	Navsari: ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari - 396 450 Phone : 02637-282144	Coconut: Crop Improvement & ProductionCocoa: Crop Improvement	Navsari Agricultural University, Navsari, Gujarat - 396 450
Karnataka	Arsikere: Horticultural Research and Extension Station, Arsikere, Hassan Dt. -573 103 Phone: 08174-291565/291711	Coconut: Crop Improvement, Crop Production & Crop Protection	University of Horticultural Sciences, Navanagar, Bagalkot, Karnataka - 587 102
	Sirsi: Horticulture Research and Extension Centre, Sirsi, Uttara Kannada Dt.- 581 401 Phone: 08384-226797/247787	Cocoa: Crop Improvement	

	Bavikere: Agricultural and Horticultural Research Station, Bavikere, Chikkamagaluru – 577 144 Phone :08261 255122	Oil palm: Crop Production	University of Agricultural & Horticultural Sciences, Navile, Shivamogga, Karnataka - 577 225
	Shivamogga: Arecanut Research Centre, College of Agriculture, Navile, Shivamogga Dt. – 577 225 Phone : 08181-267011	Arecanut: Crop Improvement, Crop Production & Crop Protection	
Kerala	Kasaragod: Central Plantation Crops Research Institute, Kasaragod - 671 124 Phone : 04994-232733	Coconut:Crop Production	Indian Council of Agricultural Research
	Pilicode: Regional Agricultural Research Station, Pilicode P.O., Kasaragod - 670 353 Phone:0467-2260450	Coconut: Crop Improvement	Kerala Agricultural University, KAU, Vellanikkara, Thrissur, Kerala - 680 656
	Thrissur: Cocoa Research Centre, Kerala Agricultural University, Vellanikkara, Thrissur Dt. – 680 656 Phone: 0487-2438457	Cocoa: Crop Improvement	
Maharashtra	Mulde: College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. - 416 520 Phone: 02362-244231/244232	Oil palm: Crop Improvement & Crop Production	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri Dt., Maharashtra - 415 712
	Ratnagiri: Regional Coconut Research Station, Bhatye, Ratnagiri Dt. - 421 612 Phone : 02352-255077	Coconut: Crop Improvement, Crop Production & Crop Protection Cocoa: Crop Improvement	
	Wakawali: Central Experimental Station, Asond block, Wakavali, Daopli Taluk.Phone : 02358-282417	Arecanut: Crop Improvement & Crop Production	

Odisha	Bhubaneswar: Department of Horticulture, (OUAT), Bhubaneswar - 751 003 Phone : 0674-2397463	Coconut: Crop Improvement & Crop Production Cocoa: Crop Improvement	Odisha University of Agriculture and Technology, Bhubaneswar, Odisha - 751 003
Tamil Nadu	Aliyarnagar: Coconut Research Station, Aliyarnagar, Coimbatore Dt. - 642 101 Phone: 04253-288722/288662	Coconut: Crop Improvement, Crop Production & Crop Protection Cocoa: Crop Improvement	Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu - 641 003
	Killikulam: Agricultural College & Research Institute, Killikulam, Vallanad, Tuticorin Dt. - 628 252 Phone : 04630-261226	Palmyrah: Crop Improvement & Crop Production	
	Pattukkottai: Agricultural Research Station, Pattukkottai, Thanjvur Dt. -614 602 Phone : 04373-235832	Oil palm: Crop Improvement & Crop Production	
	Veppankulam: Coconut Research Station, Veppankulam, Thanjavur Dt. - 614 906 Phone: 04373-260205/202534	Coconut: Crop Improvement, Crop Production & Crop Protection	
Telangana	Konda Mallepally: Horticultural Research Station, Konda Mallepally Mandal, Nalgonda Dt.- 508 243	Palmyrah: Crop Improvement & Post Harvest Technology	Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad, Telangana – 500 030
West Bengal	Mondouri: Directorate of Research, P. O. Kalyani, Nadia Dt. - 741 235 Phone :033-25827574	Coconut: Crop Improvement & Crop Production	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal - 741 252

Budget

The budget for the year 2022 was Rs. 660.56 lakhs (ICAR Share)

(Rs. in lakhs)

Sl. No.	Head	Expenditure
1.	Pay and allowances	438.27
2.	T.A.	0.50
3.	RC	173.03
4.	HRD	4.55
5	NRC	6.10
6.	NEH Capital	6.11
7.	TSP	10.50
8.	SCSP	21.50
	Total	**660.56**

Mode of implementation

The project is implemented through the respective State Agricultural/Horticultural Universities on 75:25 basis of which 75% is ICAR share and 25% share is from State Agricultural Universities.

Staff strength

Category	Present strength
Scientific	35
Technical	20
Supporting	17
Total	**72**

Staff Position

HEAD QUARTERS	
Project Coordinator's Cell, ICAR-CPCRI, Kasaragod, Kerala - 671 124	
Project Coordinator	: Dr. Anitha Karun (upto 30.11.2022)
	: Dr. Muralidharan (from 1.12.2022)
Scientist In-charge	: Dr. Ravi Bhat
Scientist (SPMA)	: Dr. Sumitha S.
Private Secretary	: Mrs. K. Narayani
Skilled supporting staff	: Mr. M. Shankara
Clerical Assistant	: Mr. S. Karunakara
ANDHRA PRADESH	
Horticultural Research Station, Ambajipeta, East Godavari Dt. - 533 214 (Phone: 08856 – 243847)	
Scientist (Horticulture)	: Mr. Kireethi
Scientist (Entomology)	: Dr. Annosha
Scientist (Pathology)	: Dr. Govardhan Rao

Horticultural Research Station, Pandirimamidi, Ramapachodavaram, East Godavari Dt. - 533 288 (Phone: 08864 – 243577)	
Scientist (Food Sci. & Tech.)	: Dr. P. C. Vengaiah
Scientist (Horticulture)	: Dr. K. Rajendra Prasad
Lab Assistant	: Mr. Pattabhi Ramayya
Horticultural Research Station, Vijayarai, West Godavari Dt. – 534 475 (Phone: 08812-225431; Fax: 08812- 225826)	
Scientist (Agronomy)	: Dr. P. Madhavilatha
Senior Technical Assistant	: Mr. B. B. Ramaswami
ICAR- Indian Institute of Oil Palm Research, Near Jawahar Navodaya Vidyalaya, Pedavegi, West Godavari Dt. – 534 450 (Phone :08812-259409/259532)	
Principal Scientist (Agronomy)	: Dr. G. Ravichandran (from 09-10-2021)
ANDAMAN & NICOBAR ISLANDS	
ICAR- Central Island Agricultural Research Institute, Port Blair - 744 101 (Phone: 03192 250436; Fax: 03192-251068)	
Scientist (Horticulture)	: Dr. Ajit Arun Waman
ARUNACHAL PRADESH	
College of Horticulture and Forestry, Central Agricultural University, Pasighat, East Siang Dt. - 791 102 (Phone: 0368- 2224887; Fax - 0368- 2225066)	
Scientist (Horticulture)	: Dr. Barun Singh
ASSAM	
Horticultural Research Station, Kahikuchi, Guwahati, Kamrup Dt. -781 017 (Phone: 0361- 2840232)	
Principal Scientist (Horticulture)	: Dr. J. C. Nath
Senior Scientist (Horticulture)	: Mrs. Rinku Moni Phukon
Technical Assistant	: Shri. Rajaram Patowari
CHHATTISGARH	
Shaheed Gundadhur College of Agriculture & Research Institute, Kumhrawand Farm, Jagdalpur, Bastar Dt. - 494 005 (Phone: 07782- 229150; Fax: 07782- 229360)	
Scientist (Horticulture)	: Dr. Beena Singh
Scientist (Agronomy)	: Shri. P. K. Salam
Technical Assistant	: Mr. Rajesh Kumar Patel
GOA	
ICAR- Central Coastal Agricultural Research Institute, Ela, Old Goa - 403 402 (Phone: 0832-2284678 / 79; Fax: 0832-2285649)	
Principal Scientist (Horticulture)	: Dr. V. Arunachalam

GUJARAT	
Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari - 396450 (Phone: 02637-282144)	
Scientist (Horticulture)	: Dr. Pankaj Pandurang Bhalerao
KARNATAKA	
Horticultural Research and Extension Station, Arsikere, Hassan Dt. – 573 103 (Phone: 08174 - 291565)	
Senior Scientist (Horticulture)	: Dr. Jagadeesha (From 11-08-2021)
Scientist (Pathology)	: Dr. Kiran Kumar K C
Scientist (Entomology)	: Dr. G. S. Chandrashekar
Technical Assistant	: Ms. Swetha
	: Mr. K. E. Dayananda
College of Agriculture, Navile, Shivamogga Dt. – 577 216 (Phone: 08182267011)	
Principal Scientist (Plant Pathology)	: Dr. B. Gangadhara Naik
Agricultural and Horticultural Research Station, Bavikere, Chikkamagaluru Dt. 577 144 (Phone: 08261 255122)	
Scientist (Horticulture)	: Dr. Nagarajappa Adiavappar
Horticulture Research and Extension Centre, Sirsi, Uttara Kannada Dt.- 581 401 (Phone: 08384-226797/247787)	
Scientist (Horticulture)	: Dr. Sudheesha Kulakarni
KERALA	
ICAR- Central Plantation Crops Research Institute, Kasaragod- 671 124 (Phone: 04994-232893)	
Principal Scientist (Agronomy)	: Dr. P. Subramanian
Regional Agricultural Research Station, Pilicode, Kasaragod Dt. – 670 533 (Ph: 0467-2260450/2282737)	
Principal Scientist (Plant Breeding)	: Dr. Ninitha K U
Cocoa Research Centre, Kerala Agriculture University, KAU P.O. Vellanikkara, Thrissur, Kerala- 680656 (Phone: 0487-2438457)	
Senior Scientist (Plant Breeding)	: Dr. B. Suma
MAHARASHTRA	
College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. – 416 520 (Phone: 02362 244231 – 244232; Fax: 02362 – 244231)	
Scientist (Horticulture)	: Dr. Prashant Debaje
Senior Technical Assistant	: Shri N. M. Naik
Regional Coconut Research Station, Bhatye, Ratnagiri Dt. – 421 612 (Phone: 02352- 235077; Fax: 02352 – 235331)	
Senior Scientist (Plant breeding / Horti.)	: Dr. K.V.Marshe
Scientist (Agronomy)	: Dr. S. L. Ghavale

Scientist (Entomology)	: Dr. S. M. Wankhede
Agricultural Assistants	: Mr. S. B. Chavan
	: Mr. N. M. Madhav
Central Experimental Station, Asond block, Wakawali, Ratnagiri Dt. (Phone : 02358-282417)	
Scientist (Horticulture)	: Dr. C. M. Praful
ODISHA	
Department of Horticulture, OUAT, Bhubaneswar – 751 003 (Phone: 0674 – 2390463)	
Scientist (Horticulture)	: Dr. A. K. Sahoo
Technical Assistant	: Mr. P. C. Behera
TAMIL NADU	
Coconut Research Station, Aliyarnagar, Coimbatore Dt. – 642 101 (Phone: 04253- 288722)	
Scientist (Horticulture)	: Dr. V. Sivakumar
Scientist (Entomology)	: Dr. B. Vinoth Kumar
Scientist (Agronomy)	: Dr. C. Sudhalakshmi
Scientist (Plant Pathology)	: Dr. P. Latha
Technical Assistant	: Mr. M. Panjalingam
Agricultural Research Station, Pattukkottai, Thanjavur Dt. – 614 602 (Phone: 04373 – 235832)	
Scientist (Horticulture)	: Dr. M. Tamil Selvan
Senior Technical Assistant	: Th. S. Vivekananthan
Coconut Research Station, Veppankulam, Thanjavur Dt. - 614 906 (Phone: 04373- 260205)	
Scientist (Horticulture)	: Dr. R. Arun Kumar
Scientist (Agronomy)	: Dr. R. Babu
Scientist (Plant Pathology)	: Dr. Surali Rajan
Technical Assistant	: Mrs. B. Sundari: Mr. P. Nallathambi
Agricultural College & Research Institute, Killikulam, Vallanad, Tuticorin Dt. – 628 252 (Phone: 04630 – 261226; Fax: 04630 – 261268)	
Scientist (Horticulture)	: Dr. C. Ravindran
Technical Assistant	: Smt. P. Anantha Bai
TELANGANA	
Horticulture Research Station, Konda Mallepally Mandal, Nalgonda Dt. – 508 243	
Scientist (Horticulture)	: Dr. T. Suresh Kumar
WEST BENGAL	
Department of Plantation Crops, Faculty of Horticulture, BCKVV, Mondouri (Kalyani), Nadia Dt. -741 235 (Phone: 033- 25827574)	
Senior Scientist (Horticulture)	: Dr. Dipak Kumar Ghosh (LKN)
Technical Assistant	: Vacant

IV. Genetic Resources and Crop Improvement

4.1. Coconut

Coc./Gen.1: Conservation and evaluation of coconut genetic resources in different agro climatic regions

Evaluation of conserved germplasms

This trial was laid out at Bhubaneswar, Navsari and Sabour centres for conservation and multi-location testing of coconut germplasm for yield as well as biotic and abiotic stress reactions. The trial was laid out as un-replicated observational experiment with 14 palms per genotype at Sabour and 5 palms per genotype at Bhubaneswar and Navsari centres.

Bhubaneswar

At Bhubaneswar centre, the experimental material included 16 genotypes comprising of 12 tall and 4 dwarf genotypes planted during 2004 as an un-replicated trial. Among the tall accessions, shortest height (4.35m) was recorded in Java Tall followed by Pratap (4.47 m). Maximum girth (109.75 cm) at 1m height from ground level was observed in Zanzibar tall. Maximum number of functional leaves (32.00/palm) was observed in St. Vincent. However, maximum number of annual leaf production (10.6), number of inflorescence (10.4) and female flowers (212.6/palm) was recorded in the germplasm Andaman Ordinary. Maximum nuts/palm/year (50.60) was noted in Andaman Ordinary. Among the dwarf cultivars, shortest plant height (3.80 m) was recorded in GBGD followed by COD (3.94 m). However, among the dwarf accessions, GBGD performed better by producing maximum number of functional leaves (24/palm) as well as highest number of female flowers (204.33). On the other hand, the highest number of nuts (49.00/palm/year) was recorded in MYD. The poor performance of palms was due to cyclonic storm "FANI" which occurred during 3rd May, 2019 and palms are reviving gradually and yield is also increasing gradually.

Navsari

Two dwarf and fourteen tall genotypes were planted during August, 2014. The maximum annual leaf production (10.58), total number of leaves on the crown (31.67 numbers), maximum numbers of inflorescence per annum (10.67 numbers) and high nut yield/palm/year (51.72 nuts) were recorded in Kappadam Tall. The highest leaf length (563.69 cm) and petiole length (186.38 cm) were recorded in PHOT while, LCT flowered early at the age of 43.33 months after planting. Regarding the reaction of biotic stresses, 2-3% palms of all genotypes are infected by rhinoceros beetle whereas, there was no other infestation of pests and diseases observed in the experimental plot.

Sabour

The experiment began in 2011 as an observational trial with 14 coconut genotypes, and seedlings were planted during 2011, 2012, and 2013. Based on the observations on growth parameters, maximum palm height was noted in variety Shakhi Gopal (6.87 m) followed by MYD (6.61.m). Tiptur Tall had the shortest palm height (3.60m), followed by Arasampatti Tall (2.85m) and Gonthemballi (3.88 m), respectively. The maximum number of functional leaves was noted in Shakhi Gopal Tall (22.4 leaves/plant) followed by COD and MOD with 21.0 and 20.8 leaves respectively. The earliest to flower was MYD (63.0 months after planting) and COD (65.0 months after planting). Shakhi Gopal was the most productive variety in Sabour conditions, yielding 71.0 nuts per palm, followed by COD (61.0 nuts/palm) and MYD (58.0 nuts/palm).

Collection, conservation and evaluation of location specific germplasms

This trial was initiated with a view to collect, conserve and evaluates the local germplasm of coconut for yield and response to biotic and abiotic stresses. The evaluation materials comprise of 10 to 15 local germplasms (with IC No.) collected in each centre, some are evaluated in replicated field experiments and some are in observational field trials.

Aliyarnagar

A total of eleven coconut ecotypes were collected during 2007 at Aliyarnagar centre and established for evaluation during 2008. Among the local

germplasm collections, five ecotypes (IC 610370, IC610375, IC610376, and IC610377 &IC610378) were evaluated in replicated trial and the remaining six genotypes (IC610371, IC610372, IC610373, IC610374, IC610375 &IC610379) were evaluated as un-replicated observational experiment.

Five ecotypes are being maintained under replicated experiment. The local ecotype IC610375 recorded the minimum trunk height (3.39m) and pronounced its dwarf stature among the ecotypes under replicated trial. The genotype IC610370 registered the maximum values for trunk girth (114.5 cm), number of leaf scars in 1 m length (15.6), annual leaf production (11.5/palm/year), number of functional leaves (36.3), number of inflorescence production (10.8/palm/year), number of spikelets per inflorescence (38.3), number of buttons per inflorescence (25.6) and annual nut yield (105.6/palm/year). The total leaf length (563.4 cm) and petiole length (148.3 cm) were maximum in IC610376. The genotype IC 610378 was found to be superior for fruit component parameters *viz.*, maximum fruit length (25.9 cm), fruit breadth (18.4 cm), fruit weight (1863.5 g), de-husked nut weight (746.1 g), copra weight (185.6 g/nut) and volume of tender nut water (337.5 ml). The genotype IC610370 recorded maximum copra yield per palm (16.5 kg) and copra yield per hectare (2.9 t/ha). The highest kernel thickness (1.4 cm) was recorded in IC610375.

Ambajipeta

Thirteen local elite germplasm accessions were collected from traditional coconut growing districts *viz* Srikakulam, East and West Godavari districts of Andhra Pradesh and seedlings were raised. The experiment was laid out during February 2013. Five accessions out of thirteen *viz.*, IC610311 IC610309, IC610306, C610307 and IC610310 were planted in RBD with four replications and four palms in each replication. Remaining eight accessions were planted as an observational trial with six palms per accession and it is in vegetative to bearing stage.

The data pertaining to growth attributing characters for the year 2021 were recorded and significant differences were noticed among different accessions. The maximum palm height (3.37 m), number of leaves on crown (29.44), total leaf length (5.54 m) and petiole length (155.75 cm) were recorded in IC610311, while the maximum palm girth at 1 m height (106.45 cm) and the annual leaf production (12.88) were recorded in IC610306 and IC610309 respectively. With regard to flowering, IC610310 was the earliest to flower in 37 months. Yield attributing characters for the year 2020-21 showed significant variation for number of nuts per annum. Higher nut yield (88.95 nuts/palm/year) was recorded in IC610306 which was statistically at par with IC610307 (84.83) and IC610309(69.29). The lowest yield (49.50 nuts/palm/year) was recorded in IC610310. With regard to tender nut characters of local germplasms, the maximum tender nut fruit weight (1429.35 g), water content (347.50 ml), TSS (7.55 Brix^{O}) and sweetness of water was good in IC610310.

Arsikere

A total of five local germplasm *viz.*, IC610333, IC610339, IC610341, IC610342 and IC610343 were planted in a replicated trial during July, 2013. Maximum plant height (5.76 m), plant girth (150.4 cm), functional leaves per palm (22.9), dehusked nut weight (760 g), kernel thickness (1.4cm), kernel weight (395 g/nut) and copra content (354 g /nut) were observed in IC610339 followed by IC610341. Among the five different genotypes, the IC610339 has recorded more number of nuts per palm (60.0/year) and observed to be earliest to flower at 60 months after planting followed by IC610342 (55 nuts/palm) and IC610341(50 nuts/palm).

Bhubaneswar

A field trial was initiated during December 2003 with eleven local ecotypes as a non-replicated observational trial with 10 palms per ecotypes. During the period of study it was observed that IC612467 performed better as compared to others by producing maximum number of inflorescences (9/palm/year), number of female flowers (157.10/palm/year) and high nut yield (41.90/palm/year). However, IC612467 registered shortest plant height (5.03 m). Maximum number of functional leaves (28.11/palm) and annual leaf production (10.56/

palm/year) was recorded in IC612459 and longest leaf (6.35 m) was found in IC612465. The palms were damaged severely due to the cyclone "FANI" which occurred on 3rd, May, 2019. However, palms are recovering and yield is increasing gradually.

Jagdalpur

The six locally collected accessions were planted in July 2011 in RBD with four replications and four palms per replication and observations on growth parameters were recorded. The difference in petiole length, leaf length, annual leaf production as well as the number of functional leaves was not significant among genotypes. However, the maximum plant height and plant girth at base was recorded in IC610325 (6.30m and 146.8 cm respectively). The number of inflorescences, number of female flowers and number of buttons were observed to be the maximum in IC610324 (11.5, 14.5 and 12.1 respectively). IC610324 was the earliest to flower as compared to the other genotypes. With regard to the pest incidence, rhinoceros beetle incidence was maximum in IC610328 (3.7) while the red palm weevil incidence was the highest in IC610325 (8.9). The incidence and intensity of rugose spiriling whitefly was the maximum in IC610327 (34.3 and 22.1) respectively.

Kahikuchi

The experiment was initiated at Kahikuchi centre with 10 local accessions IC 610353 to IC 610362 along with two check varieties *viz.*, Kamrupa and WCT under replicated trial during 2005. Five new coconut genotypes *viz.*, IC610363, IC610364, IC610365, IC610366 and IC610367 were also collected from two districts of Assam *viz.*, Nowgaon and Marigaon and planted during 2009 in a non-replicated single row planting with six palms per genotype as observational trial.

The maximum number of leaf scars (15.6) in 1 m length was observed in IC610357, whereas the lowest (12.5) was recorded in IC610358. With regard to reproductive characters, the maximum number of inflorescences (11.8), and fruit setting (30.6%) were recorded in Kamrupa followed by the genotype IC610357 and the lowest values for number of inflorescences and female flowers were obtained in IC610358. Among the accessions, significantly the highest nut yield of 86.7 nuts/palm/year was observed in IC610357 while the lowest (64.8 nuts/palm/year) was found in IC610355. With regard to nut characteristics, the IC610354 recorded the highest de-husked nut weight, weight of husk, percentage of husk, kernel thickness, kernel weight and copra content/nut. However, copra yield was highest (16.4 kg/palm) in Kamrupa which was at par with IC610357 (15.3 kg/palm). With respect to pest incidence, the minimum incidence of rhinoceros beetle infestation (3.1%) was recorded in Kamrupa, while highest of 9.5% was found in IC610361. No incidence of eriophyid mite and RSW was noticed.

Mondouri

A total of ten local ecotypes were collected from different districts of West Bengal. Out of these local germplasms, five (IC 612447, IC612448, IC612449, IC612450 &IC612451) were planted in replicated trial during 2007 and remaining five local genotypes (IC612452, IC612453, IC612454, IC612455 &IC612456) were planted in observational trial during 2009. The ecotype IC612449 recorded maximum palm height of 6.89 m followed by IC612448 (6. 80m). IC612450 recorded minimum trunk height of 333.7cm. IC612450 recorded maximum basal girth of 160.7cm whereas IC612447 recorded minimum basal girth of 114.7cm. Number of functional leaves per palm was maximum (11.3) in IC612449 followed by IC612450 (11.3). The ecotype IC612450 recorded maximum 12.3 number of inflorescence/palm/year whereas IC612449 recorded minimum of 6.3 numbers per palm. Maximum (64.7) number of female flowers per palm per year was recorded in IC612447 whereas minimum (22.7) numbers were recorded in IC612449. Nut production was maximum (27.3 per palm) in IC612450 and minimum (11.0 per palm) in IC612447. Highest water content of 426.7 ml/nut was recorded in IC612451 followed by IC612447 (406.7 ml) and minimum of 247.3 ml per nut was recorded in IC612449. TSS content was highest (5.1 ^{0}Brix) in IC612447 followed by IC612448 (5.0 ^{0}Brix) and IC612451 (5.0 ^{0}Brix) respectively, whereas minimum of 4.9^{0}Brix was recorded in IC612449.

Navsari

Four ecotypes (IC610319, IC610320, IC610321 and 610322) were planted in Randomized Block Design (RBD) with five replications during 2013. The minimum plant height (2.97 m) and collar girth (94.60 cm) with maximum numbers of annual leaf production/palm (11.04 numbers), total number of leaves on crown (30.60 numbers), inflorescence production per annum (10.65 numbers) and nut yield per palm per year (55.00 nuts) was recorded in IC 610319. Whereas, highest length of leaf (500.60 cm) and petiole (142.80 cm) with earliness in flowering (45.33 months) was observed in IC 610320. Regarding reaction of biotic stresses, 3.0-3.54% and 28-32% palms of all genotypes are infected by rhinoceros beetle and eriophyid mite, respectively whereas, no other infestation of pests was observed in the experimental plot.

Ratnagiri

A total of six ecotypes (IC 599111 to IC599116) collected from Konkan region were planted in replicated trial and remaining six (IC599994 to IC599999) were planted in observational experiment for evaluation. These were planted in 2007 and 2010 respectively. Further, germplasm of sweet coconut- *Mohachanaral* having IC No. 599123, and one embryo cultured plantlets were collected from Guhagar Tahsil of Ratnagiri district. Totally fourteen seedling types and one set of embryo culture plantlets were planted in the field during 2007 for evaluation.

Among the genotypes evaluated under replicated trial, significant variations were recorded in different vegetative characters. Among the accessions, IC599115 recorded maximum plant height (6.14 m), IC599114 recorded maximum plant girth (105.8 cm), IC599111 recorded maximum annual leaf production (12.2 nos.), IC599116 recorded maximum number of functional leaves (31.9), IC599114 recorded highest leaf length (382.5 cm) and IC599113 recorded maximum petiole length (161.9 cm). IC599112 and IC599114 recorded maximum number of inflorescences (11.9) and IC599112 recorded maximum female flowers (178.8). The accession IC599112recorded maximum nut yield (73.4 nuts), IC599113 recorded maximum whole nut weight (1202.5 g) and highest copra content (192.5g) among all accessions under study. In respect of pest incidence, the percentage of rhinoceros beetle incidence was lowest in IC599113 (8.4 %) whereas highest incidence was observed in IC599115 (17.2%).

Veppankulam

Five local ecotypes of ECT tall have been collected through exploration for their promising characters like higher nut yield, tolerance to drought and salinity and were planted during 2005 as under-planting, along with two check varieties (Kera keralam and ALRCN1). The old palms in this experiment were removed during 2012 and the palms are in bearing phase. Due to the occurrence of "Gaja" cyclone during November, 2018, 12 palms were lost and bunches in all the genotypes with different maturity fell down. The trees are recovering slowly after adequate irrigation and application of recommended dose of fertilizers with incorporation of vermicompost, neem cake, bio-fertilizers and green manuring.

Among the ecotypes, IC599266 was dwarf statured (780 cm) and slender palm was observed in Kerakeralam (146.00 cm). IC599264 recorded highest annual nut yield of 95.66 nuts/palm, while IC599265 recorded superior nut quality characters, *viz*., maximum whole nut weight and copra content (1385 g/nut, and 153.4 g/nut respectively). Both IC599263 and IC599266 recorded more than 10 kg copra yield per palm per year. The average and accumulated yield indicate that the genotype IC599264 recorded highest yield (90.44 and 271.32 nuts respectively)

Evaluation of elite germplasm

This trial was initiated with a view to assess few elite exotic coconut genotypes in replicated field experiments for their yield performance and to observe for reaction to biotic and abiotic stresses. *Inter-se* mated seed nuts of different sets of materials were supplied to AICRP-Palm centers from CPCRI and the experimental layout consisted of six test entries and one local check, planted in randomized block design (RBD) with three replications and four palms per genotype per replication. In all the centres,

seedlings were planted during 2014 to 2016, and the trial is in bearing stage.

Ambajipeta

Inter se crossed seed nuts of exotic genotypes were received from CPCRI, Kasaragod during May 2014 and the seedlings were raised in poly pots. The experiment was planted in March 2016 and it is in vegetative stage. Regarding growth parameters for the year 2021-22, lowest plant height of 1.81 m was recorded in Straits Settlements Green, while the highest plant height of 2.46 m was recorded in Kenya Tall. However, no significant differences were noticed among the elite germplasm selections for plant height, palm girth, number of functional leaves, total leaf length and petiole length. Verrikobbari Tall recorded early for flower initiation (42 months) followed by Straits Settlements Green (46 months). Flower initiation was noticed this year in Kenya Tall (54 months), East Coast Tall (55 months) and Zanzibar Tall (59 months). Verikobbari Tall recorded more nut yield (20.58 nuts/palm/year)

Aliyarnagar

The experiment was initiated during 2015 with Verikkobari Tall, Guam-III Tall, Straits Settlement Green Tall, Markham Tall, Nigerian Green Tall, Palawan Tall and West Coast Tall (Local check).

There was a non-significant variation among different exotic collections except for stem girth, annual leaf production and functional leaves. However, the minimum plant height (2.79 m) was recorded by the exotic genotype SSGT. West Coast Tall (local check) recorded the maximum value for palm girth (112.6 cm). The genotype Guam-III Tall recorded high rate of annual leaf production (11.2), more number of functional leaves (29.8) and maximum leaf length (541.8 cm), whereas the maximum petiole length of 146.9 cm was observed in Verrikkobari Tall. Regarding the floral and yield parameters, maximum number of inflorescence production per annum (9.2), average number of spikelets (37.0), fruit setting (20.6 %) and nut yield (32.8/palm/year) were recorded in Guam-III Tall. Maximum number of female flowers (17.9) per inflorescence was recorded in the genotype Nigerian Green Tall. The incidence of rhinoceros beetle (4.2 %), rugose spiralling whitefly (6.3 %), and eriophyid mite (10.8 %) were CRP759 least in the genotype Guam-III Tall as compared to the other exotic genotypes under evaluation.

Arsikere

Among the genotypes evaluated under replicated trial significant variation were recorded for different vegetative characters. SSGT was more vigorous and recorded significantly maximum plant height (4. 38 m), plant girth (108.3 cm), total leaf length (236.7cm), petiole length (137.4 cm), annual leaf production per palm (10.4) and functional leaves (19.3) compared to other elite genotypes under evaluation followed by St. Vincent Tall, Markham tall and Verrikobbari tall. The average incidence of rhinoceros beetle leaf damage and whitefly damage was 63.75% and 41.52% respectively.

Bhubaneswar

The field experiment was conducted at Coconut Research Station, Konark under Bhubaneswar centre with six exotic tall varieties and one local tall check. There was significant variation among the different germplasm with regard to growth parameters like functional leaves, petiole length and nuts harvested/palm/year. However palm height, annual leaf production, leaf length, number of inflorescence per palm and female flowers per inflorescence were non-significant among each other. Among the germplasm evaluated, the performance of Guam Tall was better as it had the highest bole girth (130.83 cm), numbers of leaves (21.42/palm), petiole length (135.83 cm) and female flowers (30.33/palm/year). However, maximum number of nuts (5.86) was harvested in Verikkobari Tall. The palms were performing very well in littoral sandy soil as 45.23% flowering was observed after 5 years of planting.

Ratnagiri

Data on growth parameters revealed that there was significant variation among different exotic collections. Regarding growth parameters, maximum plant height (375.0 cm) was recorded in local check Pratap, maximum plant girth (1.28m) was recorded in Nigerian Green Tall (NGT), maximum functional leaves on crown (23.3 nos.), maximum leaf length

(345 cm) and maximum petiole length (149.7 cm) were recorded in Verikkobari Tall (VKT), among the elite germplasm under study. The flowering and fruiting phase started in some palms of genotypes Straits Settlement Green Tall (SSGT), Verikkobari Tall (VKT) and Nigerian Green Tall (NGT). With regard to pest incidence, the percentage of rhinoceros beetle incidence was lowest in St. Vincent Tall (STVT) (14.4 %) whereas highest incidence was observed in the local check (Pratap) (18.1 %). Rugose spiralling whitefly incidence was lowest in Guam- III Tall (GUT) (13.4 %) while lowest intensity was in local check (Pratap) (4.3 %) among all elite germplasms under study.

Veppankulam

Among the six exotic collections under evaluation Nigerian Green Tall showed a dwarfness (1.06m) with slender stem (92 cm). Earliness in flowering was observed in Markham Tall (3.4 years after planting) followed by Nigerian Green Tall (3.8 years after planting). Till date three elite genotypes *viz.*, Markam Tall, Laguna Tall and Palawan Tall started to yield. The Rhinoceros beetle incidence ranged between 20% and 35% and RSW incidence was below 10%. There was no red palm weevil incidence during the study period (2020-21).

Performance evaluation of INGR 13065 (*Niu Lekha*) dwarf

The performance of dwarf genotype INGR 13065 (*NiuLekha*) is being evaluated at Aliyarnagar and Ratnagiri centres. The seedlings supplied by Central Plantation Crops Research Institute, Kasaragod, Kerala were used for planting as un-replicated trial along with local checks (COD and KTD) during July 2015 and they are in establishment phase.

Aliyarnagar

INGR 13065 proved its earliness with spathe emergence at the age of 33 months after planting. Data on growth, floral and yield attributes revealed that, maximum palm height (2.45m), girth at base (204.9 cm), annual leaf production (11.6), functional leaves (28.9), leaf length (502.9 cm), petiole length (127.3 cm), inflorescence production per annum (10.6), average number of spikelets (36.8/ inflorescence), average number of buttons (19.5/ inflorescence) and nut yield per palm (50.9 /palm/ year) were recorded in INGR 13065. The least values for all the above characters were registered by the local checks COD and KTD. However, KTD registered maximum fruit setting percentage of 26.9 as compared to INGR 13065 and COD. The average rhinoceros beetle leaf damage (3.6 %), rugose spiralling whitefly incidence (8.9 %) and intensity (7.2 %) were minimum in INGR 13065. The local check varieties KTD and COD registered least eriophyid mite incidence of 6.7 and 8.6%.

Ratnagiri

The annual leaf production and number of functional leaves were higher in INGR 13065 as compared to COD. The yield attributing traits including age at first flowering was observed maximum in INGR 13065. The palms of INGR 13065 started flowering and fruiting. With regard to pest incidence, the percentage of rhinoceros beetle incidence was lowest in COD (14.4%). The percent of rugose spiralling whitefly incidence (18.0%) and intensity (5.7%) were lowest in INGR 13065.

Evaluation of new coconut hybrids of location specific cross combinations

Centers: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Kahikuchi, Mondouri, Ratnagiri and Veppankulam

The objective of the experiment is to assess the performance of newly developed location specific hybrid combinations in terms of yield and reaction to biotic stresses. This experiment was laid out at eight centers in RBD with four replications.

Ambajipeta

The seedlings of cross combinations *viz.*, ECT x CCNT, GBGD x CCNT, ECT x PHOT, GBGD x PHOT, PHOT x GBGD and ECT x GBGD were planted during June 2011 in a randomized block design with four replications. However, due to Helen and Philin cyclones during October & November 2013, some of the accessions were badly affected. Gap filling has been taken up during the month of February 2014 and the genotypes are in bearing stage. Growth and yield attributing characters of new coconut hybrids revealed that the cross combination ECT x PHOT recorded significantly highest plant

height (4.67 m) and plant girth (116.79 cm). Minimum plant height was recorded in GBGD x CCNT (3.45 m) and plant girth was noted in PHOT x GBGD (87.80 cm). ECT x GBGD produced more number of leaf scars in 1m (15.47). ECT x Cochin China recorded maximum petiole length of 1.64 m. The cross combinations showed no significant differences for other growth characters. PHOT x GBGD recorded early flowering, *i.e.* 45 months after planting followed by GBGD x CCNT (46 months). With regard to nut yield for the year 2020-21, the cross combination ECT x GBGD has recorded the highest yield (136.22 nuts/palm/year) followed by ECT x Cochin China (105.75 nuts/palm/year). Lowest yield was recorded in GBGD x Cochin China (80 nuts/palm/year).

Aliyarnagar

This trial consists of five location specific cross hybrid combinations (ALR x MGD, MGD x ALR, KTD x ALR, COD x ALR and COD x WCT), which were planted during 2012 in Randomized Block Design (RBD) with four replications as Set I. Besides, these five location specific hybrid combinations in Set I, three new hybrid combinations *viz.* ,COD x Etamozhi Tall, KTD x Etamozhi Tall and WCT x KTD were also planted during 2014 in Randomized Block Design (RBD) with four replications and six palms per replication along with check WCT as Set II. Among the hybrids, cross combination COD x WCT proved its dwarf stature by registering minimum palm height (3.49m) and the maximum was recorded in ALR x MGD (4.23m). Maximum trunk girth (114.8 cm) was noticed in local check variety WCT. Among the five hybrid combinations, the combination MGD x ALR was the earliest to flower (34 months). Maximum number of leaf scars (17.3/m), annual leaf production (11.8), number of functional leaves (31.2/palm), higher leaf length (546.5 cm), number of spikelets (36.2 /spathe) and number of female flowers (17.2/inflorescence) were registered by COD x ALR hybrid. The maximum nut yield was also recorded in the hybrid COD x ALR (109.1 nuts/palm/year) followed by KTD x ALR (94.6 nuts/palm/year) and ALR x MGD (93.6 nuts/palm/year). With regard to the nut component traits, the cross combination COD x WCT recorded higher fruit length (25.1 cm), fruit breadth (16.2 cm), whole nut weight (1823.0 g), de-husked nut weight (723.5 g), kernel weight (423.6 g) and copra content per nut (172.3 g). The maximum copra yield per palm (17.5 kg/palm), copra outturn per hectare (3.1 t/ha) and more volume of tender nut water content (453.2 ml/nut) were observed in COD x ALR cross combination. The appraisal of hybrid combination against pest incidence exposed that, ALR x MGD recorded the least incidence of rhinoceros beetle (4.1 %) and COD x ALR registered minimum incidence of Eriophyid mite (9.2 %). The rugose spiralling whitefly incidence (6.4 %) and intensity (5.6 %) were less in local check variety West Coast Tall.

Bhubaneswar

At Bhubaneswar centre, the trial was conducted with five locations specific cross combinations (SKL x COD, MGD x SKL , SKL x GBGD, GBGD x Gaum, COD x CRP794 (IC- 0612461) since February, 2008. The experiment was laid out in RBD with four replications. The parameters like plant height, annual leaf production, number of bunches and number of nuts harvested were significant, whereas other parameters were non-significant. The current year observations revealed that among the different cross combinations, the shortest plant height (3.84 m) was recorded in the cross GBGD x Guam followed by the SKL x COD (4.12 m). However, maximum number of annual leaf production (10.93 numbers/palm/year), number of bunches (9.08 number/palm/year), maximum female flowers (162.05 number/palm/year) and nuts harvested (29.06 numbers/palm/year) were recorded in the cross combination SKL x COD. All the palms in the trial were severely affected by cyclonic storm "FANI" which hit on 3rd May, 2019. However, palms are recovering gradually with time and it will take around one more year for its complete recovery.

Kahikuchi

This field trial commenced with five location specific cross combinations (AGT x CCNT, AGT x MYD, AGT x PHOT, Bengal Hazari x AGT, AYT x PHOT) of coconut along with a check (Kamrupa) during April, 2009 in Randomized Block Design (RBD) (number of replications) with six palms per

replications. Data indicated that the highest palm height (3.5 m), girth (166.0 cm) were recorded in Assam Yellow Tall (AYT) x PHOT whereas, maximum leaf production per year (12.0), total number of leaves/palm (33.0), number of inflorescences/palm (11.6), number of female flowers/inflorescence (26.5) and fruit setting (28.6 %) were observed in AGT x PHOT. Significantly highest nut yield (81.5nuts/palm/year) was recorded in AGT x PHOT followed by AGT x MYD (70.1 nuts/palm/year) whereas, the lowest yield of 62.0 nuts/palm/year was found in Bengal Hazari x AGT. With regard to nut characteristics, significantly highest de-husked nut weight, weight of husk, kernel weight, copra content and copra yield (14.5 kg/palm) were observed in AGT x PHOT. Pest incidence in different cross combinations revealed that the lowest incidence of rhinoceros beetle (3.0%) was observed in check variety (Kamrupa) followed by AGT x PHOT (4.8%) whereas, the highest incidence (9.6%) was recorded in AYT x PHOT. No incidence of eriophyid mite and RSW were noticed.

Ratnagiri

At Ratnagiri centre, six new location specific hybrid cross combinations (COD x BYR, COD x Pratap, COD x BGR, BYR x COD, Pratap x COD, BGR x COD) were planted in RBD with four replications and six palms per replication during 2006. The growth characters showed significant differences among the new coconut hybrids under evaluation. The data revealed that the hybrid BYR x COD recorded maximum plant height (5. 91m) whereas the lowest plant height (4. 10m) was in hybrid COD x Pratap. The hybrid BYR x COD recorded maximum plant girth (95.9 cm) whereas the lowest plant girth (81.1 cm) was in hybrid COD x Pratap. The highest annual leaf production (12.2 nos.) was recorded in hybrid COD x BYR. The maximum number of functional leaves (33 nos.) was observed in hybrid BYR x COD. The maximum leaf length was in hybrid COD x BGR (425.6 cm) and maximum petiole length was recorded in Pratap x COD (163.8 cm). The hybrid COD x BGR recorded maximum number of inflorescences (12.3) whereas it was lowest in the hybrid BYR x COD (10.6 nos.). The hybrid COD x BGR recorded maximum female flowers (221nos.) whereas the lowest was in BYR x COD (190 nos.). The highest nut yield was recorded in hybrid COD x BYR (89.3 nuts) followed by COD x BGR (84.1 nuts) whereas the lowest was in hybrid BYR x COD (57.3 nuts). The maximum whole nut weight (1326.3g) and copra content (172.5 g) was recorded in hybrid COD x Pratap. The percentage of rhinoceros beetle incidence was lowest in BYR x COD (11.2 %) whereas highest incidence was observed in BGR x COD (19.3%). The percent of rugose spiralling whitefly incidence was lowest in BYR x COD (12.2 %) while lowest intensity was in BGR x COD (8.8 %) and the lowest eriophyid mite incidence was recorded in BYR x COD (12.9 %) and two palms (which combination) were infested by bud rot disease.

Veppankulam

Six location specific cross combinations *viz.*, West Coast Tall x Kenthali Dwarf, West Coast Tall x Malayan Orange Dwarf, Malayan Orange Dwarf x West Coast Tall, Andaman Ordinary Tall x Chowghat Orange Dwarf , West Coast Tall x Malayan Green Dwarf and VHC 2 (Check) were planted in the main field during 2008 in RBD with four replications. Analysis of data revealed that the cross WCT x KD was dwarf (546.49cm) with slender stem (151.50cm). The cross, MOD x WCT yielded higher number of nuts (52.50). Among the cross combinations, WCT x MGD registered maximum copra content of 11.32kg/palm. However it was the most affected by Gaja cyclone among the crosses under study. Among the various pests, rhinoceros beetle incidence was higher in all the cross combinations.

Evaluation of Tall x Tall coconut hybrids

This experiment was started with the objective to assess five Tall x Tall hybrids, *viz.*, LCT x ADOT, ADOT x ECT, BENT x ADOT, ECT x LCT and WCT x TPT at various agro-climatic regions. The hybrids were produced at CPCRI, Kasaragod and supplied to eight AICRP (Palms) centres *viz.*, Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Kahikuchi, Navsari, Ratnagiri and Veppankulam for evaluation in RBD with three replications and six palms per genotype per replication.

Aliyarnagar

Five hybrids were planted during 2011 along with two local check varieties (WCT and TPT). The trial was laid in RBD with three replications and six palms per hybrid per replication. Observations on growth, flowering, yield and nut component traits were recorded. The results revealed that the cross, WCT X TPT was significantly short (4. 64m palm height), but with high rate of annual leaf production (10.9) and higher number of functional leaves on the crown (30.2). The maximum plant girth (107.4 cm), leaf scars in 1 m length (15.3), total leaf length (550.4 cm), petiole length (151.0 cm), more number of spikelets /inflorescence (37.5), female flowers (20.4/ inflorescence) and nut yield (105.2/palm /year) were recorded in the hybrid combination BENT x ADOT. With regard to nut component traits, the cross ECT x LCT recorded maximum fruit length (26.2 cm), fruit breadth (16.9 cm) and fruit weight (1723.4 g). The maximum kernel weight of 384.6 g was observed in the hybrid combination WCT x TPT. Among the Tall x Tall hybrid combinations, the combination BGR x ADOT was superior for traits such as de-husked nut weight (688.4 g), tender nut water content (430.1 ml), copra content (166.5 g/nut), copra yield per palm (17.5kg/palm) and copra outturn per hectare (3.1 t/ha).The assessment of hybrid combinations for reaction to pest incidence revealed that, BENT x ADOT recorded the least incidence of rhinoceros beetle (4.9 %), rugose spiralling whitefly incidence (7.9 %), intensity (6.1 %) and Eriophyid mite incidence (9.6 %).

Ambajipeta

The experiment on Tall x Tall hybrids was started during 2011 at Ambajipeta centre. Due to Helen and Philin cyclones in 2013, some of the seedlings were lost. Gap filling has been done during February 2014 and the experiment is in bearing stage. Growth parameters recorded during 2021 showed significant difference only for number of functional leaves (30.12) in BENT x ADOT and was at par with LCT x ADOT (29.44) whereas, the lowest number of functional leaves (27.84) was recorded in WCT x TPT. However, the remaining growth parameters *viz.*, palm height, palm girth, annual leaf production, total leaf length, petiole length and number of leaf scars were non- significant. For the yield parameters, the cross combination LCT x ADOT recorded highest number of buttons/inflorescence (22.75) and was at par with BENT x ADOT (20.50) followed by ADOT x ECT (20.25). LCT x ADOT cross combination recorded 110.44 nuts/palm/annum and was on par with BENT x ADOT (98.50) followed by WCT x TPT (86.83 nut/palm/annum) respectively. The tender nut fruit weight (1725.10 g) was maximum in the cross ECT x LCT and it was at par with BENT x ADOT (1620.58 g) and WCT x TPT (1496.90 g) followed by ADOT x ECT (1354.9g), while the lowest fruit weight was observed in ECT x ECT (1241.03 g)

Bhubaneswar

The experiment was laid out with Sakhigopal Tall – IND 041 as check in RBD with four replications during June 2013. Maximum numbers of inflorescences (9.42/palm/year), number of female flowers (141.46/palm/year) and nuts harvested (28.66/palm/year) were recorded in WCT x TPT. However, other growth parameters like number of functional leaves, annual leaf production rate, leaf length and petiole length, plant height, girth, were non-significant. All the palms in the trial were severely damaged due to cyclone "FANI" resulting in very poor performance in the current year. Palms are reviving gradually.

Kahikuchi

Experiment on Tall x Tall cross combinations was initiated at Kahikuchi centre during June, 2013 with Kamrupa as check. The highest palm height (6.10m), girth (137.5 cm), annual leaf production (11.4) and number of total leaves (30.5) were observed in LCT x ADOT whereas, the hybrid ADOT x ECT recorded the lowest values for the above characters. The cross combination BENT x ADOT recorded the lowest palm height (4.92m) with maximum inflorescence production (9.2), number of female flowers/inflorescence (22.6) and nut yield (52.4 nuts/palm/year). With regard to age at first flowering, early flowering at 65 months after planting was recorded by BENT x ADOT and the maximum months for flowering (72.0) was recorded in check variety Kamrupa. As the palms under

different cross combinations have just entered into the bearing phase, nut characteristics were not recorded.

Navsari

The field experiment was laid out in RBD with four replications and five different treatments during 2013. The result revealed that, significantly maximum plant height (3.75m), total number of leaves on the crown (29.50 numbers) and minimum age at first flowering (39 months) were recorded in ECT x LCT whereas, maximum girth of palm (114.25 cm), leaf length (540.30 cm) and petiole length(150.08 cm)were recorded in ADOT x ECT. Looking to the flowering characters, BENT x ADOT recorded maximum numbers of inflorescence production per annum (10.50 numbers) and more nut yield per palms per year (55.25 nuts).

Ratnagiri

The field experiment on five different Tall x Tall cross combinations along with one local check Pratap was laid out in RBD with four replications during August, 2011. The observations on growth parameters showed significant differences among the Tall x Tall coconut hybrids. Data showed that the local check (Pratap) recorded maximum plant height (489.9 cm) whereas among the hybrid combinations, ADOT x ECT showed highest plant height (439.8 cm). The hybrid BENT x ADOT recorded maximum plant girth (110.6 cm) whereas the lowest plant girth (95.2 cm) was in local check (Pratap). The maximum number of functional leaves (24.9 nos.) was observed in hybrid BENT x ADOT. The maximum leaf length was in local check (Pratap) (415.6 cm) and maximum petiole length was recorded in WCT x TPT (171.3 cm). The hybrid LCT x ADOT recorded maximum number of inflorescence (12.1 nos) and female flowers (194 nos.). The highest nut yield (76.2 nuts/palm) and copra content (177 g) was recorded in WCT x TPT, while maximum whole nut weight (1293.8 g) was recorded in LCT x ADOT. In respect of pest incidence, rhinoceros beetle incidence was lowest in local check (Pratap) (12.2 %) whereas highest incidence was observed in ADOT x ECT (18.1 %). The percent of rugose spiralling whitefly incidence was lowest in ADOT x ECT (10.6 %) while lowest intensity was in Local check (Pratap) (15.4 %) and the lowest eriophyid mite incidence was recorded in BENT x ADOT (11.4 %).

Veppankulam

Morphological, yield, nut characters and reaction to pest incidence of the five T x T cross combinations in coconut were recorded and analysed statistically. Among the five T x T crosses, the performance of LCT x ADOT expressed dwarf stature (5.32 m) while ECT x LCT and BENT x ADOT recorded higher number of fruit bunches (more than 10 bunches per palm). Annual nut yield of 76.20 nuts/palm/year was recorded in ECT x LCT. The copra content was highest in ECT x LCT and WCT x TPT. As far as the pest incidence is concerned, rhinoceros beetle and eriophyid mite incidence was observed in the entire cross combinations. There was no incidence of RPW.

Evaluation of location specific Tall x Tall coconut hybrids

Centers: Ambajipeta, Ratnagiri and Veppankulam

The experiment was laid out in RBD with three replications and six palms per genotype per replication to evaluate location specific Tall x Tall cross combinations for yield and reaction to biotic and abiotic stresses.

Ambajipeta

Seven location specific Tall x Tall hybrids (Java Tall x ECT, PHOT x ECT, Fiji Tall x ECT, ECT x PHOT, LCT x ECT, CCNT x ECT, ECT x Fiji Tall) with one local check (mention name) were planted during 2011. Due to Helen and Philin cyclones in the year 2013, some of the hybrids were severely affected resulting in mortality. Gap filling has been taken up during the month of February, 2014 and the experiment is in bearing stage. Growth parameters recorded in the year 2021 showed no significant differences for growth parameters except for palm girth at 1 m height. Significantly the maximum palm girth at 1 m height was recorded in cross combination PHOT x ECT (114.00 cm) followed by CCNT x ECT and ECT x Fiji Tall (105.67 cm), while the lowest palm girth of 94.00 cm was recorded in LCT x ECT.

Further, significant differences were recorded for yield attributes for the year 2020-21 for number of buttons, number of spikelets and nut yield per palm. Average number of buttons per bunch was maximum in LCT x ECT (26.15), which was significantly at par with ECT x Fiji Tall (23.18) followed by ECT x ECT (22.37) and CCNT x ECT (22.33) while the lowest number of buttons were recorded in cross combination of Fiji Tall x ECT (19.22). A significantly higher nut yield of 98.28 nuts per palm per year was recorded in LCT x ECT and was at par with ECT x Fiji Tall (88.37 nuts) followed by ECT x ECT (73.89 nuts), CCNT x ECT (72.30 nuts) and ECT x PHOT (71.73 nuts), whereas the lowest number of 61.62 nuts were recorded in cross combination of PHOT x ECT. The data pertaining to tender nut characters of Tall x Tall hybrids showed that the maximum tender nut fruit weight (2018.33 g) was recorded in cross combination of ECT x PHOT and is on a par with CCNT x ECT (1966.33 g) followed by Fiji Tall x ECT (1856.00 g) and lowest fruit weight was found in ECT x ECT (1643.00). Highest nut water content of 411.50 ml was recorded in CCNT x ECT and was at par with LCT x ECT (387.53 ml), ECT x PHOT (373.33 ml), Fiji Tall x ECT (356.10 ml) and PHOT x ECT (342.73 ml) followed by Java Tall x ECT (314.43 ml) and the lowest water content was found in ECT x ECT (176.10 ml). While the maximum TSS was found in the cross LCT x ECT (7.02) which was at par with ECT x PHOT (6.97), ECT x Fiji Tall (6.74) and PHOT x ECT (6.57) followed by Java Tall x ECT (6.52). The lowest TSS content was recorded in cross combination ECT x ECT (5.99)

Ratnagiri

In Ratnagiri centre, seven location specific Tall x Tall hybrids (PHOT x BENT, BENT x PHOT, PHOT x CRP 513, CRP 513 x PHOT, CRP 514 x PHOT, PHOT x CRP514, LCT x BENT) along with a check (Pratap) were planted during 2009 for evaluation. The observations on growth parameters showed significant differences among the location specific Tall x Tall coconut hybrids. The hybrid BENT x PHOT recorded maximum no. of inflorescences (12.7) and female flowers (216.5 nos.). The highest nut yield (87.3 nuts), maximum whole nut weight (1353.3 g) and copra content (178.3 g) were recorded in hybrid BENT x PHOT. In respect of pest incidence, the percentage of rhinoceros beetle incidence was lowest in BENT x PHOT (10.2 %) .

Veppankulam

Seven new T x T cross combinations *viz.*, West Coast Tall x Philippines Ordinary Tall, East Coast Tall x Zanzibar, East Coast Tall x Java Giant, East Coast Tall x Philippines Ordinary Tall, San Ramon x Zanzibar , West Coast Tall x Cochin China and Philippines Ordinary Tall x West Coast Tall along with a check variety VCH 3 were planted at 14B block on January, 2009 as under planting and the old palms were removed during 2015. The palm height and girth varied between 438cm to 621cm and 161 and 226 cm respectively. The annual leaf production and number of functional leaves were above nine and 28 respectively in the entire cross combinations. **The** number of female flowers ranged between 198 to 225 and the setting percent was highest in WCT x CCNT (30.28%). The number of nuts was above 49 in all the cross combinations and the highest nuts per palm per year was recorded in ECT x PHOT (59.50 nuts). The percent of husk ranged between 56 to 60 and the copra yield was higher in ECT x PHOT and WCT x CCNT exceeding seven kilograms per palm per year

Evaluation of Dwarf x Dwarf coconut hybrids in different agro climatic conditions

This experiment was laid out to develop dwarf statured hybrids for tender nut yield and quality and to screen for pest and disease resistance. The experiment included five Dwarf x Dwarf hybrids viz., COD x MYD, COD x MGD, MGD x CGD, GBGD x MOD and CGD x MGD supplied by ICAR-CPCRI, Kasaragod and a local check. The palms were planted in RBD with four replications and six palms per genotype per replication.

Ambajipeta

The experiment was planted in 2011 with GBGD as check. However, due to Helen and Philin cyclones in 2013, some of the accessions had died. Gap filling was done with planting material received from CPCRI, Kasaragod in March, 2014.

Meanwhile the production of COD x MYD seed nuts was also initiated at this centre in 2015 and seed nuts were harvested in 2016. These seedlings were raised during 2017 and selected seedlings were planted in the experimental plot in 2018. These seedlings had established well and are in vegetative stage. Meanwhile, other cross combinations of the experiment have attained the bearing stage. The data pertaining to growth attributes for the year 2021-22 showed that the mean lowest plant height was recorded in GBGD (2.48 m) and the maximum was recorded in MYD x CGD (3.74m) while the maximum stem girth was recorded in MYD x CGD cross (103.75 cm). The maximum nut yield (93.67 nuts/palm/annum) was recorded in COD x MGD cross combination which was on a par with CGD x MGD (76.12 nuts/palm/annum) and GBGD x MOD (73.06 nuts/palm/annum). Low nut yield was recorded in MYD x CGD (52.94 nuts/palm/annum). The number of inflorescence production per palm was maximum in GBGD x MOD (10.58). Tender nut water content was maximum in COD x MGD (453.50 ml/nut) which is on a par with MYD x CGD (421.75 ml/nut), GBGD (390.83 ml/nut) and CGD x MGD (385.75 ml/nut).

Ratnagiri

At Ratnagiri centre, the trial was initiated during 2011 with five D x D hybrids and one check variety (COD). The growth characters showed significant differences among the D x D hybrids under study. The data revealed that the local check COD recorded minimum plant height (241.8 cm) whereas maximum palm height (342.5 cm) was observed in COD x MYD. The hybrid COD x MYD recorded maximum plant girth (7. 90 m) and maximum annual leaf production (12.3 nos.). The maximum number of functional leaves (26.5 nos.) were observed in GBGD x MOD, maximum leaf length in COD x MYD (340 cm) and maximum petiole length in COD x MGD (137 cm). The hybrid GBGD x MOD showed early flowering after planting (28 months) followed by COD x MGD (29 months). The hybrid COD x MYD recorded maximum number of inflorescences (12.5) and maximum female flowers (224.6 nos.). The hybrid GBGD x MOD is a promising cross for the earliness. The hybrid COD x MYD recorded highest tender nut yield (81.7 nuts) followed by the hybrid GBGD x MOD (77.7 nuts) among the entire Dwarf x Dwarf coconut hybrids. Regarding the quantity of tender nut water, the hybrid COD x MYD recorded maximum volume of tender nut water (604.0 ml/nut). The maximum score for total soluble solids (TSS), was recorded in the hybrid GBGD x MOD (5.7 ^{o}Brix). With respect to pest incidence, rhinoceros beetle incidence was lowest in GBGD x MOD (13.0%) whereas highest incidence was observed in MYD x CGD (17.7 %). The rugose spiralling whitefly incidence was lowest in GBGD x MOD (15.2 %) while lowest intensity was in COD x MGD (20.8 %) and the lowest eriophyid mite incidence was recorded in COD (local check) (18.1 %).

Veppankulam

Among the 5 crosses developed from CPCRI, Kasaragod the cross MYD x CGD was the first to flower *i.e.* 22nd month after planting and is a promising cross for earliness. Now the palms are in bearing stage. Among the D x D hybrids evaluated for morphological characters, COD x MYD expressed the dwarf stature with less girth (332 cm and 119 cm respectively). Cross MYD x CGD was the first to flower *i.e.* 22nd month after planting and is a promising cross for earliness. Now the palms are in bearing stage. Regarding tender nut quality parameters, GBGD x MOD recorded maximum volume of tender nut water (610 ml/nut). Regarding the total soluble solids (TSS), maximum score was observed in the cross MYD x CGD (6.1 ^{o}brix). The crosses *viz.*, COD x MGD, GBGD x MOD and CGD x MGD recorded more than 75 nuts per palm per year. Regarding the pest incidence, all the cross combinations was affected by rhinoceros beetle, RSW and eriophyid mite. There was no incidence of RPW and BHC in all the cross combinations.

Establishment of mother palm blocks and production of quality planting material in coconut

Establishment of nucleus seed gardens for released varieties

The pivotal goal of this activity is to create nucleus seed gardens of important varieties for the production of good quality planting materials. This activity was started in Aliyarnagar, Ambajipeta, Arsikere, Jagdalpur, Kahikuchi, Mondouri, Port Blair, Ratnagiri and Veppankulam centres of AICRP (Palms).

Aliyarnagar

The quality seed nuts from the mother palms of West Coast Tall, Kenthali dwarf, MGD, CGD, MYD and COD were harvested in a staggered manner and sown in the nursery on a regular basis and elite quality seedling produced are distributed to the needy coconut farmers. The nucleus seed gardens comprising of Kalpa Prathiba, Kalpa Shatabdi, Kalpatharu, Arasampatti tall, MGD, MOD and GBGD planted during 2015 in this centre are in bearing stage. Apart from this, the production of Chandra Sankara hybrids seedlings are also being done in this centre.

From the mother palms and crossing blocks conserved at AICRP on Palms centre, Aliyarnagar, a total of 7,300 seedlings of WCT, 15,000 seedlings of Arasampatti tall, 4650 seedlings of COD, MGD, CGD & MYD, 2325 seedlings of Kenthali dwarf and 1450 seedlings of Chandra Sankara hybrids were produced and distributed to the farmers during the year 2021.

Ambajipeta

Under this project multiplication of Gautami Ganga, Kera Bastar and Kalpa Prathiba were allotted for Ambajipeta center. During 2013-14, the *inter-se* crossed seedlings of Gauthami Ganga (300 nos.) and Kalpa Prathibha (150 nos.) were planted at Horticultural Research Station, Ambajipeta for future production of quality planting material. The growth of the seed garden is satisfactory. Further, the mother block (120 nos.) of Double Century (PHOT) is also being maintained, as it is one of the parents in production of new hybrid (GBGD x PHOT) which was proposed for release from Horticultural Research Station, Ambajipeta. However, instead of Kera Baster variety Double century (PHOT) plantation was maintained to take up the production of newly released coconut hybrid Vasishta Ganga (GBGD X PHOT) and Vainateya Ganga (PHOT X GBGD) and large scale production of Godavari Ganga (ECT X GBGD) and Gautami Ganga (a selection of GBGD). During 2021, a total of 750 coconut seedlings were produced and distributed to the farming community.

Arsikere

The coconut mother palm blocks consisting of COD (50 no.), GBGD (50 no.), MYD (40 no.), MOD (40), Fiji Tall (10), Kulashekran Green (25), MGD (15), ECT (15) and Kalpatharu (50 no.) were established at Arsikere centre. Totally 9000 seedlings were produced during 2021. These seedlings are sold to needy farmers which consist of tall and dwarf varieties in order to increase the area of coconut in nontraditional belt of Karnataka.

Kahikuchi

As the female parent for the hybrid MYD x WCT is limited at the centre, a mother block garden of MYD with 25 palms has been planted in the field. Simultaneous hybridization programme of the above cross is also being done to produce planting materials. *Inter-se* crossed seedlings of Kamrupa (150 nos.) were planted at the centre during 2010 for establishment of nucleus seed garden. The growth of the seed garden is satisfactory. Most of the palms have already been started bearing. A total of 2,500 seedlings of Kamrupa were produced and distributed during the year 2021.

Mondouri

A total of 50 palms each of three varieties viz., Kalyani Coconut –1, Kera Keralam and Kalpa Mitra were planted in 2009 and the mother palm blocks are in establishment phase.

Port Blair

With the objective, to reproduce the improved varieties of coconut for distribution to island farmers, nucleus seed garden was established in the Garacharma farm of the Institute. Seedlings of four varieties of coconut *viz.* CARI- Annapurna, CARI-Omkar, CARI- Surya and CARI- Chandan were planted during 2017 and the mother palm blocks are in establishment phase.

Ratnagiri

For large scale multiplication of newly released coconut hybrids and varieties, the mother palms of released varieties are planted at Ratnagiri centre. About 175 seedlings each of ECT and GBGD and 290 seedlings of Fiji Tall have been planted for establishment of mother palm garden. The planting materials of Fiji (369 nos), GBGD (356 nos.) and ECT (214 nos) and KonkanBhatye Coconut hybrid – 1 (403 nos.) were sold during 2021.

Veppankulam

Nucleus seed garden of Kera Keralam variety has been established in an area of 2 ha and distributed 1500 seedlings of Kera Keralam to needy farmers. 250 saplings of Kalpa Prathiba have been distributed to the farmers demanding them.

4.2. Oil Palm

Evaluation of new cross combinations in oil palm

Centre: Pattukkottai

Among the hybrids, the palm height ranged from 4.74 to 5.29 m. The hybrid NRCOP -4 recorded significantly the highest palm height of 5.29 m which was closely followed by NRCOP-2 (5.25 m). The lowest palm height (4.74 m) was recorded in the hybrid NRCOP 10. The palm girth was ranged between 3.59 m and 3.90 m and the palm girth was higher in the hybrid NRCOP 7 (3.90 m). The lowest palm girth was recorded in the hybrid NRCOP-1 (3.59 m). Number of leaves produced per palm per year was the highest in NRCOP 2 (25.60) and the highest number of male inflorescence (8.32) was recorded in NRCOP 1 which was closely followed by NRCOP 3 (8.20). The lowest number of male inflorescence (7.22) was recorded in NRCOP 5. The number of female inflorescence was ranged between 10.25 and 12.38. The number of female inflorescence (12.38) was the highest in NRCOP 1; whereas, the percentage of female flowers was high in NRCOP 5 (61.00%).

Table 2 Yield performance of oil palm hybrids (2021-2022) - 14 years old

Hybrids	No. of bunches/ palm	Average bunch weight (Kg/palm)	FFB yield (kg/palm)	FFB Yield (t/ha)
NRCOP -1	11.12	15.30	170.14	24.33
NRCOP -2	9.82	18.07	177.45	25.38
NRCOP -3	10.30	18.20	187.46	26.81
NRCOP -4	9.95	17.41	173.23	24.77
NRCOP -5	10.80	17.25	186.30	26.64
NRCOP -6	10.85	16.32	177.07	25.32
NRCOP -7	**10.90**	17.80	194.02	27.75
NRCOP -8	10.65	19.90	211.94	30.31
NRCOP -9	10.50	**21.20**	**222.60**	**31.83**
NRCOP -10	10.80	20.32	219.45	31.38
S Ed	1.13	1.23	1.33	1.12
CD 5%	2.26	2.46	2.66	2.24

Data on yield attributes revealed that the number of fresh fruit bunches per palm is ranged from 9.82 to 11.12. Number of fresh fruit bunches are more in the hybrid NRCOP-1 (11.12) which was closely followed by NRCOP -7 (10.90) and NRCOP-6 (10.85). Average weight of the fresh fruit bunches ranges from 15.30 kg to 21.20 kg and highest bunch weight was observed in the hybrid NRCOP 9 (21.20 Kg/Palm). The highest FFB yield per palm of 222.60 kg and FFB yield per hectare of 31.83 tonnes was

registered in the hybrid NRCOP- 9 which was closely followed by NRCOP-10 (31.38 t/ha) during the reporting period.

OP./Gen. 8 C (1): Evaluation of New cross combination in North East regions

Centre: Pasighat

Then growth of the palms with respect to stem height and stem girth was found to be non significant and statically at par in all the cross combinations. Maximum number of male flowers were produced by the cross combination NRCOP-30, NRCOP-29 and NRCOP-28. The minimum number of male flowers were recorded in the cross combination NRCOP-22 which was significantly less than other crosses except NRCOP-27, NRCOP-26 and NRCOP-24. Maximum number of female flowers (10.60) were produced by the cross NRCOP-22 which was significantly higher than the female flowers produced by other cross combinations and at par with NRCOP-26. Minimum number of female flowers (6.86) were produced by the cross NRCOP-30. The sex ratio was recorded highest (0.74) in NRCOP-22 which was statistically at par with NRCOP-26. Sex ratio was recorded least (0.53) in NRCOP-30. Maximum number of Fresh Fruit Bunches (10.43) was produced by NRCOP-22 which was significantly higher than in any other cross combination except NRCOP- 26 where as the NRCOP-30 produced the least number of FFB (6.56) per palm.

The average bunch weight was recorded maximum (13.46Kg) in NRCOP-22 which was significantly higher than other cross combinations except NRCOP-26, NRCOP-25 and NRCOP-30 The bunch weight was least in NRCOP-23 (10.53Kg). Highest yield was recorded in NRCOP-22 (20.10 t/ha) which was significantly higher the any other cross combinations. The yield (12.01t/h) was minimum in NRCOP-30. From the above results it is evident that the performance of NRCOP-22 is the best under North Eastern Indian conditions as compared to other cross combinations.

Growth and yield parameters of Oil palm plants (Gen. 8C-I)

Cross Combination	Plant height (cm)	Collar girth (cm)	No. of leaves produced	Male flowers/ palm	Female flowers/ palm	Sex Ratio	No. of FFB/ plant	Bunch weight/ Palm (Kg)	Yield	
									Kg/ palm	t/ha
NRCOP-21	2.64	2.59	21.87	4.81	9.33	0.66	9.13	12.16	111.06	15.88
NRCOP-22	2.77	2.64	23.26	3.53	10.60	0.74	10.43	13.46	140.49	20.10
NRCOP-23	3.14	2.69	20.36	4.83	9.00	0.65	8.76	10.53	92.35	13.20
NRCOP-24	3.06	2.65	20.83	4.60	8.10	0.63	7.93	11.80	93.69	13.39
NRCOP-25	2.62	2.78	20.93	4.73	8.06	0.63	7.80	12.90	100.71	14.40
NRCOP-26	2.66	2.80	22.36	4.50	10.00	0.69	9.83	12.93	127.22	18.19
NRCOP-27	3.13	2.57	22.50	4.50	9.26	0.67	9.10	12.34	112.26	16.05
NRCOP-28	2.83	2.75	21.80	5.06	8.26	0.62	8.06	12.60	101.61	14.52
NRCOP-29	2.92	2.75	20.16	5.90	7.53	0.55	7.16	12.60	90.30	12.91
NRCOP-30	2.73	2.82	19.96	6.03	6.86	0.53	6.56	12.80	84.00	12.01
CD at 5%	**NS**	**NS**	**0.844**	**1.190**	**0.726**	**0.060**	**0.722**	**0.668**	**12.255**	**2.401**
CV (%)	**8.601**	**4.036**	**1.678**	**14.296**	**4.861**	**5.507**	**4.962**	**3.138**	**6.780**	**6.780**

OP./Gen. 8 D (I): Evaluation of new progeny cross combinations in oil palm
Centres: Mulde, Pattukkottai and Vijayarai.
Treatments details:

Sl. No.	Cross Combination	Sl. No.	Cross Combination
1	NRCOP-31 (257 CDx14 P)	**6**	NRCOP-36 (99 CDx14 P)
2	NRCOP-32 (254 CDx17 P)	**7**	NRCOP-37(66 CDx17 P)
3	NRCOP-33(198 CDx129 P)	**8**	NRCOP-38(66 CDx14 P)
4	NRCOP-34(124 CDx14 P)	**9**	NRCOP-39(42 CDx14 P)
5	NRCOP-35(124 CDx17 P)	**10**	NRCOP-40(92 CDx129 P)

Mulde:

It is reviled that, among different growth parameter significant variation in the plant height was observed. The highest plant height observed in the genotype NRCOP 33 (3.93m) and was at par with NRCOP 32(3.67m) genotype. With regards to yield parameter all parameter were differ significantly, the highest number of female inflorescences was recorded in the genotype NRCOP 31 (7.43) and superior to all genotypes under study. The same trends was also observed in the sex ratio (0.57). With regards to number of fresh fruit bunch (FFB) Table 5 significantly highest number of FFB were recorded in NRCOP 31(10.33)along with weight of FFB (16.15Kg/bunch**)** and yield (20.64 tones / ha.)Further NRCOP 32 was at par with NRCOP 31.

Pattukkottai

Nine hybrids viz., NRCOP 31, 32, 33, 34, 35, 36, 37, 38 and 39 were planted on 26.02.2013 in ARS, Pattukkottai. Among 9 hybrids received, only five hybrids (NRCOP 31, 32, 33, 38 and 39) have sufficient seedlings for the replicated trial. Other four hybrids *viz*., NRCOP 34, 35, 36 and 37 were planted as non replicated trial for observation. The seedlings have established well and trial is in stabilizing yield stage of bearing.

Among the replicated hybrids, the palm height ranged from 4.80 to 5.35 m. The hybrid NRCOP -32 recorded significantly the highest palm height of 5.35 m. The lowest palm height (4.80 m) was recorded in the hybrid NRCOP 39. The palm girth was ranged between 3.10 m and 3.68 m and the palm girth was higher in the hybrid NRCOP 38 (3.68 m). The lowest palm girth was recorded in the hybrid NRCOP-31 (3.10 m). Number of leaves produced per palm per year was the highest in NRCOP 39 (24.90) and the highest number of male inflorescence (7.90) was recorded in NRCOP 39 which was closely followed by NRCOP 33 (7.72). The lowest number of male inflorescence (6.59) was recorded in NRCOP 32. The number of female inflorescence was ranged between 11.58 and 12.55. The number of female inflorescence (12.55) was the highest in NRCOP 38, whereas, the percentage of female flowers was high in NRCOP 32 (65.00%).

Data on yield attributes revealed that the number of fresh fruit bunches per palm are more in the hybrid NRCOP 31 (9.50) which was closely followed by NRCOP 32 (9.45). Average weight of the fresh fruit bunches ranges from 15.50 kg to 19.00 kg and highest bunch weight was observed in the hybrid NRCOP 38 (19.00 kg). The highest FFB yield per palm of 178.60 kg and FFB yield per hectare of 25.54 tonnes was registered in the hybrid NRCOP 38 which was closely followed by NRCOP 32 (23.11 t/ha) during the period from April 2021 to March 2022.

Pasighat

The growth of the plants with respect to plant height was maximum (98.10 cm) in NRCOP- 37 which was at par with NRCOP- 32 NRCOP- 34, NRCOP- 35, NRCOP- 36, NRCOP- 38, NRCOP- 39 and NRCOP- 40. Coller girth and number of leaves produced over a period of one year was found to be non significant and statically at par, in all the cross combinations. Least number of male flowers(4.) was produced by NRCOP- 32 and maximum(7.3) by NRCOP- 39. Maximum female flowers(8.1) were recorded in NRCOP-31

which was statically at par with all other cross comibinations. Sex ratio was highest (0.61) in NRCOP-22 and lowest (0.51) in NRCOP-39. The number of FFB/ palm was recorded maximum (7.93) in NRCOP-33which was at par with NRCOP-37, NRCOP-32 and NRCOP-35, NRCOP-36 and NRCOP-34. FFB was observed to be least (7.8) in NRCOP-38. The average bunch weight was recorded maximum(8.06 kg) in NRCOP-37 which was at par with NRCOP-36 and significantly higher than the other crosses. The mean yield/palm and yield t/ha was maximum (63.34kg/palm and 9.05t/ha) in NRCOP-37 which was better the any other cross combination. The yield was recorded least (6.96 t/ha) in NRCOP-39

Table 10: Growth and yield parameters of Oil palm plants (Gen. 8D)

Cross Combination	Stem height (cm)	Stem girth (cm)	No. of leaves produced	No. of male flowers/ plant	No. of female flowers/ plant	Sex Ratio	No. of FFB/ plant	Bunch weight/ palm	Yield	
									Kg/ palm	t/ha
NRCOP-31	86.3	171.7	19.9	5.8	8.1	0.587	7.9	7.16	56.84	8.13
NRCOP-32	94.4	188.4	20.2	4.9	7.9	0.613	7.8	7.40	57.73	8.25
NRCOP-33	92.0	180.7	20.1	6.0	7.8	0.563	7.9	7.50	57.03	8.14
NRCOP-34	93.1	184.6	19.4	6.7	7.7	0.537	7.3	7.26	53.53	7.65
NRCOP-35	95.8	177.3	19.5	6.8	7.8	0.533	7.6	7.13	54.42	7.78
NRCOP-36	94.2	185.9	19.8	6.6	7.7	0.537	7.4	7.53	56.25	8.04
NRCOP-37	98.1	181.6	20.2	6.7	7.9	0.543	7.8	8.06	63.34	9.05
NRCOP-38	95.4	181.0	19.0	6.8	7.8	0.533	7.1	7.03	50.58	7.23
NRCOP-39	95.1	173.5	18.6	7.3	7.8	0.517	7.2	6.76	48.70	6.96
NRCOP-40	96.4	179.6	19.3	7.0	7.6	0.520	7.2	7.30	52.71	7.53
CD at 5%	**5.491**	**NS**	**NS**	**1.071**	**NS**	**0.044**	**NS**	**0.547**	**5.545**	**0.790**
CV (%)	**3.401**	**4.870**	**2.577**	**7.017**	**5.888**	**4.652**	**4.584**	**4.360**	**5.864**	**5.846**

Vijayarai

The trail was laid out during July, 2011. Ten new progeny cross combinations of oil palm (NRCOP-31 to NRCOP-40) were planted in triangular system at spacing of 9×9×9 m in RBD with 3 replications and 6 palms per treatment during 2011. There were no significant differences among new progeny cross combinations for number of leaves per palm per year, , sex ratio, number of bunches per palm/year, FFB yield (kg/palm/year) and FFB yield (t/ha/year). However, new progeny cross combinations differed significantly for palm height (m), palm girth (m) and average bunch weight(kg). Palm height was highest in NRCOP-40 (4.22 m) which was on par with the crosses, NRCOP-32 (3.93 m), NRCOP-33 (4.02 m). NRCOP-35 (3.82 m) and NRCOP-37(3.88 m). Palm girth was highest in NRCOP-39 (3.14 m) which was on par with NRCOP-34 (2.96 m), NRCOP-36 (2.87 m), and NRCOP-38 (3.10 m). The new progeny cross combination NRCOP-33 produced highest average bunch weight of (24.49.kg) followed by NRCOP-32 (22.19 kg) and NRCOP-39 (22.18 kg). (Table:1)

OP./Gen. D(II): Evaluation of D x P hybrids for dwarfness and yield in oil palm

Vijayarai:

The experiment was laid out during, 2013. Twelve entries of oil palm including eleven D×P hybrids (NRCOP-41 to NRCOP-51) along with one control (646) were planted in triangular system at spacing of 9×9×9 m in RBD with 3 replications and

9 plants per treatment during 2013. There were no significant differences among the entries for palm height (m), number of leaves per palm per year, rachis length, leaf area, specific leaf area, leaf dry weight(kg), total leaf dry weight(kg) sex ratio, and number of bunches per palm per year (Table:2) FFB yield (kg/palm/year) and FFB yield (t/ha/year). However, D×P hybrids differed significantly for palm girth (m), Palm girth was highest in NRCOP-43 (3.12 m) which was on par with the crosses NRCOP-44 (2.88 m) NRCOP-45(3.09 m) NRCOP-46 (2.94m) and NRCOP-47 (2.89 m). Average bunch weight (kg) recorded highest in NRCOP-44(18.14kg) which was on par with NRCOP-42 (15.53 kg).

Table: 12Growth and yield parameters of D X P hybrids in oil palm at Vijayarai

Name of the hybrid	Palm height (m)	Annual height increment (m)	Palm girth (m)	Number of leaves/ palm/year	Sex ratio	Number of bunches/ Palm/year	Average bunch weight (kg)	FFB Yield	
								kg/palm/ year	t/ha/ year
NRCOP-41	2.67	0.64	2.80	24.20	**73.67**	**14.73**	13.66	203.61	29.11
NRCOP-42	2.56	0.60	2.65	24.80	57.89	11.57	15.53	179.79	25.71
NRCOP-43	2.52	**0.85**	**3.12**	**23.50**	60.76	12.15	15.12	184.03	26.31
NRCOP-44	2.65	0.53	2.88	23.80	57.89	11.57	**18.14**	**210.11**	**30.04**
NRCOP-45	2.46	0.66	3.09	23.75	56.52	11.30	15.00	172.82	24.71
NRCOP-46	2.32	0.60	2.94	23.60	52.32	10.46	12.71	131.26	18.77
NRCOP-47	2.21	0.34	2.89	24.80	68.03	13.60	13.80	191.81	27.43
NRCOP-48	**2.09**	0.59	2.71	25.30	66.39	13.27	12.59	176.14	25.18
NRCOP-49	2.46	0.88	2.81	23.80	60.89	12.17	11.65	149.61	21.39
NRCOP-50	2.45	0.55	2.70	23.80	67.22	13.44	13.52	180.71	25.84
NRCOP-51	2.65	0.93	2.82	23.00	55.13	11.02	14.12	155.47	22.23
Control	2.85	1.12	2.87	24.20	62.63	12.52	12.40	156.63	22.40
CD (5%)	**NS**	—	**2.42**	**NS**	**NS**	**NS**	**2.86**	**NS**	NS
S.Em(±)	**17.69**	—	**4.99**	**11.45**	**22.79**	**22.79**	**12.04**	**29.94**	29.11
CV (%)	2.67	0.64	2.80	24.20	**73.67**	**14.73**	13.66	203.61	29.11

4.3. Palmyrah

Survey, collection and evaluation of palmyrah germplasms

Centers: Killikulam and Pandirimamidi

Killikulam

Survey and collection of palmyrah germplasm was done to identify dwarf and superior palmyrah genotypes for high neera and nungu yield. So far 265 number of Palmyrah germplasm accessions were collected and are being maintained as year wise germplasm blocks at Agricultural College and Research Institute, Killikulam. The germplasm accessions are being evaluated for various biometric, yield and yield related characters.

Performance of palmyrah germplasm collected during 1995

Significant variation is observed among the planted germplasm accessions. Among the germplasm planted during 1995, accession 18 has recorded maximum palm height (503.33 cm) and leaf length (113.67 cm) whereas accession 38 recorded lowest palm height (199.52cm) and accession 5 recorded

shorter leaves (101.32cm). Accession 01 recorded higher number of leaves (47.82 nos) whereas accession 5 recorded lowest number of leaves (36.65nos). Accession 21 recorded higher value for stalk length (159.22 cm) whereas accession 34 recorded lower value for stalk length (107.46cm).

Performance of palmyrah germplasm collected during 1997

The data recorded from the germplasm planted in 1997 indicated that the accession 67 recorded maximum palm height (516.73cm) accession 41 recorded lowest palm height (238.11cm).Highest number of leaves was recorded in accession 58 (52.23nos) and lowest (49.44nos) in accession 46. The length of the leaf was found to be highest in the accession 41 (134.33 cm) and lowest in accession 46(115.33cm). The length of the stalk was highest in the accession 58 (172.43 cm) and lowest in accession 48 (147.11cm).

Performance of palmyrah germplasm collected during 1999

Among the germplasm collected during 1999, the accession 74 recorded highest plant height (263.12 cm) while accession 80 with lowest plant height (113.62cm), accession 73 was recorded to have highest leaf length(117.41 cm) and the lowest leaf length (68.37cm) was recorded as accession 84.The accession 88 recorded highest number of leaves(46.62nos) and accession 79 was recorded lowest number of leaves(41.56nos). Accession 73 recorded higher value for stalk length (131.12 cm) whereas accession 86 recorded lower value for stalk length (49.22cm).

Performance of palmyrah germplasm collected during 2001

The accessions planted during 2001 showed maximum palm height (369.12 cm), number of leaves (46.47nos), with accession 92. The maximum leaf length (97.78cm) and stalk length(164.33 cm) was also recorded in the accession 92. Accession 96 recorded lower values for all the characters i.e., palm height (95.32cm), number of leaves (36.17nos), leaf length(70.21cm) and stalk length(66.47 cm).

Performance of palmyrah germplasm collected during 2003

Among the germplasm accessions planted during the year 2003, accession 153 recorded the maximum palm height(211.44 cm), number of leaves(28.24), leaf length (85.66 cm)and stalk length(99.78 cm) whereas accession 149 recorded the lowest palm height (101.24cm), number of leaves (32.86nos), leaf length(68.32cm) and stalk length(57.51 cm)

Performance of palmyrah germplasm collected during 2004

Among the 2004 planted germplasm accessions, the accession 160 recorded increased palm height (163.78 cm)accession 164 recorded lowest plant height (109.38 cm). Accession 165 was recorded to have highest leaf length(81.22 cm) and the lowest leaf length (66.76 cm) was recorded as accession 164.The accession 168 recorded highest number of leaves(39.44nos) and accession 173 was recorded lowest number of leaves(37.13nos). Accession 169 recorded higher value for stalk length (89.81cm) whereas accession 164 recorded lower value for stalk length (53.41cm).

Performance of palmyrah germplasm collected during 2005

Among the 2005 planted accessions, accession 176 showed the maximum palm height(175.47 cm), accession 174 for maximum number of leaves(34.61nos) and leaf length(98.55) . The stalk length was maximum (104.94 cm) in the accession 180 and the lowest plant height(102.41cm), number of leaves (30.19 nos), leaf length (73.23 cm)and stalk length(66.21cm) was recorded with the accession 179.

Performance of palmyrah germplasm collected during 2006

The data collected from germplasm accessions during the year 2006 showed maximum palm height (180.24 cm) with the accession 196. The accession 180 has recorded lowest plant height (83.27cm). Accession 184 recorded more number of leaves (37.34 nos), accession 192 recorded increased leaf length (89.55 cm), lesser number of leaves (30.32) and lowest leaf length (65.42cm) was recorded in accession 196. Accession 186 recorded higher value

for stalk length (75.12cm) whereas accession 190 recorded lower value for stalk length (55.26cm).

Performance of palmyrah germplasm collected during 2007

Among the germplasm collected during 2007, the accession 204 recorded increased palm height (161.74 cm) accession 208 recorded lowest plant height (103.26 cm). Accession 207 was recorded to have highest leaf length(83.62 cm) and the lowest leaf length (68.73 cm) was recorded as accession 198. The accession 203 recorded highest number of leaves(36.19nos) and accession 197 was recorded lowest number of leaves(27.47nos). Accession 206 recorded higher value for stalk length (77.33cm) whereas accession 202 recorded lower value for stalk length (42.57cm).

Performance of palmyrah germplasm collected during 2008

Among the 2008 planted accessions, the accession 209 has recorded maximum values in terms of plant height(116.45 cm), number of leaves(19.56), leaf length(107.28 cm) and stalk length(75.48 cm). Accession 212 recorded lowest plant height(101.84cm), lowest number of leaves (23.74nos) was recorded in accession 216 and accession 217 recorded lowest leaf length(56.45cm) and stalk length(43.77cm).

Performance of palmyrah germplasm collected during 2009

Much variation was observed among the accessions planted during 2009. Among the 2009 planted accessions, palm height (119.66 cm) and length of leaves (71.34cm) was highest with the accession 219. Lowest palm height (75.16cm) was recorded in accession 248 whereas lowest leaf length (55.66 cm) was recorded in accession 225. Highest number of leaves (33.11nos) were recorded in accession 226 and lowest number of leaves (26.98nos) in accession 224. Maximum stalk length (37.11cm) was recorded in accession 225 and lowest stalk length (33.42cm) was recorded in accession 223.

Performance of palmyrah germplasm collected during 2010

Among the accessions collected during the year 2010, accession 256 has recorded maximum palm height (113.92cm), and stalk length (67.77cm).Maximum number of leaves(32.54nos) was recorded in accession 257 and maximum leaf length (84.23cm) was recorded in accession 254. Minimum palm height (74.42cm) and number of leaves(25.78nos) was recorded in the accession 249. Minimum leaf length (55.64cm) was recorded in accession 255 and minimum stalk length (33.17) in accession 258 was recorded.

Performance of palmyrah germplasm collected during 2011

Among the germplasm collected during 2011, the accession 274 recorded maximum palm height (115.75 cm), leaf length (77.49 cm). The number of leaves (29.18nos) was highest in the accession 275.Maximum stalk length (51.42cm) was recorded in accession272 Minimum palm height(63.67cm) and minimum number of leaves (23.22nos) was recorded in the accession 263 . Minimum leaf length (54.20cm) was recorded in accession 264 and the minimum stalk length (29.46cm) was recorded in accession 275.

Performance of palmyrah germplasm collected during 2012

Among the germplasm collected during 201 (39.14cm).Maximum number of leaves (23.42nos) was recorded in accession 279 and maximum leaf length (61.32 cm) was recorded in accession 286. Minimum palm height (71.26cm) was recorded in the accession 282. Minimum number of leaves (21.32 nos) in accession 284, minimum leaf length (45.62cm) in accession 287 and minimum stalk length (35.84cm) in accession 279 was recorded.

Performance of palmyrah germplasm collected during 2013

Much variation was observed among the accessions planted during 2013 The accessions planted during 2013 showed maximum palm height (61.46 cm), and leaf length (45.26 cm) with accession 290. The maximum number of leaves (23.84nos) was recorded in accession 291.The maximum stalk length(34.65 cm) was recorded in the accession 289. Accession 288 recorded lower values for palm height (47.16cm).Minimum number of leaves (19.33 nos) were recorded in accession 295. Accession 289 recorded lowest leaf length (35.83cm). The

lowest stalk length (29.32cm) was recorded in accession number 293

Palmyrah germplasm fruit data collected in the year 2021

Tree planted in the year 1995, 1997 and 2001started flowering. In 1995 planted germplasm accessions the highest bunch weight (5.8kg), average number of fruits per bunch (6) was recorded with Acc. No. 02/95 followed by Acc.no.22/95 after 25 years of planting.

Among the 10 accessions of 1997 planted germplasm, Acc. No. 1/97 has recorded the highest bunch weight (9.2kg) where as maximum number of fruits per palm was recorded in ACC.no.25/97.

In 2001 year planted germplasm accessions flowering was observed only in few palms among them the highest bunch weight (8kg), fruit weight (560g) was recorded in Acc.72/01.This Accession is identified as bigger sized fruits among the all germplasm accessions.

Pandirimamidi

Survey and collection of palmyrah germplasm was done to identify dwarf and superior palmyrah genotypes for high neera and nungu yield. So far 272 number of Palmyrah germplasm accessions were collected and are being maintained as separate year wise germplasm blocks at Horticultural Research Station, Pandirimamidi. The germplasm accessions are being evaluated for various biometric, yield and yield related characters.

The data on biometrical observations as well as flowering and fruiting characters were recorded for all the germplasm accessions assembled.

Germplasm collected during the year 2020-21

In the year 2020-21 one accession was collected from the Burugupudi village of Korukondamandal, East Godavari district, Andhra Pradesh. The location details are latitude of N 17^0 7'14.79"and longitude of E $81^0$49'49.32". The data recorded are palm height of 9m, circumference 2m, spread in EW direction is 3.5m, and NS direction is 4.2.m, number of bunches per palm is 12. The average number of fruits per palm is 1000, and stones per palm recorded is 2500. In 1991 planted germplasm accessions the highest bunch weight (9kg), average number of fruits per palm (52) was recorded with Acc. No. 10/91 followed by Acc.no.5/91 after 30 years of planting.

Among the 10 accessions of 1993 planted germplasm, Acc. No. 2/93 has recorded the highest bunch weight (10kg) where as maximum number of fruits per palm was recorded in ACC.no.5/93. In 2000 year planted germplasm accessions flowering was observed only in few palms among them the highest bunch weight (14kg), fruit weight (1850g) was recorded in Acc.18/00.This Accession is identified as bigger sized fruits among all the germplasm accessions.

In the 2001 planted germplasm accessions, Acc. No. 43/01 has recorded the highest number of bunches (10), bunch weight (10kg), number of fruits per bunch (14).

Among the 2003 germplasm accessions, Acc.no.2/2003 observed four branched bunches with a highest bunch weight of 16kg, with 10 number of bunches, 26 number of fruits, followed by Acc no.4/2003. In 2004 planted germplasm, Acc.3/04 recorded the highest number of bunches (11) (three branches) fruit number (10).

4.4. Arecanut

Evaluation of varieties and establishment of mother blocks for production of quality planting material in arecanut

Shivamogga

Seven arecanut varieties viz., Mangala, Sumangala, Sreemangala, Mohitnagar, Swarnamangala, Madhuramangala and Sreewardhini were planted at Honnaville Station during 2015. Out of seven varieties evaluated for their growth characters variety, Mohitnagar showed a maximum plant height of 3.86 m (from ground level to base of the crown region) followed by Sumangala (3.82 mt). The maximum number of functional leaves (11.90) was recorded in Mohitnagar followed by Sumanagala and Swarnamangala (10.33). However other parameters like leaf length, leaf breadth, leaf sheath length and leaf sheath breadth varied among the varieties. The highest green nut yield was observed in Mangala (2.75 kg). **Wakawali**

The growth observations were recorded at five years of planting revealed that the plant height ranged from

86.9 to 155.3 cm with mean of 115.4 cm. It is revealed that the Mohitnagar variety recorded maximum plant height (155.33 cm) which was at par with Sumangala variety (133.0 cm). Mohitnagar recorded maximum number of leaves (7.9) followed by Sreemangala (7.8) and Madhuramangala (7.6) respectively.

Nucleus seed gardens for varieties

Goa

Nucleus seed garden of Hirehalli Dwarf was established in different phases and being maintained with currently 284 surviving palms of which 82 are available at reproductive stage. The vegetative characters recorded on 113 plants are given below which indicates the mean height of the plant from plant base to base of crown was only 1.35±0.03 m at 10 years of planting. The palms are in bearing stage and the yield during the current year varied from 0 to 54 nuts per palm per year.

Port Blair

In order to produce quality planting material of arecanut variety Samrudhi for distribution to the island farmers, a nucleus seed garden was developed during 2017 at the Garacharma farm of ICAR-CIARI, Port Blair. During this year, flower initiation was noticed in a palm, while all other palms are still in the juvenile phase. The mean trunk length of the palms was 161.7 cm while the mean palm height was 502.9 cm. Mean palm girth was 56.7 cm with an average of 10.2 leaves per palm.

Shivamogga

Hirehalli dwarf variety planted during August 2015 (Six year old as on 2021) showed a mean collar girth (55.2 cm), plant height (162 cm) and crown length(105 cm) with partially drooping type of crown shape. Apart from that, the plant has showed a mean collar girth (36.40 cm) and an internodal length of 5.25 cm. A total number of functional leaves (9.8), leaf length (115.0 cm), leaf breadth (42.2 cm), leaf sheath length (38.8cm), leaf sheath breadth (14.3 cm) and 68.50 numbers of leaflets per leaf were recorded. However, out of 38 palms survived only 3 plants started bearing inflorescence (at 55th month) producing a mean green nut yield of 0.5 kg.

Wakawali

Two arecanut varieties i.e. Hirehalli Dwarf and Shriwardhani were planted during 2015-16. The growth observations recorded after five years of planting showed that the Hirehalli Dwarf plants showed short stature with plant height ranging from 9.0 to 44.0 cm, the crown length ranged from 39.0 to 79.0 cm, and the girth of palm ranged from 33.0 to 55.0 cm. The number of leaves varied from 7.0 to 8.0, leaf length 39.00 to75.00 cm and leaf breadth 39.0 to 65.0 cm.

The plant height of Shriwardhani variety ranged from 129.0 to 167.0 cm, the crown length ranged from 120.0 to 163.0 cm and the girth of palm ranged from 46.0 to 61.0 cm. The number of leaves varied from 7.0 to 9.0, leaf length 72.0 to 112.0 cm and leaf breadth 65.0 to 89.0 cm.

Demonstration block of Shriwardhani variety of Arecanut

Centre: Wakawali

The experiment has been planted with Shriwardhani variety of arecanut as demonstration block in year 2015-16. The plant height of Shriwardhani variety ranged from 147.0 to 203.0 cm, the crown length ranged from 132.0 to 169.0 cm and the girth of palm ranged from 52.0 to 68.0 cm. The number of leaves varied from 7.0 to 10.0, leaf length 76.0 to 112.0 cm and leaf breadth 67.0 to 82.0 cm.

4.5. Cocoa

Cocoa/Gen.5: Evaluation of Cocoa clones/ Hybrids

Ambajipeta and Veppankulam Centres

Cocoa variety/ hybrid: 6; VTLC-1, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3 and VTLCH-4

Design: RBD; Replications: 4; No. of plants per treatment: 6

Spacing: Coconut: 7.5 m x 7.5 m; Cocoa: 3.0 m × 7.5 m;

Year of start: 2008-09 (Ambajipeta and Veppankulam);

Veppankulam

There are six cocoa verities/hybrids viz., T_1: VTLCC 1,T_2: VTLCH 1,T_3 : VTLCH 2, T_4 : VTLCH 3,T_5 :

VTLCH 4 , T_6 : VTLC 1 (control) were planted and the performance as intercrop in coconut gardens is being evaluated and reported. The trial was laid out in RBD with four réplications**.**

Among the cocoa clones and hybrids evaluated, the VTLCH 1 has performed well in terms of plant height (3.28 m), stem girth (38.22 cm), canopy spread East West (2.32 m) and North South direction (2.98m). VTLCH2 registreredshort plant (2.75 m), slender stem girth in CTLC1 (28.22 cm), canopy spread in East West and North South direction viz.,1.98 and 2.05 m.

Table .Observations on economic traits of cocoa

Clones/varieties	No. of pods/ tree	Single pod weight(g)	No. of beans/ pod	Single dry bean weight(g)	Drybean yield(kg/ tree)
VTLCC1	27.21	131.11	24.11	1.00	1.66
VTLCH1	33.22	142.34	31.21	1.97	1.81
VTLCH2	29.65	113.16	22.15	1.00	1.53
VTLCH3	27.56	99.87	22.28	0.94	1.38
VTLCH4	26.21	92.52	22.54	0.92	1.24
VTLC1	25.65	86.23	21.32	0.93	1.21
CD (5%)	3.89	5.22	1.56	0.20	0.58
CV (%)	9.90	20.05	15.37	9.39	16.19

Six clones/ hybrids evaluated for yield and quality of cocoa from 2008 at CRS, Veppankualm. The number of pods varied between 33.22 (VTLCH1) and 25.65 (VTLC1). The highest single pod weight was recorded in VTLCH1 (142.34g) and the lowest in VTLC1 (86.23g). The number of beans per pod ranged from 21 to 31. The dry bean weight was higher in VTLCH 1 (1.97g) which was significantly different from other types evaluated.

Ambajipeta

Six cocoa clones *viz.*, VTLCC – 1, VTLCH – 1, VTLCH – 2, VTLCH – 3, VTLCH – 4, VTLC – 1 (Control) were planted in November, 2008, in RBD with four replications and gap filling was done during December 2012 and are being evaluated for their performance. Data pertaining to growth characteristics like girth, height at first branching, and canopy spread for the year 2021 recorded no significant differences (Table 1.). Plant height and stem girth was recorded maximum in VTLCH-2 (314.70 cm and 42.71 cm respectively). With respect to yield for the year 2021, VTLCH-2 recorded significantly higher dry beans yield (2.13 kg/tree/year) and it was followed by VTLCH-4 (1.65 kg/tree/year). Further number of beans per pod was also highest in VTLCH-2 (45.60) on par with VTLCH-4 (42.10). VTLCH-1 recorded less no. of beans per pod (39.05) and VTLC-1 noted less dry bean yield 1.28 kg/tree/year. Single dry bean yield was recorded maximum in VTLCH – 2 (1.23 g) which was on part with VTLCH-4 (1.14 g)

Table 3 Performance of cocoa clones for growth parameters:

Treatments	Plant height (cm)	Girth (cm)	Height at 1st branching (cm)	Canopy spread		Canopy Area (m^2)
				E-W(cm)	N-S(cm)	
VTLCC – 1	282.29	37.48	73.48	377.44	363.51	16.64
VTLCH – 1	301.35	38.67	76.79	420.73	392.67	19.66
VTLCH – 2	314.70	42.71	79.35	396.69	392.20	19.29
VTLCH – 3	274.04	38.44	72.36	374.08	353.95	15.67
VTLCH – 4	299.41	39.28	62.97	379.08	361.86	17.60
VTLC-1	300.53	37.58	66.03	392.69	376.41	18.41
S Em ±	12.40	1.98	10.03	16.39	19.38	1.62
CD at 5%	NS	NS	NS	NS	NS	NS

Table 4: Performance of cocoa clones for yield characteristics

Treatments	Pod weight (g.)	No. of beans per pod	No. of pod per plant	Single dry bean weight(g.)	Dry bean yield/ tree/year(kg.)
VTLCC – 1	403.50	40.40	32.75	1.01	1.14
VTLCH – 1	411.25	39.05	37.83	1.05	1.36
VTLCH – 2	490.00	45.60	46.00	1.23	2.13
VTLCH – 3	412.50	40.44	35.58	1.07	1.31
VTLCH – 4	443.00	42.10	39.41	1.14	1.65
VTLC-1	324.25	39.88	38.58	0.96	1.28
S Em +	25.18	1.36	2.59	0.03	0.12
CD at 5%	75.90	4.11	7.82	0.10	0.36

Expt. 5: Multilocation trial (MLT) of cocoa clones under Palms

At Aliyarnagar centre, 13 numbers of cocoa clones/ hybrids (VTLCP 1, 3, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16)along with one check variety (VTLC-9) were established during 2013-14 ata spacing of 3.75 m × 7.50 m with two replications and six cocoa plants pergenotype. Observations recorded on vegetative characters showed significant differences across the parameters studied (Table 1). Between the genotypes,the maximum plant height (278.9cm), girth (37.5 cm), East-West canopy spread (3.0 m), North-South canopy spread(3.3 m), canopy area (12.9 m^2)and number of branches per plant (4.6) were recorded in VTLC-16. Whereas, the maximum jorquetting **h**eight (80.6 cm) was observed inVTLCP-11followed by VTLCP-8 (77.9 cm).

Data pertaining to the yield and yield component traits expressed significant variations across the parameters studied. Among the genotypes under evaluation, VTLCP-16 recorded maximum number of pods per tree (45.8), number of beans per pod (41.7), pod yield per plant (19.2 kg), single dry bean weight (1.4 g)and dry bean yieldper plant (2.1 kg). This was followed by by VTLCP-15 which has recorded 1.8 kg drybean yieldper plant. The genotype VTLCP-15 also recorded a single dry bean weight of 1.4 g, same as that of VTLCP-16.

Kahikuchi

The cocoa clones and hybrid collected from CPCRI, Regional Station, Vittal and planted on 02-10-2015 in RBD design with 2 replications in coconut garden. The observations on plant height, stem girth, jorquette height, spread and canopy area were recorded and presented in Table 11. The highest plant height (292 cm), girth (40.2 cm), plant spread (E-W and N-S) and canopy area (12.91 m^2) were recorded in VTLC-20 followed by VTLC -18 and the lowest values for the above characters were observed in EYT. Cocoa clone VTLC-20 also registered highest number of pods/tree (36.2), single pod weight (12.5 g), single dry bean weight (1.3 g), no. of bean/pod 35.6.) and dry bean yield/tree/year (1.67 kg) as against the lowest under YET.

V. Experimental Results in Crop Production

5.1. COCONUT

Studies on fertilizer application through micro-irrigation technique in coconut

Sabour

Experiment was laid out with six fertigation levels viz., T_1: No fertilizer; T_2: 25% Recommended dose of fertilizer (RDF) (NPK) through drip system; T_3: 50% RDF (NPK) through drip system; T_4: 75% RDF NPK through drip system; T_5: 100% RDF (NPK) through drip system; T_6: 100% RDF (NPK) through soil application replicated four times in coconut variety Shakhigopal. The recommended dose of fertilizer was 500:320:1200 g N:P:K per palm per year. The fertilizers were split into 8 parts for application through fertigation. Fertigation with different doses of fertilizers had significant influence on plant growth parameters like palm height, palm girth, number of functional leaves and leaf characteristics. Maximum palm height of 5.8 m was recorded with fertigation of 100% RDF (T_5) which was at par with 75% RDF (T_4) and 100% RDF NPK through soil application (T_6). Control registered lower palm height. Parameters like collar girth (220.0 cm), number of functional leaves (29.5 per palm) and annual leaf production (9.5 per palm) were highest in T_5 followed by T_4. Significantly lowest growth was recorded in T_1 (No fertigation) with minimum collar girth (159 cm), number of leaves (22.5 per palm) and annual leaf production (7.8 per palm) (Table 1). Palms under T_5 produced maximum number of inflorescence (8.8 per palm) which was at par withT_4. Minimum number of inflorescence was noted in control (T_1). Nut yield was maximum (48.0 nuts per palm per year) in T_5 and was on par with T_4 whilst minimum nut yield (30.0 nuts per palm per year) was recorded in control (Table 2).

Table 1. Effect of fertigation on growth of coconut palm at Sabour Centre

Treatments	Palm height (m)	Collar girth (cm)	No. of functional leaves per palm	Annual leaf production per palm (No.s)
T_1	4.95	159	22.5	7.8
T_2	4.77	185	23.5	7.8
T_3	5.60	193	25.0	8.4
T_4	5.81	208	28.0	9.2
T_5	5.98	220	29.5	9.5
T_6	5.72	198	29.4	9.2
C.D (p=0.05)	**0.61**	**9.87**	**1.03**	**NS**

Table 2. Effect of fertigation on flowering of coconut palm at Sabour Centre

Treatments	New inflorescence per palm (No.s)	Bunches / palm(No.s)	Fruits / bunch (No.s)	Nut yield per palm (No.s)	Leaves with winter injury (%)	Initiation of new inflorescence
T_1	5.8	5.0	7.0	30.0	21.0	May 2nd week
T_2	7.0	6.4	8.0	34.5	20.0	May1st week
T_3	8.0	7.0	8.2	41.5	17.0	April 4thweek
T_4	8.5	8.2	8.5	45.0	14.0	April 1st week
T_5	8.8	8.4	8.8	48.2	12.5	Mar 4th week
T_6	8.5	7.4	8.2	40.0	13.0	April 2nd week
C.D (p=0.05)	**1.9**	**1.1**	**0.6**	**5.10**		

Development of coconut based farming systems

Integration of goat in coconut based cropping system

Aliyarnagar

The experiment was initiated during 2015 to compare integrated farming system of coconut + food trees + pasture crops- Goat (Telicherry breed) with monocrop of coconut. Area for each treatment was 0.4 ha. Fodder grass viz.Cumbu Napier hybrid(Co BN5) and legume fodder *viz*. Desmanthus were sown in the interspaces of coconut, while fodder trees *viz.Sesbania grandiflora*, *Leucaena leucocephala* and *Glyricidia* were planted along the bunds. Annual leaf production, total number of leaves and total number of inflorescence per palm were higher in IFS (T_1) plots compared to monocrop of coconut (Table 3). Total of 18360 nuts/ha/year and 28,400 kgs of fodder were realized from one ha of coconut (Table 4). A total of 15 numbers of lamb were laid by the goats, the droppings collected periodically and were applied to coconut and intercrops. Integration of coconut with pasture crops (Cumbu Napier hybrid + Desmanthus), fodder trees (*Sesbania grandiflora* + *Leucaena leucocephala* + Glyricidia) and Telicherry breed of goats recorded net income of Rs. 2,90,175 per ha as compared to Rs. 1,29,700 per ha in monocropping. Nutrient contribution and chemical fertilizer equivalent of goat manure is presented in Table 5.

Nutrient monitoring was done employing NUTMON Tool box. Under coconut monocropping and cropping system – I with balanced fertilization (application of N, P and K), there was positive balance for P and K and negative balance for nitrogen whilst in cropping system – II with imbalanced fertilization, there was negative balance for N, P and K (Table 6). Green House Gas (GHG) Emission was estimated in Integrated Farming System trial employing IFS – GHG Estimation Tool obtained from Project Directorate of Cropping Systems Research, Modipuram. GHG emission from Integrated Farming System was negative and hence it is environmentally safe (Table 7).

Table 3. Growth and yield of coconut on integration of goat in coconut based cropping system at Aliyarnagar Centre

Sl.No	Parameter	Pre-expt. period	Experimental period	
		2015-16	2021-22	
			IFS (T_1)	Monocrop (T_2)
1	Annual leaf production	12.0	12.0	11.0
2	Total leaves (Nos.)	34.9	35.0	34.4
3	Total Inflorescence (Nos.)	10.5	12.0	11.0
4	Mean Nut yield(Nut/Palm/Year)	130	150	138

Table 4. Output from the Coconut based Integrated Farming System with goat at Aliyarnagar Centre

Output (ha)	2021-22	Remarks	Gross Returns (Rs./ha)	Net Returns (Rs./ha)
IFS (T_1)				
Coconut nut yield (nos.)	18360	Avg.sale price @ Rs. 12/ nut	220320	-
Pasture production (kgs)	28400	Grazed by goats	--	-
Goat manure (kgs)	12000	Manure applied in coconut basins.	84000	-
Lamb production		Weight of 220 kgs		
(Does - 10, Bucks -5)	15 No.s	(Rs.270/Kg)	59400	-
		Total	**363720**	**290175**
Monocrop (T_2)				
Coconut nut yield (nos.)	16100	Avg.sale price @ Rs. 12/ nut	**193200**	**129700**
		Additional Income		**160475**

Table 5. Nutrient value of goat manure and equivalent cost of chemical fertilizers at Aliyarnagar Centre

Nutrient	Content (%)	Contribution from 12000 kgs	Chemical fertilizer equivalent	Price equivalent (Rs.)
Nitrogen	2.50	300	652 kg of urea	4043
Phosphorus	0.53	63.6	398 kg of SSP	3582
Potassium	1.10	132	220 kg of MOP	7920

Table 6. Nutrient monitoring employing NUTMON Tool box at Aliyarnagar Centre

	N	P	K
	(kg per ha per year)		
Monocrop	- 13.4	+ 3.4	+ 6.4
Cropping System – I (Balanced Fertilization)	- 16.4	+ 2.6	+ 2.4
Cropping System – II (Imbalanced Fertilization)	- 54.2	- 0.6	- 114.9

Table 7. Green House Gas Emission from Integrated Farming System at Aliyarnagar Centre

	Enterprises	CO_2-e(kg)
Carbon Source	Coconut	267.7
	Fodder crops	433.4
	Goatery	2393.16
	Border plantation and agroforestry	5
	Energy for household	0
Carbon Sink	Agro-Forestry- SINK	0
	Total Biomass/compost added - SINK	21146.2
	Total SOURCE	**3270.9**
	Total SINK	**21146.2**
	GHG-IFS	**-17875.3**

Veppankulam

The experiment was initiated during 2016 in which fodder crops were raised in irrigated condition using sprinkler and irrigated as and when required. The goat manures are used as additional nutrients to the coconut palms and fodder crop. The nut yield recorded in IFS model (T_1) was 14,875 nuts/ha/year and in monocrop (T_2) it yielded 12,950 nuts/ha/year. Hence, yield increase of 11.5 % was observed in IFS plots as compared to monocrop of coconut (Table 8). There exists difference between IFS treatment and monocrop with respect to functional leaves per palm. The number of inflorescence showed an increase of 10.9 % in IFS plot as compared to monocrop of coconut. During the period, 10 new lambs were laid. Totally 14 goats were sold with a live weight of 342 kg. The pasture production was 3850 kg/year and this was fed to the goats. A total of 11,320 kg /year of pasture production were realized from *Sesbania grandiflora* and *Leucaenea leucocephala* and Glyricidia and 4230 kg of goat manure were collected and was applied to the IFS plots.

Table 8. Growth, nut yield and output production of coconut on integration of goats in coconut based cropping system at Veppankulam Centre

Parameters	IFS model plot (T_1)	Coconut monocrop (T_2)
No. of functional leaves / palm	32.5	30.4
No. of inflorescences / palm	12.1	11.7
Mean nut yield (nos. / palm/ year)	85.0	74.0
Coconut nut yield (nos./ ha/year)	14875	12950
Pasture production (kg)	11320	-
Goat manure (kg)	4230	-
No. of new born lambs	10	-
No. of goats sold	14(342.0 kg live weight)	-

As regards the economics, the total cost of cultivation of IFS plots was Rs. 1,50,480/ha and the gross income and net income were Rs. 2,91,360/ha/ year and 1,40,880/ha/year respectively. However, in monocrop of coconut the gross income and net income were Rs.155,400/ ha / year and Rs. 45,050 / ha / year respectively. Thus the B:C ratio of IFS is 2.64 and that of monocrop of coconut is 1.40 (Table 9).

Table 9. Economics of coconut based integrated farming system with goat at Veppankulam Centre

Treatment	Quantity	Gross income	Cost of cultivation (Rs.)	Net income (Rs.)	Remarks
IFS (T_1)					
Nut yield (Nos. per ha)	14,875	1,78,500	1,10,350	68,150	Average sale price of Rs.12 per nut
Pasture production (kg)	11,320				Used as feed to the goat reared in IFS
Goat manure (kg)	4,230				Used for coconut as organic addition
Goat sale	14 Nos (342 kg)	1,12,860			Sale price of goat @ Rs. 330/kg of live weight
Goat feed and maintenance			40,130	72,730	
Total		**2,91,360**	**1,50,480**	**1,40,880**	
Monocrop (T_2)					
Nut yield (Nos. per ha)	12,950	**1,55,400**	**1,10,350**	**45,050**	Average sale price of Rs.12 per nut

Coconut based cropping systems for different agro-climatic region

Evaluation of coconut based cropping system models

Port Blair

Black pepper vines of eleven improved varieties/ hybrids (Panniyur 1, Panniyur 2, Panniyur 5, Panniyur 6, IISR- Girimunda, IISR- Malabar Excel, Panchami, IISR- Sakthi, Sreekara, Subhakara and IISR-Thevum) were planted with glyricidia as support at 2 m × 2 m in the interspaces of coconut. Analysis of data after two years of planting revealed that there were no significant differences among the tested genotypes for plant height (211.8 to 531.6 cm), collar thickness (4.5 to 7.7 mm), number of primary branches per vine (1.4 to 4.7) and number of leaves per vine (69.4 to 261.0) .

Coconut based multispecies cropping systems under coastal littoral sandy soil

Centres: Bhubaneswar, Kasaragod and Ratnagiri

Experimental details:

Treatment	Kasaragod	Bhubaneswar	Ratnagiri
Main plot (Cropping systems)	**CS_1:** Coconut + sapota + Vegetable Crops	**CS_1:** Coconut + sapota + Vegetable Crops (Rainy season)	**CS_1:** Coconut + *Garcinia indica* + Vegetable Crops (Rainy season)
	CS_2: Coconut + sapota + flower crops	**CS_2:** Coconut + sapota+ Pineapple	**CS_2:** Coconut + *Garcinia indica* + Pineapple
	CS_3: Coconut + sapota + fodder crops	**CS_3:** Monocrop of coconut	**CS_3:** Monocrop of coconut
	CS_4: Monocrop of coconut		
Sub plot (Nutrient management practices)	**N_1:** Green manuring + bio-fertilizers + organic recycling + FYM		
	N_2: Green manuring + bio-fertilizers + organic recycling + soil test based fertilizers application		
	N_3: Green manuring + bio-fertilizers + organic recycling + 100% RDF		

Bhubaneswar

The experiment was initiated during January 2016 in littoral sandy soil at Coconut Research Station, Konark. There was significant variation among the palms under different nutrient management practices. Maximum number of inflorescence (11.77/palm/year), female flowers (224.32/palm/year) and nuts (70.83/palm/year) was recorded in the treatment N_2 (Green manuring + biofertilizers + organic recycling + soil test based nutrient (chemical fertilizers) application. The interaction effect of cropping system and nutrient management was significant only for number of female flowers and numbers of nuts **(**Table 10) wherein maximum number of female flowers (219.08/palm/year) and maximum number of nuts (75.59/palm/year) were observed in CS_2N_2, followed by CS_2N_3 (71.75 nuts/palm/year). Sapota plants in the cropping systems started yielding since 2 years and the maximum yield (403.72 kg/ha) was obtained in the treatment CS_2N_2 (Table 11). Yield of pineapple (9094 kg/ha) and cowpea (4810 kg/ha) was maximum in plots receiving soil test based NPK (N_2) **.** Maximum net returns (Rs.4,39,951.00/ha) was obtained from the treatment CS_2N_2 whereas, lowest profit of Rs. 52,320.00 was obtained from sole cropping system with organic manure application (CS_3N_1)**.**

Table 10. Growth and yield of palms in the cropping system in littoral sandy soil at Bhubaneswar Centre

Treatment	Number of leaves/palm	Number of leaves/palm/ year	Number of inflorescence/ palm/yr	Number of female flowers / palm/year	Number of nuts/palm/yr
CS_1	39.43	11.83	11.22	211.19	62.70
CS_2	39.40	11.73	11.22	204.09	68.18
CS_3	38.52	11.67	11.24	202.94	59.64
CD (p=0.05)	**NS**	**NS**	**NS**	**1.80**	**2.19**
N_1	38.24	11.37	10.62	185.95	54.32
N_2	39.57	12.09	11.77	224.32	70.83
N_3	39.54	11.77	11.30	207.94	65.38
CD (p=0.05)	**0.91**	**0.27**	**0.22**	**16.7**	**2.34**
CS_1N_1	38.39	11.28	10.45	178.06	54.56
CS_1N_2	40.22	12.22	11.89	237.05	69.67
CS_1N_3	39.67	12.00	11.33	218.45	63.89
CS_2N_1	38.40	11.53	10.57	192.47	57.21
CS_2N_2	39.33	11.93	11.70	219.08	75.59
CS_2N_3	40.46	11.72	11.40	200.72	71.75
CS_3N_1	37.92	11.30	10.83	187.32	51.20
CS_3N_2	39.17	12.11	11.72	216.83	67.22
CS_3N_3	38.48	11.61	11.16	204.67	60.50
CD (p=0.05)	**NS**	**NS**	**NS**	**3.86**	**3.45**

Table 11. Growth parameters of sapota in the cropping system at Bhubaneswar Centre

Treatment	Plant height (m)	Plant girth(cm)	Plant spread (sq. m)		Yield(kg/ plant)	Yield (kg/ ha)
			E-W	E-W		
CS_1N_1	4.10	30.12	2.86	3.18	4.50	266.62
CS_1N_2	4.50	33.85	3.85	3.47	6.45	381.30
CS_1N_3	4.35	33.56	3.45	3.52	5.88	348.39
CS_2N_1	4.25	34.38	3.68	3.05	5.15	305.13
CS_2N_2	4.90	36.40	3.20	3.35	6.80	**403.72**
CS_2N_3	4.70	32.95	3.40	3.24	5.60	331.79

Kasaragod

In coastal littoral sandy soil, coconut + sapota (Var. DHS 2) intercropping under integrated nutrient management performed well i.e application of green manuring + biofertilizers + organic recycling + FYM@10 t/ha + 150 % RDF resulted in significantly higher sapota fruit yield of 47 kg per tree (7332 kg/ ha), nut yield (101 nuts/palm) and copra weight (173 g/copra). Coconut + sapota intercropping under green manuring + biofertilizers + organic recycling + FYM@10 t/ha + 150 % RDF resulted in higher net returns of Rs.198225/- per ha which is four times higher than the monocropping of coconut (49,098/- per ha)

Ratnagiri

Planting of Kokum has been done as per the treatment schedule. Initial soil nutrient status is presented in Table 12 and that during 2021-22 in Table 13. The number of functional leaves and number of female flowers per palm did not differ significantly with treatments. However, significantly highest yield of 17412 nuts per ha was recorded in CS_1N_2. Maximum vegetable yield was recorded in CS_1N_3, maximum pineapple yield and the height of *Garcinia indica* in CS_2N_3. The highest B: C ratio (2.28) was obtained in CS_2N_3 where Coconut + *Garcinia indica* + Pineapple together with green manuring, biofertiliers, organic recycling and 100% RDF is practiced .

Table 12. Initial soil fertility status and leaf nutrient content at Ratnagiri Centre

Parameter	Soil nutrient status (kg/ha)			Leaf nutrient (%)(Before planting of intercrop)
	0-25 cm	25- 50 cm	50-100 cm	
Available N	257	213	182	1.65
Available P_2O_5	17.6	13.8	11.8	0.11
Available K_2O	218.4	215.6	211.6	0.8

Table 13. Soil fertility status and leaf nutrient content in coconut orchard (2021-22) at Ratnagiri Centre

Parameter	Soil nutrient status (kg/ha)			Leaf nutrient (%)
	0-25 cm	25- 50 cm	50-100 cm	
Available N	264.0	217.3	187.3	1.89
Available P_2O_5	18.7	16.0	14.8	0.09
Available K_2O	224.8	2176.6	222.4	1.09

Soil and nutrient management in coconut

Organic farming in coconut based farming system

Centres: Aliyarnagar, Ambajipeta, Arsikere and Kasaragod

Experimental Details

Experiment was laid out in Randomized Block Design comprising of five treatments (Sole organic manure treatments -2, Sole chemical fertilization – 1, Integrated options -2), each treatment replicated five times with six palms per treatment. A trench of 15m length and 1.3m (4 feet) width was excavated amidst six coconut palms for the treatments $T_1 – T_4$. PGPR consortia, organic manure, husk burial and 50% recommended K_2O (600 g K_2O) as sulphate of potash were applied as per the treatments. Sunhemp seeds were sown @ 40 kg /ha in the interspaces of the coconut palms in the treatments T_1 to T_4 and was incorporated insitu at 45 days after sowing.

Aliyarnagar

Biomass addition across different treatments varied from 22750 to 23150 kg per ha (Table 14). Although the differential effect of treatments did not bring noteworthy impact on height of the palm, palm girth and number of leaves per palm registered significant variation, with T_4 superior over the rest of the treatments. Highest nut yield was realized in T_4 with 172 nuts per palm per year and the lowest was witnessed in T_1 (Table 15). Although soil reaction and electrical conductivity did not vary among the treatments, available status of macronutrients was higher in T_4 and lower in T_5. Treatments receiving sole application of organic manures (T_1 and T_2) paved way for enhancing the soil organic carbon pool compared to the rest of the treatments (Table 16). Physical properties *viz*., porosity and soil moisture content enhanced on addition of organic manures compared to sole chemical fertilization (Table 17).

Table14. Differential effect of treatments on the biomass and nutrient addition at Aliyarnagar Centre

Treatments	Total biomass (kg per ha)	N	P	K
		(kg per ha)		
T_1 - In situ organic matter recycling + PGPR consortia + In situ green manuring + Husk burial	23770	175 - 200	46 - 60	132 - 160
T_2 - T_1 + 25 kg cow dung	28145	175 - 200	46 - 60	132 - 160
T_3 - T_1 + 50% recommended K_2O through the application of Sulphate of potash	23970	175 - 200	46 - 60	132 – 160
T_4 - T_2 + 50% recommended K_2O through the application of Sulphate of potash	28345	175 - 200	46 - 60	132 – 160
T_5 - Conventional method (Chemical fertilizer application)	-	150-175	56 - 60	200-250

Table 15. Differential effect of treatments on the growth and yield of coconut at Aliyarnagar

Treatments	Palm height (m)		Palm girth (cm)		Leaves (No.s/ palm)		Nut yield(No.s/ palm/year)	
	2014 - 15	2021-22	2014-15	2021-22	2014-15	2021-22	2014-15	2021-22
T_1 - In situ organic matter recycling + PGPR consortia + In situ green manuring + Husk burial	13.4	19.8	85.1	104	34	30	157	138
T_2 - T_1 + 25 kg cow dung	14.7	19.9	86.0	104	33	32	145	140
T_3 - T_1 + 50% recommended K_2O through the application of Sulphate of potash	15.4	19.9	85.3	116	38	41	160	164
T4 - T_2 + 50% recommended K_2O through the application of Sulphate of potash	13.2	20.0	88.2	120	35	43	148	172
T5 - Conventional method (Chemical fertilizer application)	13.1	20.0	82.2	120	36	38	149	150
S.Ed	**0.48**	**0.58**	**5.42**	**6.32**	**1.11**	**1.74**	**12.4**	**5.48**
CD (p=0.05)	**NS**	**NS**	**NS**	**10.1**	**NS**	**4.26**	**NS**	**11.8**

Table 16. Influence of Organic Farming on soil fertility parameters at Aliyarnagar

Treatments	pH	EC (dSm^{-1})	$KMnO_4$ N	Olsen P	$1NNH_4OAc$ K	Organic C ($g\ kg^{-1}$)
			(ppm)			
T_1 - In situ organic matter recycling + PGPR consortia + In situ green manuring + Husk burial	7.24	0.54	124.2	5.71	80.8	0.41
T_2 - T_1 + 25 kg cow dung	7.18	0.58	128.4	6.32	91.4	0.44
T_3 - T_1 + 50% recommended K_2O through the application of sulphate of potash	7.32	0.62	132.6	6.28	96.8	0.34
T_4 - T_2 + 50% recommended K_2O through the application of sulphate of potash	7.28	0.60	136.4	6.41	100.5	0.38
T_5 - Conventional method (Chemical fertilizer application)	7.14	0.58	120.8	5.86	95.4	0.28
S.Ed	**0.067**	**0.072**	**4.38**	**0.184**	**2.64**	**0.031**
CD (p=0.05)	**NS**	**NS**	**10.2**	**NS**	**5.48**	**0.142**

Table 17. Influence of Organic Farming on soil physical properties at Aliyarnagar

Treatments	Bulk Density	Particle Density	Porosity	Soil moisture content
	Mg m^{-3}		(%)	
T_1 - In situ organic matter recycling + PGPR consortia + In situ green manuring + Husk burial	1.24	2.32	46.6	38.4
T_2 - T_1 + 25 kg cow dung	1.18	2.32	49.1	39.6
T_3 - T_1 + 50% recommended K_2O through the application of sulphate of potash	1.36	2.46	44.7	37.4
T_4 - T_2 + 50% recommended K_2O through the application of sulphate of potash	1.41	2.42	41.7	38.6
T_5 - Conventional method (Chemical fertilizer application)	1.62	2.64	38.6	36.2
S.Ed	**0.634**	**0.543**	**0.686**	**0.724**
CD (p=0.05)	**NS**	**NS**	**3.86**	**1.32**

Ambajipeta

The trial was initiated during 2015 in 30 years old East Coast Tall coconut variety in RBD with four replications. Cocoa cv. Forestero and banana (cv. Tellachakkerakeli) were planted as intercrops. The growth and yield parameters of coconut are presented in Tables 18 and 19.

Table 18. Influence of treatments on growth and yield of coconut at Ambajipeta Centre

Treatments	Palm Height (m)	Palm Girth (m)	Annual leaf production (No.s per palm)	No. of functional leaves / palm	No. of bunches/ palm	No. of buttons/ inflorescence	No. of Nuts/palm/ year
T_1	10.67	0.96	12. 79	29.08	9.07	14.19	60.69
T_2	12.19	0.97	12. 69	31.62	10.50	17.00	72.02
T_3	11.30	0.90	12.64	30.33	10.01	14.37	62.40
T_4	12.28	0.93	12.24	31.37	10.34	18.44	76.72
T_5	12.52	0.96	12.36	30.37	10.56	17.92	76.71
SEm±	**0.37**	**0.02**	**0.07**	**1.11**	**0.28**	**0.47**	**4.14**
CD (p=0.05)	**1.14**	**NS**	**NS**	**NS**	**0.85**	**1.44**	**12.77**

Table 19. Influence of treatments on yield of coconut per palm at Ambajipeta Centre

Treatments	Coconut Yield 2018-19 (No.s)	Coconut Yield 2019-20 (No.s)	Coconut yield 2020-21(No.s)	Coconut yield 2021-22(No.s)	Coconut yield 2022-23(No.s)	Cumulative nut yield	Pooled mean yield(2015-22) (No.s per palm)
T_1	121.15	115.98	81.46	62.12	60.69	802	100.21
T_2	120.25	113.50	87.61	75.44	72.02	838	104.77
T_3	116.50	117.98	83.00	60.62	62.40	795	99.40
T_4	127.25	121.43	92.16	79.50	76.71	874	109.21
T_5	121.25	124.19	105.35	75.27	76.72	898	112.21
SEm±	**1.87**	**1.35**	**3.38**	**4.74**	**4.14**	**—**	**—**
CD (p=0.05)	**5.75**	**4.17**	**10.42**	**14.61**	**12.77**	**—**	**—**

With respect to coconut, no significant differences were noticed for palm girth, number of functional leaves/palm and annual leaf production. Maximum palm height was recorded in T_5 -12.52 m. Maximum number of inflorescence /palm/year was recorded in T_5 (10.56) which was on par with all other treatments except T_1 (9.07). The treatment T_4 recorded significantly highest yield (76.72 nuts/palm/year) which was on par with $T_5$76.71 nuts/palm/year and $T_2$72.02 nuts/palm/year. Further, the pooled mean nut yield from 2015 to 2022 revealed that T_5 and T_4 had a high nut yield of 112 and 109 nuts/palm/year, respectively.

Differential effect of treatments did not exert their influence on cocoa with regard to plant height, girth, height at 1st branching and number of beans per pod. The treatment T_4 had higher number of beans per pod (24.69). Further, the dry bean yield was higher in T_4 with 0.78 kg which was at par with T_5 (0.73 kg). No. of pods per plant was maximum in T_4 (20.23) which was on par with all other treatments except T_3 (16.94). Bunch yield was maximum in T_5 with 7 kg **.** Differential effect of treatments on soil fertility status is presented in Table 20**.**

Table 20.Influence of treatments on soil nutrient status at Ambajipeta Centre

Treatments	N (ppm)	P (ppm)	K (ppm)	OC %
T_1	80.54	6.92	44.19	0.64
T_2	78.82	7.39	64.06	0.62
T_3	78.64	7.86	43.43	0.67
T_4	86.31	8.10	67.17	0.82
T_5	110.47	9.70	143.74	0.6
S Em ±	**3.29**	**0.51**	**5.62**	**0.34**
CD (p=0.05)	**10.12**	**1.58**	**17.30**	**NS**

Kasaragod

Experiment on cultivation of coconut under organic nutrient management practices revealed that the treatment T_4 -In situ organic matter (frond, leaf, inflorescence waste, husk) recycling in trenches made in the interspaces of 6 coconut palms (15 m length, 1.2 m width and 60 cm depth) + *insitu* green manuring in the basin + PGPR consortia in the basin + cowdung + 50% recommended K_2O using sulphate of potash recorded higher yield of 102.4 nuts/palm/year with 174 g of copra weight/nut over other treatments. Perusal of cocoa yield and yield

parameters when intercropped in coconut revealed that the treatment T_4 recorded significantly higher pod wt (360g), single bean weight (1.08g) and dry bean yield (893 kg/ha). Economic analysis of the system revealed that treatment T_4 recorded higher net returns of Rs. 2,05,848/- /per ha (on matured nut basis) and Rs. 2,92,878/-/ ha (on copra yield basis) over other treatments.

Management of root (wilt) disease in coconut (farmer's garden)

Package of practices proposed based on the soil test results

- Addition of organic manure @ 25 kg per palm.
- Application of *Trichoderma sp.* @ 50 g/ palm.
- Sowing daincha seeds in coconut basin @ 100 g/ palm and incorporation before flowering.
- Application of urea – 1.0 kg , SSP – 2.0 kg and MOP – 3.0 kg
- Addition of 50 g zinc sulphate per palm
- Application of $MgSO_4$ @ 1 kg per palm
- Excavation of trenches and providing subsurface drainage.

Management practices as per the package were continued in root (wilt) affected gardens at Manakkadavu village of Coimbatore district. The pH of samples was alkaline, organic carbon content was low and DTPA Zn was deficient. Based on the soil nutrient status, the above-mentioned package was developed and treatments were imposed during 2017. Disease assessment was done based on the disease grades assigned to flaccidity, yellowing and necrosis symptom in the second or third spiral as per the score chart.

Disease intensity (DI) is calculated based on the following formula

$$DI = \frac{5\ (F+Y+N)\ X\ 10}{L}$$

where F, Y and N are the grade points assigned to flaccidity (0-5), yellowing (0-3) and necrosis (0-2) and L is the total number of leaves.

Regular agronomical management practices reduced the average root wilt disease index from 15.86 (2015-16) to 5.64 (2021-22) in Coimbatore district. Nut yield in demonstration plot was maintained (82 nuts /palm /year) in Manakkadavu village compared to the pre-experimental period. However the yield obtained was not consistent over a period of time and the intensity of disease reduction did not sustain over long run appreciably (Table 21).

Table 21. Root wilt disease index in Manakkadavu village, Coimbatore Dist.

Particulars	Demonstration plot	
	2015-16	2021-22
	Pre treatment	Post treatment
Range of disease index	4 to 44	0-40
Average disease index*	15.86	5.64
Nut yield	80	82

5.2. OIL PALM

Demonstration on oil palm production potential in North East Region

The 29 oil palm seedlings planted in the year 2006 is being taken up as the material for this "maximization plot and all the recommended crop management practices are being adopted to harvest maximum yield. The average plant height, collar girth and number of leaves produced per palm per year recorded during 2020 as per the suggestion received from DOPR Pedavegi is 4.35 m , 2.82m and 23.1 leaves per palm respectively.

Flowering and fruiting in all the palms have been observed to be satisfactory over the years. The number of FFB produced per palm was 9.30 with an average bunch weight of 18.10 kg and the yield was recorded to be 24.07 t/ha.

Bavikere

Plant Geometry and Optimization of nutrients in Oil palm:

Nutrient optimization in oil palm studies began in 2019 at Bavikere center using a Factorial RBD design. The grading of NPK levels as 0, 1 and 2; N_1-1200g, N_2-2400g, P_1-600g, P_2-1200g, K_1-1800g and K_2-3600 g. The study is still in its early stages, but two years of data showed no significant changes in palm height and girth across the treatments.

Plant geometry studies in oil palm:

Plant geometry in Oil palm studies initiated during 2019 at Bavikere center with four spacing viz., M1: 9m x 9m x 9m (Triangular planting); M2: 9m x 9m (Square planting);M3: 10m x 10m x 10m (Triangular planting) and M4: 10m x 10m (Square planting) in RBD design with five replications. The experiment is in initial stage and there are no significant differences among the treatments.

Arecanut

Intercropping in juvenile Arecanut garden

The data recorded for growth performance after thirty six months of planting is presented. It is indicated that the plant height ranged from 94.2 to 262.2 cm with mean of 189.36 cm. The treatment T_1 was found maximum plant height (262.2cm) which was significantly superior over the all other treatments. The Girth of plant ranged from 17.1 to 27.3cm with mean of 22.26 cm. The treatment T_1 was found maximum Girth (27.3 cm) which was significantly superior over the all other treatments. The branches of the plant ranged 11.5-15.2 with mean of 13.33. The treatment T_2 was found maximum number of branches (15.2) which was significantly superior over the all other treatments.

VI. Experimental Results in Crop Protection

Disease management in coconut

Basal stem rot disease

Characterization of *Ganoderma* spp. associated with basal stem rot disease of Coconut

Ambajipet

Two isolate of *Ganoderma* sp.were isolated from the samples collected during the survey and the morphological and cultural characters were documented. The radial growth of isolates was around 90mm in 8 days. The colony characters found as white in colour and leathery in texture (table 1).

Table 1. Morphological and cultural variations of Ganoderma isolates collected during the survey conducted in 2021

Morphological and cultural variations of Ganoderma isolates						
Place	Source	Mycelial growth (mm)				Colony characters
		2 DAI	4 DAI	6 DAI	8 DAI	
Shankaraguptam	Root	4.67	28.00	68.00	89.67	White leathery
Vijairai	Root	4.58	29.35	67.95	90.00	White leathery

Arsikere

The roots samples from *Ganoderma* infected coconut palms were collected during roving survey. The isolation of pathogen from these samples was done under laboratory using PDA medium. The total of five isolates (G45, G46, G47, G48 and G49) were isolated from the samples of Kadur, Badravathi, Arsikere, Gubbi and Pandavapura region. The variations with respect to morphological and cultural characters were documented. The radial growth of isolates was around 90.00 mm in 9 days in almost all isolates and statistically there was no difference among the isolates with respect to growth (table 2). The colony characters of all isolates were white in colour with cottony growth.

Table 2. Morphological and cultural variations of *Ganoderma* isolates

Ganoderma Isolate	Isolate Code	Part of collection	Mycelial growth (mm) of *Ganoderma*				Morphological character
			3 DAI	5 DAI	7 DAI	9 DAI	
Kadur	G 45	Sporophore	9.00	52.00	83.00	90.00	White cottony growth
Badrvathi	G 46	Sporophore	9.00	58.00	84.00	90.00	White cottony growth
Arsikere	G 47	Sporophore	8.00	54.00	85.00	90.00	White cottony growth
Gubbi	G 48	Sporophore	8.00	55.00	87.00	90.00	White cottony growth
Pandavapura	G 49	porophore	8.00	54.00	82.00	90.00	White cottony growth
CD (P=0.01)			NS	NS	NS	NS	

*Mean of four replications DAI- Days After Inoculation

Veppankulam

Two isolates of *Ganoderma* were isolated from the sporophores collected from Coconut Research Station (CRS),Veppankulam (VPM) and morphological studies were studied during 2022. *In vitro* mycelial growth of the fungus was obtained at 3,5,7 and 9 days after inoculation in the PDA medium at room temperature and the colony characters were studied (Table 3).The results revealed that *Ganoderma* isolate.-CRS (VPM) 4

showed maximum radial growth 9 days after inoculation followed by *Ganoderma* isolate CRS-5. Two *Ganoderma* isolates were showed white cottony growth.

Table 3. Measurement of radial growth of *Ganoderma spp*. in different days after inoculation under Potato Dextrose Agar medium at room temperature and observation of colony characters

S.No	Particulars	New Isolates *Ganoderma spp.*	
1	**Designated Code of Isolate**	CRS (VPM) 4	CRS(VPM) 5
2	**Location/Place**	CRS, Veppankulam	CRS, Veppankulam
3	**Crop**	Coconut	Coconut
4	**Source**	Sporophore	Sporophore
5	**Colony Characters**	White cottony	White cottony
6	**Mycelial growth at different DAI**	***Mean radial growth of mycelium (cm)**	
	3DAI	1.80	3.80
	5DAI	2.60	5.30
	7DAI	4.80	7.60
	9DAI	6.40	9.00
	CD@5%	**NS**	**NS**

DAI-Days After Inoculation

Management of coconut basal stem rot disease through biological control agents

Ambajipet

Effective bacterial endophytes were isolated from healthy coconut plant materials and one among them fond effective against Ganoderma, and the enophyte isolate was kept for dual culture studies against different *Ganoderma*. Among all the endophtes tested EP4 isolate showed 51.11 per cent inhibition remaining all isolates showed 90 mm growth after 8 days after inoculation. The effective endophyte was sequenced on outsourcing basis and identified it as *Bacillus amyloliquefaciens* .

Field experiment: The bacterial bioagent named *Bacillus amyloliquefaciens* was found to be promising in arresting the growth of *Ganoderma sp*. under in vitro conditions. The same isolate was taken to field conditions to test field efficacy of *Bacillus amyloliquefaciens* against Basal stem rot disease in coconut. The talc based formulation was applied in soil along with FYM 50 Kg, where as bacterial broth was fed through roots and root feeding of Hexaconazole was used as standard check.

Table 4. Influence of bacterial bio-agents on Basal stem rot disease of coconut :

Treatments	Disease index											reduction Over initial
	Beforetreatment	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	24 MAT	27 MAT	30 MAT	
T_1	38.48 (38.28)	38.48 (38.28)	38.09 (38.05)	38.48 (38.28)	36.77 (31.07)	35.22 (36.40)	33.15 (35.15)	32.48 (28.81)	30.50 (29.20)	30.01 (33.12)	29.54 (32.84)	23.33
T_2	34.69 (35.68)	34.69 (35.68)	34.69 (35.68)	33.26 (34.83)	30.21 (27.84)	27.73 (31.78)	27.52 (31.64)	27.24 (31.47)	27.86 (31.21)	27.20 (31.22)	27.01 (31.10)	22.12
T_3	41.46 (39.88)	42.25 (40.39)	42.25 (40.37)	42.25 (40.39)	39.43 (32.19)	34.76 (36.13)	29.35 (28.36)	27.15 (25.77)	26.29 (25.53)	25.29 (30.04)	25.29 (30.04)	39.00
T_4– Control	52.37 (49.57)	53.54 (50.25)	54.25 (50.07)	54.32 (50.66)	55.43 (40.03)	55.78 (48.32)	57.53 (41.04)	59.24 (42.60)	61.32 (42.91)	61.32 (51.55)	61.32 (51.55)	0
S.Em±	6.14	6.01	5.75	5.60	1.19	1.20	1.45	1.96	1.93	1.72	1.67	
CD (P= 0.05)	NS	NS	17.73	17.27	3.59	3.63	4.39	5.92	5.84	5.23	5.10	

T_1- Soil application of 100g talc formulation of *Bacillus amyloliquefaciens* along with 50kg FYM
T_2 -Root feeding of bacterial strain 50 ml broth (10^8 cfu/ml) in 100 ml water
T_3 - Root feeding of Hexaconazole 3 ml in 100 ml water
T_4– Control

The results revealed that among all the treatments, there was a significant variation with respect to disease index at three months after treatment. At 30 months after treatment T1- Soil application of 100g talc formulation of *Bacillus amyloliquefaciens* along with 50kg FYM found superior with 23.33 % reduction over control and was on par with T2 - Root feeding of bacterial strain @ 50 ml broth (10^8 cfu/ml) in 100 ml water recorded 22.12 per cent reduction over initial. Further the positive check recorded 39.00 % of reduction over initial. (Table 4).

Arsikere

The bacterial bioagent named EP10 was found to be promising in arresting growth of test pathogen *Ganoderma* sp. under *in-vitro* conditions. The same isolate was taken to field conditions to test efficacy against BSR disease in coconut. The talc based formulation was applied to soil along with FYM 50Kg, whereas the bacterial broth was fed through roots and root feeding of Hexaconazole was used as standard check. Each palm constituted one replication and six replications were maintained under each treatment. The result revealed that among all the treatments there was no significant variation with respect to disease index at 36 month after treatment. However, the effective treatments of this experiment has been merged with IDM module experiment.

Table 5 . Influence of Bacterial bioagents on BSR disease of coconut

Treatments	Before initiation of treatment	*Disease Index at different month									% reduction over initial
		Oct-20	Jan 21	Apr-21	July - 21	Octo-21	Jan-22	April-22	July-22	Oct-22	
T1- Soil application of 100g Talc formulation of EP10 along with 50 Kg FYM	34.66 (36.07)	35.98 (36.3)	35.20 (36.4)	35.31 (36.82)	34.14 (35.75)	31.28 (34.31)	30.94 (33.80)	30.31 (33.34)	29.10 (32.64)	25.87 (30.57)	25.31
T2- Root feeding of bacterial strain 50 ml broth (10^8CFU/ml) in 100 ml water	34.64 (36.05)	39.03 (38.7)	39.61 (39.0)	37.57 (39.81)	34.83 (36.17)	32.01 (35.53)	31.25 (33.99)	30.90 (33.77)	30.19 (33.33)	28.38 (32.19)	18.11
T3- Root feeding of Hexaconazole 3 ml in 100 ml water	35.86 (36.79)	38.55 (38.4)	38.91 (38.6)	38.96 (38.62)	35.40 (37.11)	31.62 (36.04)	30.68 (33.63)	29.97 (33.19)	29.55 (32.93)	24.99 (28.94)	31.94
T4- Control	35.25 (36.42)	39.87 (39.2)	40.57 (39.6)	40.69 (39.64)	40.92 (39.77)	41.28 (39.98)	42.10 (40.46)	42.58 (40.73)	42.81 (40.87)	43.89 (41.49)	-24.51
SEm±	0.42	0.65	0.65	0.67	0.64	0.80	0.70	0.74	0.81	1.41	
CD@5 %	1.30	1.99	2.01	2.06	1.97	2.46	2.15	2.29	2.51	4.35	

*Mean of six replications MAT- Months After Treatment

Veppankulam

Based on the *in vitro* evaluation of bio-control agents, effective bacterial strain *Bacillus subtilis* EPC5 was selected for the management of basal stem rot under field condition. The trial was laid out in randomized block design with following four treatments and five replications. For each replication, four coconut palms were selected. The trial was initiated during October, 2018 at Coconut Research Station, Veppankulam. The effective bacterial strain EPC5 was given as soil application and root feeding at quarterly intervals and compared with fungicide (Hexaconazole). Among the treatments, root feeding of Hexaconazole 3ml/100 ml of water at 3 months interval was found superior as compared to other treatments. Soil application of *Bacillus subtilis* @ 100g and root feeding of *Bacillus subtilis* EPC5 (nutrient broth)/ 50 ml in 100 ml of water at 3 months interval was found significant in containing the disease by registering 16.62 per cent and 13.75 per cent reduction over initial respectively as compared to the control (Table 6) and the same treatments showed the increased nut yield over the control.

Table 6. Effect of bio-agent *Bacillus subtilis* against BSR of coconut @ CRS, Veppankulam during 2021-22

Treatments	Initial Disease Index (%)	Basal stem rot disease Index* (%)-2022-23							%Disease reduction over initial
		Apr-21	Jul-21	Oct-21	Jan-22	Apr-22	Jul-22	Oct-22	
T1	17.75 (24.92)	29.08 (32.63)	29.01 (32.59)	20.00 (26.57)	15.00 (22.79)	15.00 (22.79)	15.00 (22.79)	14.80 (22.63)	**16.62**
T2	19.13 (25.94)	13.62 (21.66)	13.38 (21.46)	14.00 (21.97)	14.00 (21.97)	14.50 (22.38)	16.50 (23.97)	16.50 (23.97)	**13.75**
T3	14.8 (22.63)	15.74 (23.37)	15.51 (23.19)	15.00 (22.79)	13.00 (21.13)	12.00 (20.70)	12.00 (20.70)	12.00 (20.27)	**18.92**
T4	11.36 (19.70)	37.48 (37.75)	38.03 (38.07)	38.20 (38.17)	38.53 (38.37)	38.84 (38.55)	39.25 (38.79)	22.61 (28.39)	**-99.01**
SEM	1.72	5.65	5.82	5.62	1.35	1.36	1.34	1.87	
CD@5%	**1.13**	**11.03**	**11.09**	**7.79**	**4.15**	**4.2**	**4.11**	**5.75**	

*Mean of five replications (4 palms/Replication) Design: RBD

Stem Bleeding Disease

Management of coconut stem bleeding disease through biological control agents

Ambajipeta

Evaluation of cake formulations of bio agent, *Trichoderma* was done against stem bleeding disease of coconut at Horticulture Research Station farm, Ambajipeta. Effect of *Trichoderma reseei* cake formulation as well as *Trichoderma reesei* paste formulation along with positive control (paste application of copper oxychloride) was tested against stem bleeding disease of coconut on Ganga bondam variety. In case of cake application the treatment was given only once during the study period whereas the paste application was done at every month. The treated palms were observed every month for the disease symptom and the percent recovery of the treated palms were observed.

Table 7. Field evaluations of cake and paste formulations of *Trichoderma* species against stem bleeding disease of coconut during 2021-22

S. No	Treatment	Disease index(DI)	
		BT	3 MAT
1	*T.reesei* cake	11.28 (19.52)	0.00 (0.00)
2.	*T.reesei* paste	10.14 (18.52)	1.64 (7.31)
3	COC Paste	12.16 (20.58)	3.34 (10.05)
4	Control	11.09 (19.38)	12.76 (20.87)
	SE(m)±	**NS**	**0.83**
	C.D.	**NS**	**2.52**

DAT – Days after treatment
BT- Before treatment
DI- Disease index

During the year 2021-22 the experiment results revealed that application of *T. reesei* cake formulation completely recovered the diseased palms when compared to the paste application of *Trichoderma reesei* and Copper Oxychloride against stem bleeding disease of coconut. Disease index of 11.28

was brought down to 0.00 per cent within 50 days of cake application. Disease index of 10.14 and 12.16was reduced to 1.64 and 3.34respectively with paste application of *Trichoderma reesei* and copper oxychloride. However, the treatments differ significantly at 50 DAT (Table.7).

Leaf Blight Disease

Yield loss assessment in coconut due to leaf blight disease

Twenty five healthy and 25 leaf blight infected palms were selected in Puliyankandi village, Anamalai block, Coimbatore district and nut yield were recorded from January2022–December 2022. The results are presented in Table8 . The per cent reduction in yield was assessed using the formula

$$\frac{\text{Nut yield in healthy palm-Nut yield in infected palm}}{\text{Nut yield in infected palm}} \times 100$$

From the results it was found that the percent reduction in nut yield due to leaf blight disease in coconut ranged from 6.07 to 21.74 per cent with an average nut yield loss of 10.36 per cent. In addition to leaf blight rugose spiralling white fly infestation was observed to an extent of 10 per cent.

Table 8 . Assessment of yield loss due to leaf blight disease

S. No	Date of harvest	Nut yield (Mean of 25 palms)		% reduction inNut yield
		Healthy Palms	Infected Palms	
1.	28.01.2022	22.02	19.75	11.49
2.	15.03.2022	18.70	15.36	21.74
3.	30.04.2022	21.40	19.78	8.19
4.	13.06.2022	20.35	18.58	9.26
5.	26.07.2022	19.45	17.78	9.56
6.	08.09.2022	21.40	19.64	8.96
7.	22.10.2022	21.02	19.52	7.68
8.	05.12.2022	19.90	18.76	6.07
			Mean	**10.36**

Epidemiology of leaf blight disease in coconut

Aliyarnagar

The observations on symptoms of leaf blight disease in Coconut were taken on weekly intervals from January 2022 to December 2022 in order to understand the pattern on incidence in correlation with weather parameters prevailing in different seasons. The weather parameters namely Temperature, Rainfall, Relative Humidity (Morning and Evening) and Evaporation prevailed in Standard Meteorological Weeks (SMW) were recorded and the respective incidence of leaf blight during these weeks were also recorded. The observations are presented in following table 9.

Table 9 . Weekly wise weather data and intensity of leaf blight during Jan 2022 to Dec 2022

Month	Std week	DI of leaf blight	Temp (°C)		RH (%)		Rainfall (mm)	Evpn. (cm)
			Max.	Min.	Morning	Evening		
Jan'22	1	22.0	29.9	24.4	91.1	71.0	0.0	2.0
2	21.2	32.1	25.4	92.85	70.0	0.0	5.0	
3	19.1	33.4	23.1	91.0	68.43	0.0	4.4	
4	19.0	33.6	23.5	90.57	66.28	0.0	4.0	
Mean		**20.32**	**32.25**	**24.1**	**91.38**	**68.43**	**0.0**	**3.85**
Feb'22	5	20.1	33.0	25.5	91.14	81.57	0.0	4.86
6	23.0	28.6	20.2	92.8	56.9	0.0	3.6	
7	22.0	32.9	24.8	90.8	64.4	0.0	5.0	
8	21.0	34.3	24.9	90.8	66.0	0.0	5.0	
Mean		**21.5**	21.525	23.85	91.39	67.22	0.0	4.6
Mar'22	9	21.5	34.3	23.3	84.5	54.0	0.0	6.2
10	21.9	34.67	25.00	89.00	58.17	0.00	5.83	
11	22.1	36.90	26.40	87.20	56.80	0.00	6.40	
12	25.1	35.67	27.33	91.33	70.50	3.20	3.78	
13	28.8	35.80	26.40	91.40	62.60	0.40	5.00	
Mean		**20.32**	**32.25**	**24.1**	**91.38**	**68.43**	**0.0**	**3.85**
April'22	14	27.0	36.50	27.70	92.40	61.80	0.00	5.00
15	26.4	34.00	26.25	94.00	58.00	7.20	7.75	
16	27.3	35.50	27.88	89.33	67.75	4.86	3.00	
17	28.6	35.58	28.25	93.40	70.40	1.86	4.33	
Mean		**27.3**	**35.40**	**27.52**	**92.28**	**64.49**	**3.48**	**5.02**
May'22	18	28.5	34.1	26.9	76.6	63.9	1.2	3.0
19	28.9	31.4	26.4	86.0	67.3	3.3	3.6	
20	26.3	30.4	26.6	84.0	73.7	5.5	2.2	
21	27.8	34.3	27.9	78.8	69.7	1.03	5.0	
Mean		**27.9**	**32.55**	**26.95**	**81.35**	**68.65**	**2.76**	**3.45**
June'22	22	26.7	35.2	27.8	73.8	64.0	0.0	5.9
23	26.5	35.0	28.4	73.8	63.2	0.0	5.0	
24	27.8	34.5	27.8	79.8	71.2	0.69	4.8	
25	25.9	33.5	28.3	83.6	72.6	0.77	3.9	
26	25.7	32.7	28.0	77.7	67.7	4.33	3.2	
Mean		**26.5**	**34.2**	**28.0**	**77.74**	**67.74**	**1.2**	**4.6**
July'22	27	28.0	29.1	26.7	84.3	87.2	3.3	1.1
28	26.6	29.9	27.1	81.4	76.2	4.8	1.8	

29	25.2	31.0	28.8	87.2	78.5	2.2	2.5	
30	22.0	32.7	24.6	90.0	64.5	2.2	3.0	
Mean		**25.5**	**30.675**	**26.8**	**85.73**	**76.6**	**3.2**	**2.1**
Aug'2231	26.5	30.3	26.8	86.2	81.5	17.9	1.3	
32	23.7	30.7	25.4	75.0	63.0	0.8	2.1	
33	24.8	34.0	26.8	72.6	61.9	0.0	3.4	
34	25.7	31.8	26.8	87.8	57.0	1.2	2.7	
Mean		**25.12**	**31.7**	**26.45**	**80.4**	**65.85**	**5.0**	**2.4**
Sep'2235	26.5	30.4	25.5	91.6	68.5	9.5	1.8	
36	22	31.2	26.0	84.7	68.5	2.8	1.0	
37	23.7	31.9	26.2	79.2	66.7	0.0	2.9	
38	22.9	33.0	25.3	79.8	62.0	0.0	4.2	
39	20.9	33.4	26.0	83.0	58.5	0.0	3.0	
Mean		**23.2**	**31.98**	**25.8**	**83.66**	**64.84**	**2.46**	**2.58**
Oct'2240	20.2	33.2	26.5	83.0	73.0	0.8	**5.3**	
41	19.8	32.3	27.2	94.0	71.5	3.9	2.7	
42	19.3	32.2	26.1	94.8	75.2	16.5	2.3	
43	20.0	33.1	25.0	91.5	66.5	0.0	3.4	
Mean		**19.8**	**33.2**	**26.5**	**83.0**	**73.0**	**5.4**	**3.5**
Nov'22	44	19.2	31.3	27.0	94.2	71.2	8.9	3.5
45	19.8	30.4	25.5	87.2	72.0	6.7	2.4	
46	19.3	30.4	25.0	91.0	72.4	4.7	2.6	
47	18.0	32.0	23.8	93.2	69.2	0.0	3.0	
Mean		**23.88**	35.5	25.7	88.7	60.4	0.72	5.4
Dec'2248	20.5	33.2	23.3	91.6	68.5	9.5	1.8	
49	19.7	31.0	25.00	84.7	68.5	2.8	1.0	
50	19.4	30.2	26.40	79.2	66.7	0.0	2.9	
51	19.2	34.0	27.33	79.8	62.0	0.0	5.2	
52	19.1	34.6	26.40	83.0	58.5	0.0	4.0	
Mean		**19.5**	**32.6**	**25.7**	**83.66**	**64.84**	**2.46**	**3.0**

Table .10 Correlation between leaf blight incidence and weather parameters

	Weather parameters	Correlation coefficient
Leaf blight incidence	Temperature (Maximum)	0.626
	Temperature (Minimum)	-0.593
	RH (Morning)	-0.079
	RH (Evening)	0.393
	Rainfall	-0.545
	Evaporation	2.01

The results given in the above table 32 revealed that nevertheless, the leaf blight symptoms were exhibited all through the year or in all months of the year, the incidence was maximum during hot months of March, April and May months of the year 2022 it got decelerated during October, November, December months of 2022.

The correlation results given in table 10 revealed that there existed positive correlation between temperature (Maximum and Minimum) and leaf blight incidence. It could be inferred as rise in every degree of temperature there is every likelihood that there will be increase in the infection of leaf blight disease in coconut.

Similarly, there existed negative correlation between RH and leaf blight incidence as shown in the table 10. This could be inferred as the increase in RH resulted in decrease in the incidence of the leaf blight disease which could be corroborated from the observations given in table 10. that the months coinciding the increased RH experienced lesser incidence of leaf blight.

Management of leaf blight Disease in coconut

Aliyarnagar

Management of leaf blight disease using chemicals has been one of the pragmatic option and in order to arrive at the best option among the recent fungicides available, a field experiment has been contemplated with seven treatments. The fungicides namely propiconozole and tebuconozole have been selected for this experiment. Randomized block design was chosen for the study which involved seven treatments with three replications and the study was undertaken in the coconut garden of farmers in Puliyankandi village. The observations have been made in coconut trees before the start of the treatment and 36 months after the treatment. The results are given in the following table 11.

Table 11. Evaluation of systemic fungicides against leaf blight disease

Treatment No.	Treatment details	Leaf blight intensity (PDI)			Leaf blight severity (%)			Nut yield	C:B ratio
		0 MAA	36 MAA	Diseaser eduction	0 MAA	36 MAA	Severity reduction		
1.	Root feeding of tebuconazole @ 2ml + 100 ml water	28.50 (32.27)^{a}	20.50 (26.92)^{e}	8.0 (16.43)^{e}	100 (90)	55.8 (48.33)^{c}	44.2 (41.67)^{c}	115^{cd}	1:1.09
2.	Root feeding of tebuconazole @ 5ml + 100 ml water	29.87 (33.13)^{a}	10.12 (18.55)^{b}	19.75 (26.39)^{b}	100 (90)	44.42 (41.80)^{b}	55.58 (48.20)^{b}	123^{b}	1:1.19
3.	Root feeding of tebuconazole @ 10ml + 100 ml water	29.00 (32.58)^{a}	15.32 (23.04)^{d}	13.68 (21.71)^{d}	100 (90)	55.4 (48.10)^{c}	44.6 (41.90)^{c}	120^{bc}	1:1.18
4.	Root feeding of propiconazole @ 2ml + 100 ml water	32.09 (34.51)^{b}	14.95 (22.75)^{cd}	17.14 (24.46)^{c}	100 (90)	44.1 (41.61)^{b}	55.9 (48.39)^{b}	118^{bcd}	1:1.19
5.	Root feeding of propiconazole @ 5ml + 100 ml water	30.01 (33.22)^{a}	2.98 (9.94)^{a}	27.03 (31.33)^{a}	100 (90)	32.2 (34.57)^{a}	67.8 (55.43)^{a}	132^{a}	1:1.24
6.	Root feeding of propiconazole @ 10 ml + 100 ml water	31.71 (34.27)^{b}	14.71 (22.55)^{c}	17.0 (24.35)^{c}	100 (90)	45.4 (42.36)^{b}	54.6 (47.64)^{b}	114^{d}	1:1.18
7.	Untreated control	39.2 (38.76)^{c}	41.76 (40.26)^{f}	-2.56^{f}	100 (90)	100 (90)^{d}	0 (0)^{d}	101^{e}	-
	SEd	0.72	0.244	0.319	-	1.633	1.097	2.686	
	CD(P=0.05)	1.59	0.537	0.703	-	3.597	2.417	5.916	

MAA-Months after application

Values are mean of three replications. Values in Parentheses are arcsine transformed values

The results showed in the above table 35 clearly revealed that the treatment of root feeding of propiconazole @ 5ml +100 ml water was found to be very effective in controlling leaf blight disease when compared to all the other treatments. The effect of the treatment was such that the disease incidence reduced from the PDI of 30.01 to 2.98 which was calculated to be 27.03 percent reduction. In terms of severity of the disease, the treatment was reported to effect 67.8 percent reduction in the severity of the disease. Nut yield was also found to be significantly increased when compared to other treatments. It was reported that 132 nuts have been harvested with a benefit cost ratio of 1:1.24. Next best treatment was root feeding of tebuconazole @ 5ml + 100 ml water which has resulted in 19.75 percent reduction in the leaf blight disease and the severity was reduced to the level of 55.58 percent with the nut yield of 123/tree/year and benefit cost ratio of 1:1.19.

Demonstration on integrated management of leaf blight disease

Aliyarnagar

An Integrated Disease Management protocol was arrived at and it was demonstrated in one acre coconut farm which consisted of 72 palms located in Aliyarnagar village of Anaimalai block in Coimbatore district.

The following four components were demonstrated as integrated disease management strategy

- Removal and destruction of severely affected fronds (once in 3 months)
- Spraying of Bordeaux mixture 0.5% or copper oxychloride 0.3% two times at 45 intervals during summer months (Feb /April).
- Root feeding of Propiconazole @ 2ml + 100 ml water (Root feeding to be done at three months interval during Jan, April, July and October)
- Basal application of *Bacillus subtilis* @ 200g along with 50 kg FYM per year.

The observations were made pre treatment of this IDM module and post treatment after six months and the results are presented in table 12. From the table 35 it could be inferred that the incidence of leaf blight disease which was an average of six months got reduced significantly from 13.01PDI (initial) to 9.27PDI respectively. The average intensity of leaf blight disease was reduced from 9.27 PDI to 6.15 PDI after 6 months of application accounted for the disease reduction of 3.74 per cent. In control plot the disease incidence slightly increased from 12.35 PDI (initial) to 14.52 PDI after 6 months of application. Clear difference was observed between control and the treated palms as there was increase in the incidence of leaf blight in control plot.

Table 12. Intensity of leaf blight disease in demonstration plot

S.No.	Treatment details	Percent Disease Index				Nut Yield
		Before Initiation	January 2022	July 2022	Difference (% reduction / increase)	
1.	Treated as per Schedule (IDM module)	13.01	9.27	6.15	6.86 (52.73% disease reduction)	80
2.	Untreated Control	12.35	13.01	14.52	+2.17 (17.57% increased)	67

Average of 72 palms PDI – Per cent Disease Index

Values are mean ± Standard error

Ambajipet

Demonstration of integrated disease management on leaf blight disease was executed in one acre coconut garden at Adurru village of East Godavari district for the year 2021-22. Integrated disease management with cutting and removal of the severely affected leaves once in three months, root feeding with Carbendazim @2g in 100ml water, soil

application of *Pseudomonas fluorescens* @ 200g/ palms with 50 kg of FYM and spraying of Copper oxy chloride @ 0.3 % was recorded significant reduction of the leaf blight disease from 8.32 to 3.98 PDI whereas the disease intensity was increased from 8.32 to 15.01 PDI in control plot. Further, the demonstration plot was selected in Garlamadugu village, Pedavegi mandal of West Godavari district for the year 2022-23 where the disease incidence was observed. Pre-treatment data was collected and imposed the treatments.

Arsikere

One acre garden with leaf blight incidence was selected at Boranakoppalu village in Arsikere Taluk for demonstration trial on management of leaf blight. A separate control plot was also selected in nearby place. The above treatments were imposed at appropriate time. The initial incidence of disease is 12.16 per cent in treated plot and 12.60 in untreated control (table 13). The incidence was decreased in treated palm to 5.76 and Where as increased in untreated palms (19.89). However, the PDI has been reduced from 10.08 to 1.87 in treated plot and it was increased from 9.64 to 13.59 at untreated plot in six months duration.

Table 13. Incidence of leaf blight disease in demonstration gardens

Particulars	Demonstration plot				Control plot			
	Pre treatment (0 MAA) PDI	Post treatment (6 MAA) PDI	Disease incidence (%)		Pre treatment (0MAA) PDI	Post treatment (6 MAA) PDI	Disease incidence (%)	
			0 MAA	6 MAA			0 MAA	6 MAA
Ranges of disease intensity	0-24.01	0-9.56	12.16	5.76	0-26.58	0-37.33	12.60	19.89
Average*	10.08 ± 0.09	1.87± 1.03	-	-	9.64± 0.86	13.59± 1.04	-	-

Root (Wilt) Disease of Coconut

Assessing the incidence of root (wilt) disease in Tamil Nadu

Aliyarnagar

Roving survey was carried out during January 2022 – December 2022 to assess the incidence of root (wilt) in different villages of Coimbatore, Tirupur, Dindigul, Theni, Tirunelveli and Kanyakumari districts. The highest root wilt incidence of 58.40 per cent was recorded in Thappatikelavenpudur village, Anaimalai block, Coimbatore District followed by Vellimalai (54.63%) and Thippiramalai villages (54.42%) Kuruthencode and Killiyoor blocks, Kanyakumari District (Table 37).

In Coimbatore district, among the four blocks surveyed the severe root (wilt) incidence was observed in three blocks *viz.*, Pollachi South, Pollachi North and Anamalai and only meager incidence was observed in surveyed villages of Periyakalandai, Sheripalayam and Kappalankarai, Kinathukadavu block. The root wilt incidence of Coimbatore district ranged from 4.80 to 58.40 per cent and the maximum incidence of 58.40 per cent was recorded in Thappataikelavenpudur village of Anaimalai block and followed by 53.50 per cent was observed in Ambarampalayam village of Pollachi South block. The block average for the Anaimalai and Pollachi (South) blocks were 15.74 and 9.53 per cent respectively. The district average of root wilt incidence was 8.35 per cent.

The status of root (wilt) was surveyed in four blocks of Tirupur district and only meager incidence of root wilt was observed in Tirupur district with district average of 4.38 per cent. In Tirupur district, among the four blocks surveyed the root (wilt) incidence was observed in three blocks *viz.*, Gudimangalam (8.25%), Udumalai (6.78%) and Tirupur (2.50%) and it was not found in surveyed villages of Avinashi block. The root (wilt) incidence was not recorded

in surveyed villages of Dindigul and Tirunelveli district.

In Theni district severe incidence of root (wilt) was recorded in Kamayangoundanpatti (41.6%), Kombai (38.7%), Anaipatti (35.3%) and Pudupatti (32.1%) villages of Cumbum block. The mean root (wilt) incidence of Bodinaickenur block was found to be 15.67 per cent. The root (wilt) incidence was not found in surveyed villages of Periyakulam blocks. Among the surveyed districts and blocks, the highest district average of 13.58 per cent and the highest block average of 27.71 percent were recorded in Theni district and Cumbum block respectively.

A total of six blocks were surveyed for assessing the status of root (wilt) incidence in Kanyakumari district. The disease was recorded in six blocks *viz*., Kuruthencode, Rajakamangalam, Thovalai, Killiyoor, Agastheeswaram and Thuckalay. The maximum incidence of 54.63 per cent was recorded in Vellimalai village of Kuruthencode block. In Kuruthencode block the disease was observed in all the four villages surveyed with the block average of 28.4 per cent.The district average of Kanyakuamri district was 11.16 per cent.

Among the 26 blocks of Coimbatore, Tirupur, Dindigul, Theni, Tirunelveli and Kanyakumai districts surveyed for the incidence of root (wilt) incidence. Kuruthencode block recorded the highest mean incidence of 28.4 per cent followed by Cumbum block (27.71%) (Table.14). Among the districts surveyed for the occurrence of root wilt incidence, Theni district recorded the highest mean incidence of 13.58 per cent followed by Kanyakumari district (11.16%).

Table.14. Incidence of coconut root (wilt) disease in different districts of Tamil Nadu (Jan 2022 - Dec 2022)

Districts	Blocks	Root (wilt) incidence (%)	Root wilt severity (Disease Index)
Coimbatore	Pollachi North	5.96 ± 0.71	35.80
	Pollachi South	9.53 ± 0.48	53.50
	Anaimalai	15.74 ± 0.88	58.40
	Kinathukadavu	2.17 ± 0.6	12.80
	Mean	**8.35 ± 0.67**	**40.13**
Tirupur	Udumalpet	6.78 ± 3.2	15.00
	Gudimangalam	8.25 ± 0.79	35.50
	Tirupur	2.5 ± 0.00	5.50
	Avinashi	0.00 ± 0.00	0.00
	Mean	**4.38 ± 0.99**	**14.00**
Dindigul	Palani	0.00 ± 0.00	0.00
	Ottenchithiram	0.00 ± 0.00	0.00
	Reddiyarchathiram	0.00 ± 0.00	0.00
	Nilakottai	0.00 ± 0.00	0.00
	Mean	**0.00 ± 0.00**	**0.00**
Theni	Cumbum	27.71 ± 3.1	53.20
	Uthamapalayam	10.95 ± 2.08	38.97
	Periyakulam	0.00 ± 0.00	0.00
	Bodi	15.67 ± 1.65	43.78
	Mean	**13.58 ± 1.71**	**33.98**

Tirunelveli	Ambasamudram	0.00 ± 0.00	0.0
	Manur	0.00 ± 0.00	0.0
	Radhapuram	0.00 ± 0.00	0.0
	Vallioor	0.00 ± 0.00	0.0
	Mean	**0.00 ± 0.00**	**0.00**
Kanyakumari	Rajakkamangalam	2.96 ± 0.56	10.50
	Killiyoor	18.46 ± 7.57	32.50
	Thuckalay	15.3 ± 7.06	28.96
	Agastheeswaram	3.69 ± 0.23	12.40
	Thovalai	0.93 ± 0.74	7.80
	Kuruthencode	28.4 ± 1.3	59.70
	Mean	**11.16 ± 2.91**	**25.31**

Awareness Programme:

Awareness creation is the key to disseminate the technologies to control root (wilt) disease and to check further spread of the disease. Hence, a series of awareness programmes have been planned and conducted and a list is given below.

Awareness programme for root wilt disease in coconut

Date	Topic	Place	No. of Beneficiaries
13.01.2022	Awareness of Coconut Root wilt disease Pollachi	Somanthuraichittoor, 20	
25.01.2022	Awareness of Coconut Root wilt disease Pollachi	Thensanganpalayam, 20	
03.02.2022	Awareness of Coconut Root wilt disease Pollachi	Ganganpalayam, 25	
08.02.2022	Awareness of Coconut Root wilt disease	Pethanaickenu, Pollachi	25
05.05.2022	Awareness Programme on Coconut Root Wilt	CRS, Aliyarnagar	35
14.06.2022	Awareness Programme on Coconut Root Wilt	CRS, Aliyarnagar	38
25.08.2022	Awareness programme in coconut root wilt-ATMA farmers	Udumalpet, Tiruppur Dt	55
11.11.2022	Awareness Programme of Coconut Root wilt	Edappadi, Salem District	60
14.11.2022	Awareness Programme of Coconut Root wilt – ATMA farmers, Chengalpattu	CRS, Aliyarnagar	42
23.11.2022	Awareness Programme of Coconut Root wilt – NABARD farmers, Kerala	CRS, Aliyarnagar	25
09.12.2022	Awareness Programme of Coconut Root wilt – ATMA farmers	Kinnathukadavu, Coimbatore Dt	48
16.12.2022	Awareness Programme of Coconut Root wilt and other Coconut diseases – ATMA farmers	Kappanlankarai, Coimbatore Dt	45

Twelve awareness programmes were conducted where the root (wilt) disease was predominant and based on the queries received from farmers of these places. The awareness programmes were conducted in Pollachi, Aliyarnagar, Udumalai, Kinnathukadavu and Kappanlankarai in which totally 423 farmers have participated and benefitted. The awareness creation will further trickle down to other farmers through the participants of these programmes.

Pest Management

Coconut

Pest surveillance in coconut

Aliyarnagr

Roving survey

Roving survey was carried out in seven districts of Tamil Nadu *viz.*, Coimbatore, Tiruppur, Dindugul, Theni, Tirunelveli, Kanniyakumari and Thanjavur during 2021 - 2022. The extent of damage caused by major pests of coconut were recorded in terms of incidence (%) and intensity (%). Among the districts surveyed Thanjavur recorded higher damage of rhinoceros beetle in terms of percent incidence (28.14%) and intensity (32.18 %) followed by Kanniyakumari (26.14 and 20.17 %) and Tirunelveli (21.68 and 16.51 %). Eriophyid mite nut damage recorded higher in Thanjavur (48.64 %) followed by Tiruppur (42.18 %), Tirunelveli (41.76 %), Theni (40.59 %) and Kanniyakumari (40.52 %). Rugose spiralling whitefly incidence was more in Tiruppur (31.47 %) and Coimbatore (28.62) followed by Thanjavur (27.38 %) and Kanniyakumari (23.74 %). Highest percent parasitism noticed in Coimbatore (63.82 %). Incidence of black headed caterpillar and red palm weevil were very low in Tamil Nadu. Based on the roving survey it infer that in Tamil Nadu, mean percent of rhinoceros beetle incidence, Leaf damage, Spindle damage, eriophyid mite nut damage, rugose spiralling whitefly Incidence, parasitism rugose spiralling whitefly by *Encarsia guadeloupae*, black headed caterpillar Incidence and red palm weevil Incidence were 19.70, 16.11, 7.15, 40.60, 23.43, 59.24, 4.41 and 1.06 percent, respectively.

Ambajipeta

Roving survey was carried out in East Godavari, West Godavari, Vishakapatnam, Vizianagaram and Srikakulam districts of Andhra Pradesh during the year 2021-2022. Rhinoceros beetle, red Palm weevil, black headed caterpillar, eriophyid mite and rugose spiralling whitefly are the major pests infesting coconut in this region. The incidence of rhinoceros beetle was highest (13.04%) in West Godavari district and low incidence of 9.04% was recorded in Visakhapatnam district. The leaf damage by the beetle was 12.94, 7.85 per cent in the West Godavari and Vizianagaram districts respectively. The incidence of red palm weevil was noticed in the range of 0.56 to 0.74 per cent and incidence was high in Srikakulam (0.74%) and was low (0.56 %) in West Godavari district. The infestation of eriophyid mite was recorded from all the plantations observed in the surveyed districts and was in the range of 63.26 (in Vizianagaram) to 85.80 (in East Godavari) per cent. Intensity of mite was mild to moderate in all districts surveyed. Infestation of black headed caterpillar was recorded in Srikakulam district (70.79%) and no incidence of pest was recorded in other surveyed districts. The infestation of rugose spiralling white fly was recorded from all the surveyed districts and it is in the range of 30.52 to 45.11 per cent and a high incidence of pest was recorded in East Godavari district (45.11). However as compared to other districts a high incidence (34.11%) of Bondar nesting white fly was recorded in Vizianagaram district.

BNW was recorded in all the surveyed districts of Andhra Pradesh and it is in the range of 25.97 to 29.48. Low incidence (25.97%) of BNW was observed in Srikakulam district with intensity of 25.02 %. High incidence (29.48%) was recorded in vizianagaram district. During roving survey low-medium termite incidence was observed in Vizianagaram (4.1%) and Srikakulam (3.4%) districts.

Ratnagiri

The extent of damage in terms of incidence and intensity were recorded for major pests of coconut during these surveys. The data revealed that the mean

incidence of rhinoceros beetle, red palm weevil, black headed caterpillar, eriophyid mite, rugose spirallingwhitefly and *Encarsia* parasitism were recorded 7.7, 0.3, 2.9, 15.7, 10.0 and 28.9 per cent in Konkan region of Maharashtra during 2021. The infestation of coconut rhinoceros beetle (RB) was noticed in the palms of all age groups in all the Districts surveyed. The infestation ranged from 7.3 to 8.3 per cent. The maximum incidence of RB was observed in Sindhudurg (8.3%) with highest leaf damage (4.1%) and spindle damage (0.5%). Whereas, minimum incidence of RB (7.3 %) and spindle damage (0.2 %) was recorded in Palghar. The least leaf damage was observed in Raigad (1.8%). The red palm weevil (RPW) infestation ranged from 0.2 to 0.4 per cent and maximum infestation (0.4%) was observed in Raigad while, minimum incidence (0.2%) was noticed in Palghar. The infestation of black headed caterpillar was observed only in Raigad and Palghar Districts with a value of 2.6 and 3.2 per cent, respectively. The eriophyid mite infestation was recorded in the range of 14.5 to 16.5 per cent. The highest nut damage due to eriophyid mite was noticed in Ratnagiri district (16.5 %) with a mean grade index (MGI) of 0.2. The MGI noticed was mild in all the districts. The least nut damage (14.5%) was observed in Palghar district. The Raigad and Sindhudurg districts recorded 15.8 and 16.0 per cent nut damage by eriophyid mite. The rugose spiralling whitefly (RSW) incidence and intensity was observed in all the districts of Konkan which ranged from 8.6 to 11.5 and 9.2 to 15.5 per cent, respectively. Maximum incidence and intensity of RSW was noticed in Palghar (11.5% and 15.5%, respectively) followed by Ratnagiri (11.0 and 12.2 %), Sindhudurg (9.0 and 10.4 %) and Raigad (8.6 and 9.2 %, respectively).

Table 1. Average infestation of pests infesting coconut during roving survey in Konkan region of Maharashtra

Districts	Rhinoceros beetle			RPW incidence (%)	BHC (%)		Eriophyid mite		Rugose spiralling whitefly		
	Incidence (%)	Leaf damage (%)	Spindle damage (%)		Incidence (%)	Larva/ leaflet	Infestation (%)	MGI	Incidence (%)	Intensity (%)	*Encarsia* parasitism (%)
Ratnagiri	7.8 ± 0.4	2.5 ± 0.2	0.3 ± 0.1	0.3 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	16.5 ± 0.4	0.2 ± 0.0	11.0 ± 2.4	12.2 ± 2.9	32.3 ± 7.2
Sindhu Durg	8.3 ± 0.4	4.1 ± 1.5	0.5 ± 0.1	0.3 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	16.0 ± 1.3	0.1 ± 0.01	9.0 ± 1.3	10.4 ± 1.4	17.4 ± 2.5
Raigad	7.7 ± 0.6	1.8 ± 0.1	0.2 ± 0.1	0.4 ± 0.1	2.6 ± 1.8	0.6 ± 0.4	15.8 ± 1.2	0.1 ± 0.01	8.6 ± 1.9	9.2 ± 2.1	29.3 ± 7.0
Palghar	7.3 ± 0.7	2.2 ± 0.3	0.2 ± 0.1	0.2 ± 0.1	3.2 ± 1.7	0.8 ± 0.5	14.5 ± 1.0	0.1 ± 0.01	11.5 ± 2.1	15.5 ± 3.2	36.7 ± 5.1
Mean ± SE	7.7 ± 0.2	2.6 ± 0.5	0.3 ± 0.0	0.3 ± 0.0	2.9 ± 0.9	0.3 ± 0.2	15.7 ± 0.4	0.2 ± 0.01	10.0 ± 0.8	11.8 ± 1.5	28.9 ± 4.7

Arsikere

The Roving survey was carried out in Chikkamagaluru, Tumkur, Mysore, Davanagere, Chitradurga, Shivamogga, Hassan and Mandya districts and the extent of damage in terms of per cent incidence and intensity were recorded for major pests of coconut during these surveys .The infestation of rhinoceros beetle was noticed mostly in all newly planted gardens in all the age group of 2 to 48 years. The highest rhinoceros beetle incidence15.2 per cent incidence was noticed in Mandya district and mean incidence of 13.1per cent was recorded in the Mysore district. The incidence of red palm weevil was maximum (up to 0.8%) in Chikkamagaluru

district followed by 0.7% infestation in Tumkur district. The incidence of red palm weevil was also noticed in Mysore (0.5 %), Mandya (0.4 %), Shivamogga(0.4 %), Hassan(0.4 %), Davanagere (0.2 %), and Chitradurga(0.2 %)district.

The infestation by Coconut black headed caterpillar was noticed in all the 8 major coconut growing districts of Karnataka, moderate (19.8 %) incidence was noticed in Hassan district throughout the year. The other districts where the caterpillar incidence observed include Chikkamagaluru (18.1%), Davanagere (11.4 %), Chitradurga (6.1 %), Mysore (4.3 %), Mandya(2.1%)Tumkur(1.8%) and Shivamogga 1.4 per cent.The infestation of eriophyid mite was also noticed in all major districts of Karnataka and in most cases, the incidence was as high as 100 per cent in the harvested nut samples. The highest incidence of mite incidence was recorded in Tumkur district (22.5%) followed by 20.4 per cent Chikkamagaluru, Mysore (12.4%), Chitradurga (12.1 %), Hassan (11.8 %), Davanagere (11.3 %),Mandya(7.6%)and Shivamogga 5.3 per cent district(Table 2).

Table 2 Mean Incidence of major coconut pests in important districts of Karnataka 2022

District	Black headed caterpillar Mean Incidence (%)	Rhinoceros beetle Mean Incidence (%)	Red palm weevil Mean Incidence (%)	Eriophyidmite Mean Incidence (%)
Chikkamagaluru*	18.1 ± 3.6	7.2 ± 1.3	0.8 ± 0.3	20.45 ± 3.8
Mysore*	4.3 ± 0.5	13.1 ± 2.1	0.5 ± 0.2	12.4 ± 3.2
Mandya*	2.1 ± 0.2	15.2 ± 2.5	0.4 ± 0.1	7.6 ± 1.8
Tumkur*	1.8 ± 0.1	8.5 ± 1.4	0.7 ± 0.2	22.5 ± 4.2
Chitradurga*	6.1 ± 1.2	5.1 ± 1.2	0.2 ± 0.1	12.1 ± 1.5
Hassan*	19.8 ± 3.4	10.8 ± 1.6	0.4 ± 0.1	11.8 ± 1.9
Davanagere*	11.4 ± 2.2	6.8 ± 0.8	0.2 ± 0.1	11.3 ± 1.6
Shivamogga*	1.4 ± 0.2	3.5 ± 0.6	0.4 ± 0.1	5.3 ± 0.8

* Values expressed are Mean ± Standard error

The per cent leaf damage by rhinoceros beetle was noticed in all the 8major coconut growing districts of Karnataka and was ranged between 5.6 to 11.3per cent, highest per cent leaf damage (11.3%) was noticed at Mysore district followed by 10.2 per cent in Mandya district, Hassan (8.5 %), Tumkur(7.8%), Davanagere (6.9%), Chikkamagaluru (6.7%), Shivamogga (6.4 %) and Chitradurga district 5.6 per cent. The mean grade index of mite ranged from 0.5to 2.4, highest MGI of 2.4was observed at Tumkurdistrict followed by 1.8 per cent in Chikkamagaluru district,Chitradurga (1.4 %), Hassan (1.2 %) ,Mandya (0.9 %), Mysore (0.8 %)Davanagere (0.7 %) and Shivamogga 0.5 per cent.

The leaf damage by coconut black headed caterpillar was ranged between 0.8to 11.6per cent in all 8 different district, highest per cent leaf damage (11.6%) was noticed at Hassan districtwith a number of larvae per 100 leaflets was 4.3.

Minor pests

In addition to the majorpests there weresome minor pests noticed during the surveys. In Chikkamagaluru district mealybug, termite and scale was noticed as a spot occurrence , the mealybug, *Pseudococcus* spp. was observed up to 9 % and its infestation in the spindle leaf as well as in harvested bunches was observed. In Tumkurdistrict, scaleincidence was noticed in the range of2.1 to9.8 percent, whereas white fly incidence was noticed up to 11 per cent (Table 13). Incidence of an whitefly (4%) was noticed in coconut during December 2021 during surveys in Mangalavillages of Mandya district. Observations on the natural enemy fauna in the infested gardens revealed a diverse array of

coccinellids along with an aphelinidparasitoid, *Encarsiaguadeloupae*and few numbers of Chrysopa were observed. Parasitisation by *E. guadeloupae* was observed to an extent of 36.5 per cent.

Multi location evaluation trial of the nylon net for the management of rhinoceros beetle in coconut palms

Aliyarnagr

Field trial was initiated on 11.04.2022 to evaluate the nylon net for the management of rhinoceros beetle in coconut palms. Thirty palms aged 2 years were selected and wrapped the spear leaf base with 2-3 adjacent leaf bases with nylon nets (size – 3.2 x 3.2 cm). When new leaf emerges, nylon nets were loosened and rewrapped. Another thirty palms were selected and labeled for control.

Before imposing treatment, number of damaged leaves due to beetle attack and total number of leaves per palm were counted to assess the percent damage caused by rhinoceros beetle. After imposing treatment number of beetles entrapped in the net and per cent reduction in damaged leaves were observed at weekly interval.

Table 3. Assessment of nylon net for the management of rhinoceros beetle (RB) infesting coconut at Aliyarnagar

	Leaf damage (%)		Spindle damage (%)		Adults trapped on Net/palm (Nos.)
	Treatment	Control	Treatment	Control	
Pre count (April 2022)	9.3	9.1	13.3	10.0	-
May 2022	8.9	9.2	10.0	13.3	0.18
June 2022	8.5	9.2	6.7	13.3	0.21
July 2022	8.1	9.4	6.7	16.7	0.15
August 2022	7.4	9.5	3.3	16.7	0.12

Ambajipeta

The experiment was initiated on 28.04.22 at horticultural research station, Ambajipeta. In this trail 30 juvenile palms (aged 2-5 years) were selected and pre data was recorded on leaf damage and spindle leaf damage. The spindle portion of the palms was covered with nylon net to trap the beetle. Post data on leaf damage and spindle leaf damage and number beetles trapped per trap was recorded at weekly intervals as per the protocol.

Table 4 Effect of nylon net for management of Rhinoceros beetle in coconut

	Average percent of leaf damage/ palm	Average percent of spindle leaf damage/ palm	Total beetles trapped	Average no. of beetle trapped / trap
Pre data	31.81	16.66	-	-
Post data (with one week interval)				
First week	31.51	16.66	0	0
Second week	31.10	16.66	1	0.3
Third week	30.51	13.33	1	0.3
Fourth week	29.57	13.33	1	0.3
Fifth week	29.35	10.00	0	0
Sixth week	28.72	10.00	1	0.3
Seventh week	27.50	6.66	2	0.6
Eighth week	26.50	6.66	1	0.3

Arsikere

The experiment was carried out at Horticulture Research and Extension Centre, Arsikere, totally there was 30 Tiptur tall (TPT) coconut palms were selected for evaluation of the nylon net for the management of rhinoceros beetle in coconut palms over natural control for each treatment against rhinoceros beetle. The method of treatment which includes Wrapping the spear leaf base with 2-3 adjacent leaf base with nylon nets (size – 3.2 x 3.2 cm), When new leaf emerges, nylon net has loosened and rewrapped suitable to the newly emerged leaf was implemented in the plot as per the experimental protocol. Before imposing treatment, number of damaged leaves due to beetle attack and total number of leaves per palm were counted. After imposing treatment, number of beetles entrapped in the net was counted at weekly intervals and per cent reduction in damaged leaves was recorded by again counting the number of damaged leaves and total number of leaves per palm. Simultaneous observations were also made in control plot. After imposition of treatments, the per cent leaf damage by rhinoceros beetle infestation gradually decreased from 36.3 per cent to 1.9 per cent in treatment and in control plot the per cent leaf damage by rhinoceros beetle increased from 35.8 to 46.7per cent (Table 5). The Nylon-net wrapped treatment trapped maximum adult's rhinoceros beetle population, which ranges from 0.67 to 2.43 beetle/week which was significantly superior over natural control (Table 18).

Table 5 Per cent leaf damage by rhinoceros beetle in coconut palms wrapped with the nylon net

	Before imposing the treatment (APRIL)	MAY-22	JUNE-22	JULY-22	AUG-22
Nylon net wrapped palm (T-1)	36.3 ± 0.25	15.5 ± 0.18	5.2 ± 0.13	3.0 ± 0.1	1.9 ± 0.08
Control (T-2)	35.8 ± 0.78	38.3 ± 0.93	42.8 ± 0.98	45.3 ± 1.05	46.7 ± 0.81

Average means ± standard error

Ratnagiri

The present experiment was carried out in plot no. 9 at RCRS, Ratnagiri wherein the most susceptible coconut varieties are infesting by rhinoceros beetle. As per the technical programme, pre-count observations on leaf damage and spindle damage of coconut by rhinoceros beetle were recorded. The post treatment observations were recorded on leaf, spindle damage and no. of adults beetle trapped on nylon net. The data presented in Table 19 indicated that the maximum leaf and spindle damage were found 37.7 and 51.4 per cent, respectively during pre-count observations in the months of May, 2022. However, minimum leaf damage (26.2%), spindle damage (15%) and adults beetle trapped on nylon net (0.42 nos.) were observed after one months of applications of treatment. In June, 2022, maximum leaf damage (29.4%) and spindle damage (42.9%) was observed during pre-count observations. However, minimum leaf, spindle damage and adults trapped on nylon net were observed 20.9, 14.3 per cent and 0.97 nos., respectively during post count observations. The pooled mean data of May and June, 2022 indicated that the leaf damage (33.5%) and spindle damage (47.1%) was observed during pre-count observations. However, it was reduced in 23.5 and 14.6 per cent, respectively. The maximum 0.69 adults beetle trapped on nylon net was noticed.

Table.6 Assessment of nylon net for the management of rhinoceros beetle (RB) infesting coconut

Observations	May, 2022		June, 2022		Mean	
	Pre-Count	Post-Count	Pre-Count	Post-Count	Pre-Count	Post-Count
RB adults trapped on Net/palm (Nos.)	-	0.42 ± 0.16	-	0.97 ± 0.08	-	0.69 ± 0.12
Leaf damage by RB (%)	37.7	26.2 ±1.5	29.4	20.9 ± 2.7	33.5	23.5 ± 2.0
Spindle damage by RB (%)	51.4	15.0 ± 4.3	42.9	14.3 ± 4.3	47.1	14.6 ± 4.2

Average mean ± Standard Error

Production and supply of parasitoids

Aliyarnagar

The parasitoid, *Bracon brevicornis* for the management of coconut black headed caterpillar, *Opisina arenosella* is being mass cultured at Biocontrol Laboratory of Coconut Research Station, Aliyarnagar and the same was distributed to the needy farmers. Coconut leaflets containing *Encarsia guadeloupae* were collected from rugose spiralling whitefly infested palm and released in newer areas of infestation. During 2022, a total of 7476 packets of *Bracon brevicornis* and 323 packets of *Encarsia guadeloupae* were distributed to the coconut growing farmers for the management of black headed caterpillar and rugose spiralling whitefly.

Table 7 Production and supply of parasitoids for the management of coconut pests in Aliyarnagar centre

Month	*Bracon brevicornis*No. of packets	*Encarsia* parasitoidsNo. of packets
January 2022	252	59
February 2022	760	115
March 2022	990	50
April 2022	1040	4
May 2022	448	37
June 2022	643	—
July 2022	235	—
August 2022	227	—
September 2022	492	—
October 2022	239	54
November 2022	1026	2
December 2022	1124	2

Each packet contains 100 numbers of parasitoids

Ambajipeta

Mass multiplication of parasitoids *viz., Bracon hebetor , Bracon brevicornis, Goniozus nephantidis, Pediobius imbrues, Trichogramma chilonis, Trichogramma japonicum* and predator *Apertochrysa astur* are being carried at Bio control Laboratory, Dr. YSRHU-HRS, Ambajipeta and *B. hebetor* (49,400), *B. brevicornis* (30,000), *G.*

nephantidis (1), predator *A. astur* eggs (17,30,706), *A. astur* grubs (5,42,500), *T. chilonis* cards (261 cc), *T. japonicum* cards (12 cc) were supplied to the farmers of East Godavari, West Godavari, Dr. B. R. Ambedkar Konaseema, Eluru, Vizianagaram, Visakhapatnam, Srikakulam, and Tirupati districts of Andhra Pradesh , Medchel district of Telangana state. 20,138.7 cc of *Corcyra cephalonica* has been produced at Dr YSRHU-HRS, Ambajipeta. Initial culture of *Bracon brevicornis* was brought from ICAR-CPCRI, Kasargod during May 2022 for multiplication at Dr. YSRHU-HRS, Ambajipeta instead of *B. hebetor*. 50 *Encarsia guadeloupae* leaf clippings (5 -10 *Encarsia* parasitized pupae per leaf clipping) also provided to AICRP Palms centre, Chattisgarh for release in their gardens infested with whitefly.

Arsikere

Wide spread incidence of coconut black headed caterpillar infestation was recorded in Chikkamagaluru, Tumkur, Mysore, Hassan, Davanagere, Chitradurga, Shivamogga and Mandya districts. Mass multiplication of *Bracon brevicornis* and *Goniozus nephantidis* is being carried out at Biocontrol Laboratory of Horticulture Research and Extension Centre, Arsikere and a total of **7800** *Bracon brevicornis* and **49600** *Goniozus nephantidis* parasitoids were supplied for release in approximately 131Palms (*Bracon*) +826 Palms (*Goniozus*)of black headed caterpillar infested coconut palms(Table 8).

Table 8 Production and supply of parasitoids for the management of coconut black headed caterpillar in Arsikere centre

Months	*Braconbrevicornis*	*Goniozusnephantidis*
April 2022	1000	2800
May 2022	1200	1400
June 2022	300	800
July 2022	800	1000
August 2022	900	2000
September 2022	1000	15000
October 2022	500	1500
November 2022	100	2000
December 2022	100	5000

Ratnagiri

The mass multiplication of *Bracon brevicornis* and *Goniozus nephantidis* was carried out at Bio-control laboratory of Regional Coconut Research Station, Bhatye Dist. Ratnagiri and a total of 110255 nos. of *B. brevicornis* and 69510 nos. of *G. nephantidis* parasitoids were mass multiplied and supplied for released in RCRS, Ratnagiri farm and farmers fields. The reduviid bugs and *Encarsia* parasitoids also multiplied and sold out 6600 nos. and 4400 nos., respectively (table 13) for the effective management of leaf eating caterpillar and rugose spiralling whitefly. AICRP-RCRS, Ratnagiri has also generated receipt of Rs. 66200/- by selling of parasitoids to the farmers.

Table 9. Production and supply of natural enemies

Months	*Bracon brevicornis*		*Goniozus nephantidis*		Reduviid Bug	*Encarsia* parasitoids
	No. of Parasitoids mass multiplied	Sale (Rs.)	No. of Parasitoids mass multiplied	Sale (Rs.)	Sold out (Rs.)	Sold out (Rs.)
Jan., 22	2950	1150	700	1000		-
Feb., 22	1960	-	500	-	820/-	-
Mar., 22	13000	8500	300	-	2500/-	2400/-
April,22	12000	7200	400	200	2000/-	2000/-
May, 22	13500	2500	500	200	-	-
June, 22	1550	-	80	-	-	-
July, 22	800	-	30	-	-	-
Aug., 22	1450	-	200	-	-	-
Sept., 22	800	-	100	-	-	-
Oct., 22	500	-	400	-	-	-
Nov., 22	5350	4000	4500	-	1200/-	-
Dec., 22	24200	7000	24300	11000	-	-

Demonstration of Integrated Pest Management of Rugose Spiralling Whitefly (RSW) – conducted during 2022

Aliyarnagar

One acre coconut garden with Dwarf genotype (Gowthami Ganga) aged six years has been selected for the demonstration and a separate one acre control plot also maintained. IPM practices (Installation of yellow sticky traps (12 Nos) in the garden, Three rounds of neem oil spray 0.5% at 15 days interval and Three rounds of jet water spray 10 days after spraying neem oil) has been followed in the demonstration plot. Detailed observation on RSW was recorded before treatment and after 10 days of last treatment imposition. Results revealed that, the intensity of the RSW was reduced from 74.2 to 29.5 percent and percent parasitization of RSW by *Encarsia* was increased from 23.4 to 55.36 percent after imposing the IPM practices (Table 10). Hence it is proved that, the current IPM practices effectively control the RSW in short span of time.

Table 10. Integrated pest management of rugose spiraling whitefly during 2022

Months	Incidence (%)	Intensity (%)	Grade	Live colony*			**Natural enemies		Parasitization(%)
				Eggs	Nymphs	Adult	Spiders	Predators	
Pre - treatment observations									
T1-IPM	47.6	74.2	1.4	18.6	17.8	15.2	0.4	0.9	23.4
T2-Natural control	47.2	73.9	1.3	18.9	18.2	14.8	0.5	1.0	22.9
Sig. (P= 0.1)	NS	NS	NS	NS	NS	NS	NS	NS	NS
't' value	0.4	0.5	0.2	0.6	0.5	0.4	0.2	0.2	0.7
Post - treatment observations									
T1-IPM	39.2	29.5	0.7	6.8	8.2	5.5	0.6	1.5	55.36
T2-Natural control	46.2	71.5	1.4	16.6	16.5	15.7	0.9	1.2	38.14
Sig. (P= 0.1)	*	*	*	*	*	*	*	NS	*
't' value	4.7	12.5	0.6	4.8	5.3	7.2	0.2	0.4	7.9

Ambjipeta

The experiment was conducted in HRS, Ambajipeta in Andhra Pradesh. A total of 50 palms of the variety Godavari Ganga which were 5 years old juvenile palms in continuous area 25 IPM and 25 natural were selected. IPM package was implemented in the field as per the experimental protocol. Pre data on the leaf incidence and intensity of pest was 73.13%, 62.18% in IPM garden and the mean no. of spirals, nymphs and pupae per four leaflets per palm was 13.87, 61.70 and 33.99 respectively in IPM garden. where as post treatment observations revealed that, there was gradual decrease in leaf infestation and pest intensity, mean no. of spirals per four leaflets (Table 11)

Table 11. Integrated pest management of rugose spiraling whitefly at Andhra Pradesh during 2021-22

Integrated pest management of rugose spiraling whitefly at HRS, Ambajipeta during 2021-22						
Treatments	**Pre-treatment observations**					
	Incidence of RSW (%)	**Intensity of RSW (%)**	**Grade**	**Mean no. of pest stages per 4 leaflets**		
				Spirals	**Nymphs**	**Pupae**
T1-IPM	73.13 ± 0.46	62.18 ± 0.47	1.20 ± 0.95	13.87 ± 0.51	61.70 ± 0.63	33.99±0.51
T2-Natural control	71.07 ± 0.94	61.68 ± 0.51	1.10 ± 0.69	11.94 ± 0.59	57.08 ± 0.69	31.68 ± 0.39

Post data on the leaf infestation and intensity of pest was 73.45%, 53.34% in IPM garden and the mean no. of spirals, nymphs and pupae per four leaflets per palm was 6.07, 12.91 and 10.12 respectively in IPM garden, where as post treatment observations revealed that, there was gradual decrease in leaf infestation and pest intensity, mean no. of spirals per four leaflets

Arsikere

The experiment was carried out at Karagunda village of Arsikeretaluk, totally there was 25 Tiptur tall (TPT) palms were selected for determination of IPM strategies over natural control for each treatment against rugose spiraling whitefly. IPM package for Rugose spiralling whitefly was implemented in the plot as per the experimental protocol. Pre data on

the incidence and intensity of whitefly was recorded in the month of October 2021. Post treatment observations were recorded on an incidence and intensity of whitefly. Simultaneous observations were also made in control plot. After imposition of treatments, the whitefly infestation gradually decreased from 18.7per cent to 7.6per cent in treatment and in control plot the whitefly infestation increased from 18.2to 29.5per cent . The IPM treatment recorded minimum adult's population (1.6), nymph (2.2) and egg (0.3) which was significantly superior over natural control. The IPM treatment also registered the highest predator population (9.2) over the control (3.1).

Ratnagiri

The IPM strategies and natural control were adopted in 25 GBGD variety palms for management of whitefly complex. The present experiment was initiated in October, 2021 and the generated data indicated that the non significant results registered during pre-experimental observations. The integrated pest management (IPM) treatment could reduce the incidence and intensity of rugose spiralling whitefly (RSW) to 23.0 and 22.5 per cent, respectively over pre-experimental values (41.9 and 43.7%, respectively). The IPM treatment was found significantly superior over the natural control. The grade pest intensity was reduced in IPM to 0.75 (Low) as compared to pre-experimental value 2.2 (High). The non significant results were observed in natural enemies (spiders/predators) and *Encarsia* parasitism associated with rugose spiralling whitefly (RSW). The natural control registered the increase of incidence and intensity of RSW to 55.5 and 58.4 as compared to pre-experimental observations (40 and 44.9 %), respectively. The natural enemies like spiders, predators and *Encarsia* parasitism was recorded maximum in unsprayed plot (1.2, 0.8 and 58.1 %) over sprayed plot (0.8, 0.6 and 47.5%, respectively).

IX. MONITORING REVIEWS AND MEETINGS

Monitoring Reviews Monitoring Reviews

Approved technical programmes were monitored by visiting the center, reviewing the monthly progress report of the centres. Reviewed the Centres and ascertained the implementation of technical programmes as per the schedule through physical mode. Time to time advice and direction was given for proper implementation of the technical programmes through emails, personal contact and over direct contact via phone as and when required.

Monthly progress report and budget utilization information were obtained from centres regularly and the same were reviewed critically. During the review meetings, discussions were held with concerned scientists of ICAR-AICRP on Palms for the smooth functioning of the research programmes. During review meeting, PC has given guidelines for proper utilization of budget, publications and improving the technical programmes.

S. No	AICRP centres	Date
1	Arsikere	12.4.2022
2	Shivamogga and Bavikere	13.4.2022
3	Kahikuchi	25.5.2022
4	Mondouri	26.5.2022
5	Pilicode	6.6.2022
6	Pasighat	24.9.2022 to 25.9.2022
7	Arsikere, Bavikere and Shivamogga	11.10.2022 to 12.10.2022
9	Killikulam	27.10.2022 to 29.10.2022
10	Sabour	19.12.2022 to 21.12.2022

Events Conducted:

The 31st Annual Group Meeting of All India Co-ordinated Research Project on Palms was conducted at Central Plantation Crops Research Institute, Kasaragod from 16-18 September 2022, which coincided with the Golden Jubilee Year of AICRP (Palms). The meeting was inaugurated on 16th September 2022 by Dr. V. Geethalakshmi, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore. The formers Project Coordinators Dr.P.Rethinam, Former Executive Director, ICC (APCC), Jakarta, Dr.S.Arulraj, Former Director, IIOPR, Pedavegi, Dr.H.Hameed Khan Former Project Co-ordinator of AICRP (Palms) and Dr.H.P.Maheswarappa, Director of Research, UHS, Bagalkot were the Guests of honour. Dr. R.K.Mathur, Director, IIOPR, Pedavegi, Dr.V.S. Korikanthimath, Former Director, ICAR Research Complex for Goa and Dr. P. Chowdappa, Former Director, ICAR – CPCRI Kasaragod, also participated in the inaugural session.

Dr. Ravi Bhat, Acting Head (Crop Production) and Scientist in-charge, Project Co-ordinator Cell, CPCRI, Kasaragod welcomed the dignitaries and delegates in which he highlighted the yeomen service and spade work of the Former Project Co-ordinators of AICRP (Palms) in moulding the programme to hit several milestones in the Plantation Crops Sector. The Project Co-ordinator presented a brief note on the mission of the Project Directorate since its genesis in1972 on five mandate crops - Coconut, Oil palm, Palmyrah, Arecanut and Cocoa distributed across 28 AICRP centres of 14 States, 13 State Agricultural Universities, 4 ICAR institutes and one Central Agricultural University of the nation. He opined that the release of Oil plam variety NRCOP – 4, identification of the precocious coconut hybrid Godavari Ganga and Tall x Tall hybrid combinations of coconut, Coconut based multispecies cropping system models in transformation of unproductive ecosystems to vibrant environment, Integrated

Nutrient Management for higher productivity and profitability of dwarf coconut, Development of location specific Integrated Farming System models, Integrated Pest and Disease Management modules for the management of stem bleeding, leaf blight and Rugose Spiraling Whtiefly in coconut stands testimony to the work of AICRP (Palms). Intercropping of Burmese Coriander in Arecanut System, multiplication of superior cocoa clones VTLCH 7 and 14 for planting material production to cater the need of North East India and export of a consignment of dehydrated tuber and tuber flour of Palmyrah to UK were underlined by him. Taking technology to the farmers' door steps and to the technologically deprived through series of trainings under SCSCP / TSP mission, supply of biocontrol agents to curb pest and disease menace, supply of elite seedlings of plantation crops remain added strength of the programme.

Dr.V.Geethalakshmi, Vice Chancellor, TNAU, Coimbatore in her Inaugural Address applauded AICRP (Palms) for the release of 21 varieties of coconut and 11 varieties of arecanut and a bouquet of crop production technologies towards improving the standard of living of the plantation crop growers. Non scientific management and senile palms remain major impediments in achieving higher productivity. She also emphasized the need for developing varieties tolerant to pests, diseases and to weather extremities. She invited the palm researchers to enlighten the farmers on crop diversification and value addition to overcome the frequent depression in price chart of copra and also to devise strategies to enhance water use efficiency. She outlined the scope for oil palm and palmyrah and hinted the need for Mechanization and Artificial Intelligence with robotics and sensors in the era of labour scarcity. Following the Inaugural Address, Dr.P.Rethinam, Founder Director, IIOPR, Pedavegi in his Golden Jubilee Lecture "Reminiscences on Research Imprints of AICRP (Palms)" listed the glorious achievements of AICRP (Palms) in its 50 years journey in terms of release of improved varieties catering to the demands of the farmers, path breaking research technologies like Cropping Systems Approach, Eradication of Tatipakka disease in Andhra Pradesh and effective management of Basal Stem Rot of Coconut. He set forth the need for establishment of Centre of Excellence in Palmyrah as this drought hardy crop provides livelihood security to the rural unemployed. He congratulated all the torch bearers of the AICRP (Palms) scheme for placing the programme in the pinnacle of grandeur.

Dr. H. Hameed Khan, Former Project Co-ordinator in his felicitation appreciated the rigorous efforts of palm scientists in addressing location specific problems and for improving the production base. He rolled out a red carpet to intensify research in value addition of coconut. Dr.S.Arulraj, Former Director, IIOPR in his felicitation expressively looked back the social concern of the palm scientists in overriding the emotional setbacks of the farmers in the events of natural disasters. Dr.H.P. Maheswarappa, Former Project Co-ordinator, AICRP (Palms) and Director of Research, University of Horticultural Sciences, Bagalkot attributed the accolades like Best AICRP Centre of ICAR during 2015 and 'OUTSTANDING' rank of Quinquennial Review Team of 2020 to the exemplary guidance of the predecessors together with the industrious efforts of the palm scientists garnished with enthusiasm across the nation.

Dr. Anita Karun, Director, CPCRI and Project Co-ordinator (Acting), AICRP (Palms) in the Presidential Address extended profuse gratitude to the entire palm scientists for the achievements of AICRP (Palms) which helped transform the lives of the palm growers towards economic prosperity. She also wished that all the palm scientists should join hands to take the AICRP (Palms) programme and plantation crops sector to greater heights in the nation. The inaugural session concluded with the formal vote of thanks by Dr. P. Subramanian, Principal Scientist (Agronomy), CPCRI, Kasaragod. About 100 participants from across different AICRP centres of the nation attended the Annual Group Meet. Navsari Centre, Gujarat received the Best AICRP (Palms) Centre Award for the year 2021. Bouquet of publications in terms of Technical Bulletins, booklets and folders prepared by the palm scientists were released in the event. The inaugural session was followed by technical sessions on Genetic Resources and Crop Improvement, Crop

Production, Crop Protection and Post Harvest Technology.

Brainstorming session on coconut and arecanut pest and diseases

Brainstorming session on coconut and arecanut pest and diseases in different regions of Karnataka was jointly organized by Keladi Shivappa Nayaka university of Agricultural and Horticultural sciences, Shivamogga and ICAR- AICRP on Palms, ICAR-CPCRI, Kasaragod on 12.10.2022 at Shivamogga. Dr. Anitha Karun, Director and Project Coordinator (Palms) Dr. Vinayaka Hegde, Head (Crop Protection) ICAR- CPCRI, Kasaragod Dr, Ravi Bhat, Head (Crop Production) ICAR- CPCRI Dr. Sumitha. S, Scientist ICAR- CPCRI, Kasaragod also attended the meeting. The programme was attended by about 30 officials from University and Department of Horticultural, Government of Karnataka.

Palmyrah Breeder Meet:

Palmyrah breeder meet was organised in AICRP on Palms center, Killikulam to 28.10.2022 to prepare the Road Map for Palmyrah breeding. Dr. Anitha Karun, Director ICAR – CPCRI, Kasaragod, Dr. Ravi Bhat Head (Crop Production), Dr. V. Niral, Principal Scientist (Plant Breeding and Genetic), Dr. Sumitha. S Scientist (SPMA) from ICAR – CPCRI, Kasaragod and Dr. B. A. Jerald, Head (Horticulture and Forestry) ICAR- CIARI Port Blair and Scientist from AICRP on Palms, Palmyrah center, Pandirimamidi and Konda Mallepally also attended the meeting. The programme was attended by about 30 members including farmers, official from University and Department of Horticultural, Government of Tamil Nadu. Model descriptors was prepared in the technical session of the meeting.

XI PUBLICATIONS

Reports

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3. AICRP (Palms), 2022. Annual Report 2021. ICAR-All India Co-ordinated Research Project on Palms, (Eds. Ravi Bhat and Sumitha, S). ICAR-CPCRI, Kasaragod. 134 P.

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S.L. Ghavale, K.V. Malshe, S.M. Wankhede, S.G. Bhave, Ravi Bhat and S. Sumitha. 2022. Assessment of Dwarf x Dwarf coconut (*Cocos nucifera*) hybrids for yield and quality parameters in coastal track of Maharashtra (India). National Conference on Enhancing Competitiveness in Horticulture Through Technology Innovations, 17-18 November 2022, ICAR- Central Plantation Crops Research Institute, Kasaragod, Kerala, 23 pp.

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- OIL PALM (Telugu) - Udyana panchagam book

- COCOA in (Telugu) - Udyana panchagam book

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Weather data of Co-ordinating Centres

ALIYARNAGAR					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	32.3	24.4	91.2	68.7	0
February	32.1	23.3	91.7	62.3	0
March	35.5	25.7	88.4	60.6	24.4
April	35.5	27.7	92.5	66.0	97.4
May	32.7	26.8	85.5	74.7	83.9
June	34.3	28.1	77.8	67.7	10.2
July	30.8	26.7	85.7	76.2	109.1
August	31.4	26.3	81.6	65.7	146.8
September	32.1	25.8	82.1	66.7	60.1
October	32.6	26.4	92.3	70.9	126.2
November	31.1	25.4	92.0	72.1	198
December	0	0	0	0	0

AMBAJIPETA					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	28.85	21.58	89.39	66.74	23.6
February	29.22	21.55	91.71	68.11	0
March	37.8	21.66	79.8	72.0	0
April	39.54	24.93	76.93	69.6	0
May	39.16	26.91	74.13	75.86	54.5
June	38.01	26.83	89.46	65.96	73.0
July	33.45	25.31	95.55	70.16	216.9
August	35.55	25.83	95.55	66.52	69.0
September	34.96	25.22	97.5	69.47	237.5
October	34.27	23.58	97.13	63.23	276.0
November	33.62	20.79	95.6	53.13	37.5
December	0	0	0	0	0

ARSIKERE					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	38.18	22.55	66.13	47.1	0
February	37.39	24.63	51.64	35.43	0
March	39.47	27.0	49.48	36.13	0
April	41.4	29.57	60.5	39.57	18.0
May	39.95	26.34	70.06	54.58	241.4
June	38.83	25.97	70.33	50.57	27.9
July	31.68	24.1	80.1	67.42	90.0
August	31.11	23.06	78.9	66.39	190.6
September	32.49	22.7	72.27	63.6	179.1
October	31.02	23.29	70.84	58.35	86.4
November	30.97	22.5	69.27	54.53	16.4
December	30.24	21.56	66.0	49.81	31.0

BHUBANESWAR					
Month	Temperature (°C)		Relative Humidity %		Rainfall
	Max	Min	7 hr	14 hr	(mm)
January	26.5	14.7	94.0	47.0	29.1
February	30.0	17.2	95.0	71.0	41.1
March	35.4	22.5	94.0	70.0	0
April	36.9	26.5	94.0	76.0	0
May	35.9	26.3	93.0	79.0	185.9
June	35.4	27.1	93.0	83.0	98.2
July	32.3	26.1	95.0	91.0	379.3
August	32.2	25.7	94.0	90.0	329.4
September	32.8	25.8	95.0	89.0	234.1
October	31.8	24.0	93.0	84.0	169.1
November	30.7	18.6	83.0	52.0	0
December	29.2	16.3	87.0	44.0	0

GOA					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	32.22	19.38	83.61	41.65	0
February	33.94	19.5	90.07	41.11	0
March	35.6	23.56	83.61	49.1	0.3
April	35.21	24.95	86.07	55.37	51.2
May	33.66	25.88	88.97	62.58	99.6

June	31.06	23.92	92.97	78.4	700.6
July	29.45	23.37	93.97	82.71	1098.3
August	29.65	22.87	93.97	79.65	347.6
September	30.21	22.54	94.57	73.67	276.8
October	32.49	21.72	90.03	58.74	71.3
November	34.26	21.21	82.2	46.6	0
December	34.56	21.03	86.0	41.58	2.2

KAHIKUCHI					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	24.0	10.4	81.2	77.0	4.3
February	26.1	13.2	71.5	68.4	0
March	28.5	16.6	66.7	60.1	26.2
April	31.0	18.3	73.8	69.4	139.2
May	32.4	21.3	78.8	71.2	117.9
June	34.5	24.7	84.1	72.5	221.8
July	35.1	26.1	85.2	78.6	259.5
August	35.3	25.4	85.1	77.8	174.3
September	33.3	24.2	85.3	78.1	123.6
October	31.6	18.6	83.7	71.4	69.6
November	29.0	15.9	81.2	70.5	8.2
December	24.8	11.4	82.7	72.4	0

JAGDALPUR					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	26.8	11.6	94.0	42.0	65.4
February	29.5	11.9	89.4	30.6	0.5
March	35.0	17.2	81.4	23.9	1.6
April	36.9	21.7	78.1	37.8	12.6
May	36.1	23.2	74.8	43.7	84.1
June	33.5	23.2	79.8	57.4	144.8
July	28.1	22.0	92.7	79.5	582.4
August	29.3	21.8	92.6	74.6	679.9
September	29.9	21.7	92.6	71.7	452.4
October	29.6	18.7	91.9	60.3	88.8
November	28.9	12.9	88.9	40.3	0
December	0	0	0	0	0

KILLIKULAM					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	32.0	24.0	70.8	69.98	49.0
February	32.0	23.0	67.5	68.01	58.01
March	33.0	23.0	66.4	65.37	72.61
April	33.0	22.0	65.04	64.49	58.8
May	33.0	24.0	64.02	62.42	58.98
June	32.0	25.0	60.9	59.94	11.04
July	32.0	24.0	65.2	59.28	16.33
August	34.0	24.0	65.3	61.14	38.75
September	32.0	24.0	63.25	62.68	57.4
October	33.0	24.0	68.35	67.31	294.4
November	31.0	24.0	76.1	73.12	383.2
December	32.0	24.0	75.02	74.35	230.06

KONDA MALLEPALLY					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	28.6	15.0	86.4	48.0	4.6
February	31.3	15.0	85.5	36.9	0
March	35.8	19.0	83.1	49.7	3.2
April	38.3	23.3	77.7	35.8	6.2
May	38.0	25.2	78.8	52.7	3.6
June	35.4	24.7	85.7	50.7	87.6
July	28.8	22.5	91.6	73.4	368.8
August	30.0	22.9	89.1	67.3	92.4
September	30.0	22.5	89.9	69.8	228
October	29.6	19.8	88.7	58.7	171.8
November	29.4	15.9	83.2	42.1	0
December	29.2	15.9	89.3	45.5	3.6

MONDOURI				
Month	Temperature(°C).		Rainfall	Relative Humidity
	Max	Min	(mm)	(%)
January	24.4	12.14	0.86	78.32
February	28.14	14.12	1.29	73.82
March	33.77	20.39	0	70.75
April	36.5	25.11	0	71.59
May	34.92	25.16	6.52	79.4

June	34.24	26.32	5.57	81.08
July	33.05	26.1	5.31	83.68
August	32.69	25.61	5.11	85.45
September	29.67	24.85	3.11	83.11
October	30.89	23.18	1.9	80.71
November	29.79	16.96	0	72.17
December	26.49	12.31	0	75.19

MULDE					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	32.9	16.0	89.0	45.0	12.6
February	34.9	16.5	91.0	40.0	0
March	36.8	21.0	90.0	47.0	0
April	36.5	23.8	89.0	55.0	45.6
May	35.4	24.6	87.0	58.0	19.6
June	31.6	23.3	94.0	75.0	712.5
July	29.8	23.1	93.0	84.0	1176.2
August	30.5	23.0	94.0	80.0	567.0
September	31.1	22.5	94.0	76.0	598.5
October	32.8	21.1	93.0	69.0	244.2
November	35.0	18.8	89.0	46.0	5.8
December	34.9	17.4	92.0	47.0	5.6

NAVSARI					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	29.0	13.9	88.0	47.0	0
February	31.2	13.7	94.0	38.0	0
March	37.0	19.1	78.0	31.0	0
April	36.2	22.8	92.0	50.0.	0
May	34.9	26.8	85.0	62.0	0
June	33.3	25.5	91.0	68.0	164.0
July	29.4	24.3	96.0	87.0	995.0
August	30.7	24.0	93.0	78.0	527.0
September	31.4	23.7	96.0	75.0	660.0
October	33.6	21.3	87.0	58.0	74.0
November	33.7	16.9	82.0	33.0	0
December	29.3	15.6	76.0	36.0	0

PANDIRIMAMIDI					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	30.8	17.2	93.0	45.0	22.4
February	31.8	17.6	92.0	33.0	17.8
March	35.4	18.9	90.0	36.0	8.4
April	38.5	23.1	81.0	39.0	66.8
May	38.9	24.4	65.0	41.0	26.8
June	37.5	27.1	75.0	52.0	257.4
July	35.4	27.7	96.0	70.0	448.9
August	35.2	26.4	97.0	77.0	284.4
September	32.5	22.9	98.0	73.0	238.8
October	31.9	20.9	95.0	56.0	254.6
November	31.3	18.5	98.0	73.0	78.4
December	31.8	18.9	95.0	69.0	8.2

PATTUKOTTAI					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	30.1	21.7	81.9	65.2	192.5
February	31.0	19.2	79.4	55.3	18.5
March	34.0	23.3	79.2	56.3	7.5
April	34.3	25.2	82.7	71.5	157.5
May	36.7	25.7	79.7	66.9	0
June	34.2	25.5	82.0	77.4	4.5
July	35.3	25.2	78.5	59.6	186.75
August	34.2	24.3	91.5	76.4	100.6
September	33.6	24.7	90.5	77.8	133.25
October	32.5	24.2	93.3	77.9	119.75
November	31.8	22.5	92.5	80.0	109.0
December	30.4	21.6	91.7	82.5	137.0

PILICODE					
Month		Temperature(°C)		RH (%)	Rainfall (mm)
		Max.	Min.	Forenoon	Afternoon
January	32.01	19.77	91.71	62.65	0
February	32.95	20.54	92.25	69.11	0
March	34.68	21.15	90.03	69.58	0.53
April	34.73	22.9	78.37	76.73	2.21
May	32.44	23.68	87.58	76.35	10.74

June	31.12	23.69	90.45	90.18	16.19
July	29.24	23.45	89.3	89.22	53.83
August	30.62	23.81	87.97	87.45	20.83
September	30.68	23.79	89.07	86.63	10.95
October	32.27	23.66	87.1	81.0	0.96
November	31.85	23.07	92.58	70.81	1.23
December	31.46	21.68	94.12	66.93	1.05

PORT BLAIR					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	30.6	25.0	71.0	74.0	67.8
February	30.1	23.5	73.0	75.0	105.3
March	31.5	25.2	73.0	77.0	76.5
April	32.5	25.6	71.0	75.0	93.5
May	30.8	25.4	83.0	86.0	473.0
June	30.8	25.1	81.0	86.0	296.5
July	30.1	25.1	85.0	88.0	392.6
August	30.1	25.1	83.0	87.0	313.9
September	30.4	24.6	82.0	87.0	326.2
October	30.1	24.6	81.0	87.0	232.1
November	30.1	24.9	77.0	83.0	86.3
December	0	0	0	0	0

SIRSI					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	33.0	14.0	80.0	74.0	0
February	36.0	18.0	79.0	72.0	0
March	38.0	18.8	76.0	71.0	20
April	36.3	22.6	84.0	82.0	56.8
May	33.0	22.0	90.0	89.0	292.4
June	31.5	21.4	90.0	83.0	249.6
July	28.3	20.5	91.0	88.0	1313.4
August	29.5	20.4	91.0	88.0	825.2
September	29.5	19.9	89.0	86.0	301
October	29.7	18.7	89.0	84.0	82.6
November	30.4	16.4	86.0	79.0	0
December	30.0	18.0	82.0	71.0	0

SABOUR					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	20.3	10.8	95.5	65.7	7.7
February	23.9	11.3	93.6	58.8	32.4
March	32.6	18.8	86.7	46.5	0
April	36.3	22.8	84.7	53.3	2.0
May	35.4	23.5	82.3	48.9	68.6
June	35.8	25.3	84.9	55.3	161
July	36.0	26.1	85.0	58.7	43.6
August	33.7	25.9	87.2	63.7	77
September	32.7	25.4	89.8	69.2	48.4
October	31.8	21.4	92.5	69.2	134.6
November	29.6	13.6	95.5	67.8	0
December	24.9	9.0	96.1	68.6	0

SHIVAMOGGA							
Month	Temperature (°C)		RH (%)	Rainfall (mm)	Wind speed (Km/hr)	Sunshine Hours	Evaporation (mm/day)
	Max.	Min.					
January	30.6	15.9	69.0	0	4.0	8.9	5.4
February	32.7	16.8	54.0	0	4.8	9	5.9
March	34.7	20.1	52.0	2.8	6.1	6.1	6.3
April	34.5	22.2	63.0	135.2	4.9	6.7	5.6
May	30.5	21.9	75.0	283.6	7.1	3.4	4.6
June	30.9	21.9	79.0	48.0	7.4	0.5	0.9
July	27.5	21.4	89.0	378.7	7.8	2.1	2.5
August	27.3	21.2	91.0	364.1	7.4	2.9	2.6
September	28.9	20.9	86.0	90.8	5.3	4.2	4.4
October	29.5	19.8	81.0	119.4	3.2	5.7	4.4
November	29.5	18.3	72.0	12.4	3.5	6.6	4.6
December	29.8	17.1	70.0	24.0	4.1	7.4	4.7

THRISSUR					
Month	Temperature(°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
January	33.3	22.6	82.0	46.0	0
February	34.8	23.3	76.0	40.0	0
March	36.1	24.7	90.0	58.0	1.7
April	34.2	25.1	90.0	64.0	84.3

May	31.1	24.0	95.0	76.0	422.0
June	31.3	23.6	96.0	72.0	391.8
July	29.3	23.5	96.0	80.0	628.8
August	29.9	23.6	95.0	74.0	563.7
September	31.1	23.7	94.0	68.0	167.5
October	32.0	23.6	93.0	63.0	69.6
November	32.4	23.0	87.0	58.0	75.4
December	32.2	22.6	81.0	52.0	91.7

WAKAWALI					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	31.01	14.28	88.46	44.36	10.4
February	33.82	14.21	80.2	33.09	5.5
March	36.28	19.22	81.29	37.77	2.2
April	36.79	22.59	81.7	50.4	0
May	34.81	23.88	82.26	54.45	0
June	31.03	23.29	89.77	70.63	600.0
July	27.72	23.27	95.55	89.26	1450.2
August	30.33	23.8	92.0	78.33	1243.2
September	29.05	22.6	96.15	82.19	362.3
October	31.28	20.58	89.9	60.17	113
November	33.77	15.56	88.6	55.6	0
December	33.92	16.05	90.12	52.15	0

VEPPANKULAM					
Month	**Temperature(°C)**		**RH (%)**		**Rainfall (mm)**
	Max.	**Min.**	**Forenoon**	**Afternoon**	
January	30.1	21.7	81.9	65.2	126.4
February	31.0	19.2	79.4	55.3	17.8
March	34.0	23.3	79.2	56.3	29.8
April	34.3	25.2	82.7	71.5	125.2
May	36.7	25.7	79.7	66.9	11.4
June	34.2	25.5	82.0	77.4	46.0
July	35.3	25.2	78.5	59.6	250.4
August	34.2	24.3	91.5	76.4	169.9
September	33.6	24.7	90.5	77.8	148.6
October	32.5	24.2	93.3	77.9	117.4
November	31.8	22.5	92.5	80.0	139.2
December	30.4	21.6	91.7	82.5	115.4