आज़ादी का अमृत महोत्सव

ICAR-AICRP on Palms

ANNUAL REPORT 2021

वार्षिक प्रतिवेदन

भा.कृ.अनु.प. - अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना
भा.कृ.अनु.प. - केंद्रीय रोपण फसल अनुसंधान संस्थान
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

www.cpcri.gov.in, www.aicrppalms.res.in

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Hindi Translation
Dr. Alka Gupta

March, 2022

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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).Site Specific Nutrient Management withsecondary ($CaSO_4$. $2H_2O$ – 1 kg and $MgSO_4$– 500 g per palm per year) + Micronutrientmixture ($FeSO_4$, $MnSO_4$, $CuSO_4$, $ZnSO_4$,Borax and ammonoiummolybdate) @ 1 kg perpalm per year + Coconut frond mulching + Azospirillum – 100 g + Phosphobacteria - 100g + VAM -100 g per palm per year enhanced productivity by 32 % over farmers' practice inTender nut variety Chowghat Orange Dwarf.

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, 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.

Mar, 2022 (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 शुरु 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 रुपये 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 ग्रेंडिपलोरा* + *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/- रुपये की तुलना में, प्रति हेक्टेयर 3.16 के बीसी अनुपात के साथ 2,54,206/- रुपये की शुद्ध आय दर्ज की।

स्थान विशेष पोषक तत्व प्रबंधन के साथ द्वितियक रुप 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 रुपये के मुकाबले क्रमश: 4.38 लाख प्रति हेक्टेयर और आई एन एम 2.99 लाख रुपये 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 शुरू 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 देखा 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 देखा गया। बुश काली मिर्च से अधिकतम उपज 0.726 ग्रा. प्रति पौध और सुखे 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 पश्चिमी 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 देखा 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 हो, 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 खराब 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 देखा 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।

बैठकों का आयोजन

केंद्रीय रोपण फसल अनुसंधान, कासरगोड द्वारा वर्चुअल मोड के माध्यम से आयोजित अखिल भारतीय समन्वित अनुसंधान परियोजना की 30 विं वार्षिक समूह बैठक का उद्घाटन 22 नवम्बर 2021 को किया गया। डॉ बी.के. पांडे, सहायक महानिदेशक (बागवानी विज्ञानं II), भा कृ अनु प, नई दिल्ली ने कार्यक्रम के मुख्य अतिथि के रूप में बौठक का उद्घाटन किया। डॉ. आर.के. माथुर, निदेशक भा कृ अनु प - आई आई ओ पी आर, पेदावेगी और डॉ एकनाथ बी. चाकुरकर, निदेशक भा कृ अनु प - सी आई ए आर आई, पोर्ट ब्लेयर ने उद्घाटन सत्र में भाग लिया। डॉ अनिता करुण, निदेशक व परियोजना समन्वयक (कार्यवाहक), सीपीसिआरआई कासरगोड ने गणमान्य व्यक्तियों और प्रतिनिधियों का स्वागत किया व भाकृअनुप की प्रगति का श्रेय उपमहानिदेशक और सहायक महानिदेशक (बागवानी विज्ञान II) को देते हुए उनके द्वारा विविध क्षेत्रों पर प्रदान किए गए प्रत्यक्ष अनुभव व निरंतर समर्थन की सराहना की। तब उन्होंने (ताड़) की वर्ष 2020-2021 की रिपोर्ट प्रस्तुत की। डॉ रवि भट्ट, कार्यवाहक प्रमुख (फसल उत्पादन) और वैज्ञानिक प्रभारी, पी सी सेल द्वारा 10-11 अगस्त 2020 को आयोजित एचीएम की सिफारिशों की कार्यवाही की रिपोर्ट प्रस्तुत की गई। सहायक महानिदेशक (बागवानी) विज्ञान) ने अपने उद्घाटन भाषण में "अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के स्वर्ण जयंती समारोह के उपलभ्य में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के पचास वर्ष" पर प्रकाशन निकालने का सुझाव पेश किया। प्रतिरूप रहित विशेषता-विशिष्ट जर्मप्लाज्म के संग्रह, संरक्षण और मुल्यांकन की आवश्यकता, सूक्ष्म पोषक तत्वों के विशेष सन्दर्भ के साथ निविष्ट उपयोग क्षमता बढ़ाने, पौधों की सुरक्षा के लिए लाल लेबल वाले रसायनों के विकल्पों की पहचान और अत्याधुनिक अनुसंधान व प्रौघोगिकी के प्रदर्शन को आसान, सुलभ/सन्दर्भ के लिए डेटा का डिजिटलीकरण और राज्यों के कृषि विज्ञान केंद्रों के माध्यम से फार्म फ्रंट तक पहूँचाने की आवश्यकता पर विचार किया गया। उन्होने अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के अनुकरणीय कार्यों की सराहना की व ताड़ वौज्ञानिकों के तकनीकी मंच पर सफलता के शिखर पर पहूँचने की कामना की। टी x टी नारियल संकर का विकास, नारियल आधारित बहु-प्रजाति फसल प्रणाली, स्थान-विशष्ट एकीकृत कृषि प्रणाली मॉडल, *ट्राईकोटर्मा हर्जियानाम* और *रिसै* द्वारा तना स्रवण रोग प्रबंधन प्रौघोगिकी कैप्सूल के माध्यम से नारियल में रुगोस सर्पिल मक्ख्वी के प्रबंधन, सुपारी प्रणाली में धनिये के एकीकरण, सुपारी क्रउन चोक रोग नियंत्रण और नारियल के बगीचें में अंतलिसुलन के लिए विटिएचसी-2,16,20,17 और 4 उछे प्रदर्शन वाले कोको क्लोनों में की पहचान, जिनका वर्ष 2020 के दौरान नारियल के बगीचों की अंतलिसुलन में उल्लेखनीय योगदान रहा। विभिन्न उपकरणों और विधियों के माध्यम से प्रयोगशाला से खेत तक प्रौधोगिकी का हस्तांतरण और कोविड करपर्यू के बाजूद आवश्यकता-आधारित नैदानिक क्षेत्र का दौरा इस कार्यक्रम की प्रमुख ताकत बना हुआ है। डॉ आर.के. माथुर, निदेशक भा-कृ-अनु-प - आईआईओपीआर, पेदावेगी ने शोधकर्ताओं को वैकल्पिक कीट नाशकों का पता लगने, फसल प्रणाली हष्टिकोण विकसित करने और फसल प्रणालियों में संसाधन उपयोग दक्षता बढाने के लिए प्रेरित किया। डॉ ई.बी. चाकुरकर, निदेशक भा-कृ-अनु-प - सिआईएआरआई, पोर्ट ब्लेयर ने ताड़ वैज्ञानिकों के काम की सराहना की और उनसे स्थान-विशिष्ट कृषि प्रणाली मॉडल, लाने का अनुरोध किया जो धोटे और सीमांत किसानों की आय को दोगुना कर सकते है। विभिन्न अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केन्द्रों और आईसिएआर-केरोसअसं के लगभग 72 प्रतिभागियों को वर्चुअल माध्यम से जोड़ गया। फसलों के विशेषज्ञों ने ताड़ पर अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के कार्य को और बेहतर बनाने के लिए अपने बहुमूल्य सुझाव/सिफारिशों भी प्रदान की। बौठक में 2020-21 के दौरान की गई विस्तृत प्रगति को प्रस्तुत किया गया और आगामी वर्ष (2021-2022) के लिए तवानीकि कार्यक्रमों को अंतिम रूप दिया गया। उद्घाटन सत्र के बाद अनुवांशिक संसाधनों और फसल सुधार, फसल सुधार, फसल उत्पादन, फसल संरक्षण, काटाई उपरांत प्रौधोगिकी और प्रोधोगिकी के हस्तांतरण पर तकनीकी सत्रों का आयोजन 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 2021 (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 Ambajipeta centre, among the varieties/ hybrids evaluated for a period of 2014-2020 Godavari Ganga recorded significantly higher yield/palm/year (144nuts) followed by VHC-2 (135 nuts) and Kera Ganga (133 nuts) with the highest fruit weight (1393 g).

- 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

- 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.

- Integration of coconut with pasture crops (*Cumbu Napier hybrid* + *Desmanthus*), fodder trees (*Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia)* and Tellicherry breed of goats recorded net income of Rs. 2,54,206/- per ha with BC ratio of 3.16 as compared to Rs. 1,51,312/- per ha with BC ratio of 2.25 in the monocrop of coconut at Aliyarnagar centre.

- Site Specific Nutrient Management with secondary ($CaSO_4$. $2H_2O$ – 1 kg and $MgSO_4$ – 500 g per palm per year) + Micronutrient mixture ($FeSO_4$, $MnSO_4$, $CuSO_4$, $ZnSO_4$, Borax and ammonoium molybdate) @ 1 kg per palm per year + Coconut frond mulching + *Azospirillum* – 100 g + *Phosphobacteria* -100 g + VAM - 100 g per palm per year enhanced productivity by 32 % over farmers' practice in Tender nut variety Chowghat Orange Dwarf. Net Returns and Benefit cost ratio were Rs. 4.38 lakhs per ha and 2.99 in INM package as against Rs. 3.10 lakhs per ha and 2.66 in farmer's practice respectively.

CROP PROTECTION

Disease Management

- Thirteen new systemic fungicides were tested against the growth of *Ganoderma spp.* under *in*

vitro condition with three concentrations viz., 100, 250 and 500 ppm. The results revealed that, Hexaconazole 4% + Carbendazim 16% SC, Hexaconazole 5% + Validamycin 2.5% SC and Azoxystrobin 11% + Tebuconazole-18.3% SC were superior as compared to other fungicides in terms of per cent inhibition.

- Application of *T. harzianum* and *T. reesei* cake formulation completely cured the stem bleeding disease in coconut when compared to the application of copper oxychloride paste. Disease index of 7.96 and 6.95 was brought down to 0.0 within 50 days with application of *Trichoderma harzianum* cake (CPCRI cake) and *Trichoderma reesei* cake formulation at Ambajipeta.

Management of leaf blight disease

- Root feeding with propiconozole @ 5 ml in 100 ml of water at three months intervals during January, April, July and October reduced the leaf blight incidence by 27.0 per cent after 36 months of treatment. This treatment also resulted in highest 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

- A total of 6600 numbers of *Bracon hebetor*, 1,77,050 numbers of *G. nephantidis*, 17100 numbers of *P. imbrues*, 242 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 12,561 packets of *Encarsia* parasitoid were distributed to about 4000 farmers.
- The IPM strategies (Installation of yellow sticky traps in the garden, three rounds of neem oil (0.5%) spray at 15 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 per cent incidence and pest intensity was increased from 45.2 to 56.2% and 50.5% to 58.5% respectively.

OIL PALM

- Among the 10 hybrids evaluated at Pattukkottai for growth and yield parameters, the hybrid NRCOP 4 recorded significantly higher palm height (5.27 m), while number of leaves produced per year (25.60) was highest in NRCOP 2. The highest bunch weight of 173.25 kg/palm and per ha yield of 24.78 t/ha was recorded in hybrid NRCOP 9.
- 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.

ARECANUT

- Burmese coriander is a popular herb grown in the Andaman and Nicobar Islands. The herb was grown as an intercrop in bearing arecanut palms of variety Samrudhi to study the profitability of this herb as an intercrop in the warm humid tropical conditions of South Andaman Island. Results suggested that introduction of Burmese coriander in the interspaces could give higher net returns of Rs. 13,03,065/- as against Rs. 9,59,600/- in the arecanut sole crop. The B:C ratio of this treatment was found to be 3.19 and hence, it could be recommended for the island farmers.

COCOA

- Cocoa genotypes are under evaluation in 7 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 (Andhra Pradesh) and Veppankulam (Tamil Nadu), 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 (Tamil

Nadu), Ratnagiri (Maharashtra) and Kahikuchi (Assam), VTLCP-16, VTLC-17 and VTLC-20 were best performing respectively, whereas VTLC-57 was high yielding at Vijayarai (Andhra Pradesh) 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 at 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 30th Annual Group Meeting of All India Co-ordinated Research Project on Palms organized by Central Plantation Crops Research Institute, Kasaragod through virtual mode was inaugurated on November 22, 2021. Dr.B.K.Pandey, Assistant Director General (Horticultural Sciences II), ICAR, New Delhi inaugurated the meeting as the Chief Guest of the event. Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi and Dr. Eaknath B. Chakurkar, Director, ICAR- CIARI, Port Blair participated in the Inaugural Session. Dr. Anitha Karun, Director and Project Co-ordinator (Acting), CPCRI, Kasaragod welcomed the dignitaries and delegates in which she applauded the unstinted support rendered by the Deputy Director General (Horticultural Sciences) and the Assistant Director General (Hort. Sci. II) for the progress of the AICRP (Palms) scheme by providing first hand information on diverse arena. She presented the report of the AICRP (Palms) for the year 2020-2021. The action taken report of the recommendations of the AGM held on 10th – 11th August 2020 was presented by Dr Ravi Bhat, Acting Head (Crop Production) and Scientist In Charge, PC Cell. The Assistant Director General (Horticultural Sciences) in his inaugural address suggested bringing out a publication on "Fifty Years of AICRP (Palms)" on the eve of Golden Jubilee Celebrations of the AICRP (Palms). He envisaged the need for the collection, conservation and evaluation of trait specific germplasms devoid of duplicates, enhancing input use efficiency with special reference to micronutrients, identification of alternatives for red labeled chemicals towards hassle free plant protection and demonstration of cutting edge research technologies to the farm front through KVKs of the states and digitization of data for easy reference by the scientists. He appreciated AICRP (Palms) centres for the exemplary work and wished the Palm Scientists to reach the pinnacle of success on technological platform. Development of T x T coconut hybrids, coconut based multispecies cropping system, location specific Integrated Farming System models, management of stem bleeding disease in coconut through *Trichoderma harzianum* and *T.reesei*, technology capsule for the management of Rugose Spiraling Whitefly in coconut, integration of coriander in arecanut system, bioagents for the control of crown choke disease in arecanut and identification of best performing cocoa clones *viz.*, VTCH -2, 16, 20, 17 and 4 for intercropping in coconut gardens are the noteworthy contributions made during 2020. Effective Transfer of Technology from lab to land through diverse tools and modes and need based diagnostic field visits despite COVID curfew remain the major strength of this programme. Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi invited researchers to explore alternative pesticides, to develop cropping systems approach and to enhance resource use efficiency in cropping systems. Dr E. B. Chakurkar, Director, ICAR-CIARI, Port Blair appreciated the work of Palm Scientists and requested them to come out with location specific farming system models which can double the income of small and marginal farmers. About 72 participants from different AICRP centres and ICAR-CPCRI were connected through virtual mode. The crops experts also provided their valuable suggestions / recommendations for further improving the work of the AICRP on Palms. The detailed progress made during 2020-21 was presented and the technical programmes for coming *year (2021-2022)* were finalized during the meeting. The inaugural session was followed by technical sessions on genetic resources and crop improvement, crop production, crop protection, post harvest technology and transfer of 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 288Phone : 08864-246577	Palmyrah: Crop Improvement, Crop Production & Post Harvest Technology	
	Vijayarai: Horticulture Research Station, Vijayarai, West Godavari Dt. - 534 475Phone : 08812-225431	Oil palm: Crop Improvement & Crop ProductionCocoa: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 101Phone : 03192-250436	Coconut and Arecanut: Crop Improvement & Crop Production	Indian Council of Agricultural Research

Arunachal Pradesh	Pasighat: College of Horticulture & Forestry, Pasighat - 791 102Phone : 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 017Phone : 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 210Phone : 0641-2451001	Coconut: Crop Improvement & Crop ProductionPalmyrah: 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 - 494 005 Phone : 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 402Phone : 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 450Phone : 02637-282144	Coconut: Crop Improvement & Production Cocoa: Crop Improvement	Navsari Agricultural University, Navsari, Gujarat - 396 450
Karnataka	Arsikere: Horticultural Research and Extension Station, Arsikere, Hassan Dt. -573 103Phone: 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 401Phone: 08384-226797/247787	Cocoa: Crop Improvement	
	Bavikere: Agricultural and Horticultural Research Station, Bavikere, Chikkamagaluru – 577 144Phone :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 225Phone : 08181-267011	Arecanut: Crop Improvement, Crop Production & Crop Protection	

Kerala	Kasaragod: Central Plantation Crops Research Institute, Kasaragod - 671 124Phone : 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 656Phone: 0487-2438457	Cocoa: Crop Improvement	
Maharashtra	Mulde: College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. - 416 520Phone: 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 612Phone : 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 Horti-culture, (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 Agricul-tural 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 2021was 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
5.	SCSP	21.50
	Total	**660.56**

Centre wise budget for 2020 (ICAR share Rs. in Lakhs)

Centre	*Pay*	*TA*	*RC*	*HRD*	*Eqpt.*	*Works*	*NEH/ Capital*	*TSP*	*SCSP*	*Total*
Aliyarnagar	59.79	0.00	10.43	0.20	0.00	0.00	0.00	1.85	2.30	74.56
Ambajipeta	34.69	0.00	10.05	0.20	0.00	0.00	0.00	0.00	2.22	47.16
Arsikere	37.79	0.00	8.93	0.20	0.00	1.80	0.00	1.83	2.15	52.70
Jagdalpur	17.48	0.00	5.94	0.15	0.75	0.00	0.00	1.68	0.00	26.00
Kahikuchi (NEH)	37.93	0.00	9.15	0.20	0.00	0.00	1.61	0.00	1.95	50.84
Bhubaneswar	13.45	0.00	6.78	0.20	0.00	1.10	0.00	0.00	1.85	23.38
Mondouri	15.48	0.00	5.49	0.20	0.00	0.00	0.00	0.00	0.00	21.17
Ratnagiri	65.63	0.00	8.98	0.20	0.60	0.00	0.00	1.78	2.09	79.27
Veppankulam	43.31	0.00	5.15	0.15	0.00	0.00	0.00	0.00	1.85	50.46
Killikulam	16.02	0.00	4.76	0.15	0.00	0.00	0.00	0.00	1.70	22.63
Pandirimamidi	21.22	0.00	4.94	0.15	0.00	0.00	0.00	1.68	0.00	27.99
Pattukotai	15.44	0.00	5.24	0.15	0.00	0.00	0.00	0.00	0.00	20.83
Mulde	16.02	0.00	5.48	0.15	1.85	0.00	0.00	0.00	0.00	23.50
Vijayarai	14.03	0.00	5.15	0.15	0.00	0.00	0.00	0.00	1.85	21.18
Navasari	10.49	0.00	6.71	0.15	0.00	0.00	0.00	1.68	0.00	19.03
Sabour	11.90	0.00	5.15	0.15	0.00	0.00	0.00	0.00	1.85	19.05
Shivamogga	7.61	0.00	5.88	0.15	0.00	0.00	0.00	0.00	0.00	13.64
Wakawali	0.00	0.00	6.13	0.15	0.00	0.00	0.00	0.00	0.00	6.28
Pilicode	0.00	0.00	6.00	0.15	0.00	0.00	0.00	0.00	0.00	6.15
Bavikere	0.00	0.00	6.30	0.15	0.00	0.00	0.00	0.00	0.00	6.45
K Mallapally	0.00	0.00	2.10	0.15	0.00	0.00	0.00	0.00	1.70	3.95
Sirsi	0.00	0.00	2.00	0.15	0.00	0.00	0.00	0.00	0.00	2.15
Thrissur	0.00	0.00	2.00	0.15	0.00	0.00	0.00	0.00	0.00	2.15
Pasighat (NEH)	0.00	0.00	6.75	0.15	0.00	0.00	4.50	0.00	0.00	11.40
Port Blair (ICAR)	0.00	0.00	6.53	0.20	0.00	0.00	0.00	0.00	0.00	6.73
Goa (ICAR)	0.00	0.00	6.53	0.20	0.00	0.00	0.00	0.00	0.00	6.73
IIOPR, Pedavegi (ICAR)	0.00	0.00	6.40	0.20	0.00	0.00	0.00	0.00	0.00	6.60
Kasaragod (ICAR)	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
PC cell (ICAR)	0.00	0.50	7.11	0.00	0.00	0.00	0.00	0.00	0.00	7.61
Total	**438.27**	**0.50**	**173.03**	**4.55**	**3.20**	**2.90**	**6.11**	**10.50**	**21.50**	**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. Maheswarappa, H. P (up to 25-09-2021) Dr. Anitha Karun (from 27-09-2021)
Scientist In-chargeScientist (PC Cell)	:	Dr. Ravi Bhat (from 27-09-2021)
Scientist (SPMA)	:	Dr. Sumitha S.
Private Secretary	:	Mrs. K. Narayani
Skilled supporting staff	:	Mr. M. Shankara
Senior Research Fellow	:	Dr. Balanagouda Patil (up to 31-10-2021)
Clerical Assistant	:	Mr. S. Karunakara

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Senior Scientist (Horticulture) : Mr. R. Siddappa (up to 10-08-2021)
: 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

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Principal Scientist (Plant Breeding) : Dr. Vanaja T (up to 10-10-2021)
: Dr. Ninitha K U (from11-10-2021)

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Senior Scientist (Plant Breeding) : Dr. J. S. Minimol (up to 10-10-2021)
: Dr. B. Suma (from 11-10-2021)

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Regional Coconut Research Station, Bhatye, Ratnagiri Dt. – 421 612 (Phone: 02352- 235077; Fax: 02352 – 235331)

Senior Scientist (Plant breeding / Horti.) : Dr. V. V. Shinde
Scientist (Agronomy) : Dr. S. L. Ghavale
Scientist (Entomology) : Dr. S. M. Wankhede
Agricultural Assistants : Mr. S. B. Chavan
: Mr. N. M. Madhav

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ODISHA

Department of Horticulture, OUAT, Bhubaneswar – 751 003 (Phone: 0674 – 2390463)

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: Dr. A. K. Sahoo (from 31-3-2021)
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. M. Alagar (up to 15-09-2021)
: Dr. B. Vinoth Kumar (from 16-09-2021)
Scientist (Agronomy) : Dr. C. Sudhalakshmi
Scientist (Plant Pathology) : Dr. E. Rajeswari (up to 08-09-2021)
: Dr. P. Latha (from 09-09-2021)

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IV. EXPERIMENTAL RESULTS IN COCONUT

4.1 GENETIC RESOURCES AND CROP IMPROVEMENT

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

Expt. 1: 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).

Expt. 2: 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 (Kerakeralam 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) (table 1)

Table 1 Pooled and accumulated yield for past three years at Veppankulam (Year of planting - 2005)

IC number	2018-19	2019-20	2020-21	Average Yield	Accumulated yield
IC 599263	65	76.00	81.00	74.00	222.00
IC 599264	72	103.66	95.66	90.44	271.32
IC 599265	82	79.66	81.66	81.11	243.32
IC 599266	63	86.66	88.66	79.44	238.32
IC 599267	67	76.66	85.66	76.44	229.32
Kerakeralam	69	88.33	89.33	82.22	246.66
ALR (CN) 1	74	75.00	79.00	76.00	228.00
CD (p=0.05)	NS	5.16	6.80	3.53	6.11
CV	9.14	12.24	6.80	6.85	6.85

Expt. 3: 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).

Expt. 4 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.

Expt. 2: 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) (four 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 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.

Exp. 4 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.

Expt. 5: 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 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) (Tables 2).

Table 2: Yield and its attributes of location specific Tall x Tall cross combinations at Ambajipeta centre (Year of planting - 2011)

Hybrids	No. of inflore-scences/ palm/year	No. of buttons	Number of spikelets per inflorescence	No. of nuts/ annum	Tender nut Fruit weight (g)	Water content (ml)	TSS of water(0^0 Brix)
Java Tall x ECT	10.02	22.27	34.72	69.03	1669.33	314.43	6.52
PHOT x ECT	9.65	21.17	33.24	61.62	1727.33	342.73	6.57
Fiji Tall x ECT	10.79	19.22	31.89	69.22	1856.00	356.10	6.39
LCT x ECT	11.11	26.15	34.55	98.28	1698.33	387.53	7.02
ECT x PHOT	10.62	21.33	35.67	71.73	2018.33	373.33	6.97
CCNT x ECT	10.67	22.33	38.46	72.30	1966.33	411.50	6.03
ECT x Fiji Tall	10.17	23.18	33.80	88.37	1644.33	289.50	6.74
ECT x ECT	9.92	22.37	31.72	73.89	1643.00	176.10	5.99
S.Em±	0.95	1.06	1.19	6.98	72.96	23.08	0.15
CD (P=0.05)	NS	3.21	3.60	21.18	221.29	70.02	0.45
CV%	15.89	8.24	6.01	16.01	7.11	12.06	5.94

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

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.

Table 3: Nut attributes of location specific Tall x Tall cross combinations at Veppankulam centre (Year of planting -2009)

Hybrids	No. of female flowers/ palm	Fruit Setting %	No. of nuts / palm	Dehusked nut weight (g)	Weight of husk (g/nut)	Husk wt. %	Kernel thickness (cm)	Kernel weight (g/nut)	Copra content (g/nut)	Copra yield (kg/ palm)
WCT x PHOT	200.0	26.08	57.50	341.21	442.50	56.46	1.20	229.20	119.18	6.85
ECT x ZAN	207.0	27.75	55.50	301.50	432.12	58.90	1.20	209.20	108.78	6.04
ECT x JG	200.0	24.76	51.25	305.24	451.73	59.68	1.20	234.21	121.79	6.24
ECT x PHOT	225.0	29.75	59.50	391.54	501.10	56.14	1.20	238.00	123.76	7.36
SR x ZAN	180.0	21.89	49.25	372.16	533.50	58.91	1.10	258.00	134.16	6.61
WCT x CCNT	180.5	30.28	54.50	341.60	525.29	60.59	1.10	265.05	137.83	7.51
PHOT x WCT	198.0	28.53	51.50	438.29	461.50	51.29	1.20	259.10	134.73	6.94
VHC 3	200.0	23.36	46.25	305.21	544.33	64.07	1.20	232.00	120.64	5.58
CD (5%)	9.49	4.10	5.15	16.31	12.87	5.06	0.45	8.13	5.86	1.96
CV (%)	7.23	11.22	6.92	13.95	8.47	5.41	4.15	8.31	8.31	8.17

Expt. 6: Evaluation of Dwarf x Dwarf coconut hybrids in different agro climatic conditions

Centres: Ambajipeta, Mondouri, Pilicode, Ratnagiri and Veppankulam

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).

Table 4: Performance of Dwarf x Dwarf coconut hybrids for tender nut water at Ambajipeta centre (Year of planting - 2011 & 2014)

D x D Hybrids	Water content (ml)	TSS of water (0^0 Brix)	TSS of Endosperm	(0^0 Brix) Sweetness of water	Taste of tender nut endosperm
*COD x MYD	-	-	-	-	-
COD x MGD	453.50	8.13	8.05	Good	Good
MYD x CGD	421.75	7.88	7.75	Good	Good
GBGD x MOD	291.30	6.79	7.07	Average	Good
CGD x MGD	385.75	7.56	7.06	Good	Good
GBGD	390.83	8.10	7.67	Good	Good
S.Em ±	22.76	0.24	0.26	-	-
CD (P=0.05)	70.12	0.75	NS	-	-
CV (%)	11.71	6.32	6.87	-	-

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.

Coc./Gen. 3: Establishment of mother palm blocks and production of quality planting material in coconut

Expt. 2: Establishment of nucleus seed gardens for released varieties

Table 5: Yield performance of Dwarf x Dwarf coconut hybrids in different agro-climatic conditions at Ratnagiri centre (Year of planting - 2011)

Coconut hybrids (D x D)	Months to first flowering	Months to 50 % flowering	No. of inflore scence/ palm	No. of female flowers/ palm	Fruit Setting %	Tender nut yield / palm	Quantity of tender nut water (ml/nut)	TSS (°Brix)
COD x MYD	32.3	38.3	12.5	224.6	44.4	81.7	604.0	5.3
COD x MGD	28.8	34.5	11.8	211.5	41.4	69.7	396.0	4.7
MYD x CGD	31.6	36.8	11.3	203.4	44.1	71.6	497.5	4.6
GBGD x MOD	27.8	34.0	12.2	219.6	43.6	77.7	428.0	5.7
CGD x MGD	30.0	36.0	11.0	197.1	40.7	61.5	434.0	5.1
COD (check)	29.5	35.5	10.2	184.1	40.0	55.5	424.0	4.6
Mean	30.0	35.8	11.5	206.7	42.4	69.6	463.9	5.0
S.Em.±	0.6	0.7	0.2	3.8	1.0	1.3	8.4	0.1
CD (P=0.05)	1.7	2.0	0.6	11.4	2.9	3.9	25.3	0.4
CV %	14.2	14.0	3.7	3.7	4.6	3.7	3.6	5.5

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

Varieties for large scale multiplication

Sl.No	AICRP centre	Genotypes
1	Aliyarnagar	Arasampatti Tall,_Kalpatharu, Kalpa Prathiba, Kera Keralam, Kalpa Shatabdi, COD, CGD, KTD, MOD, MYD, GBGD and MGD
2	Ambajipeta	Gautami Ganga, Kalpa Prathiba and Kera Bastar
3	Arsikere	COD, GBGD, MYD, MOD, Fiji Tall, Kulashekran Green, MGDECT and Kalpatharu
4	Jagdalpur	Kera Bastar
5	Kahikuchi	MYD and Kamrupa
6	Mondouri	Kalyani coconut 1, Kalpa Mitra and Kera Keralam
7	Port Blair	CARI- Annapurna, CARI- Omkar, CARI- Surya and CARI- Chandan
8	Ratnagiri	Gautami Ganga, East Coast Tall and Kera Bastar
9	Veppankulam	Kera Keralam and Kalpa Prathiba

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 CROP PRODUCTION

Coc. /Agron. 5: 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.

Significant effect of different fertigation levels were observed regarding plant growth parameters of palms in terms of plant height, plant girth and number of functional leaves and leaf characters. The maximum plant height of 581.0 cm was recorded with application of 100% RDF fertigation (T_5) which was at par with 75% RDF through fertigation (T_4) (578.0 cm). The lowest plant height was observed in plants with no fertilizers (450.50cm). Similarly the maximum collar girth (220.0 cm), number of functional leaves (26.5/ plant) and annual leaf production (10.5 per plant) was recorded in T_5 (100% RDF fertigation) followed by T_4 (fertigation at 75 % RDF) having collar girth of 205.0 cm, 26 number of functional leaves and annual leaf production of 10.0. Significantly lowest growth was recorded in T_1 (No fertigation) with minimum collar girth (160 cm), number of leaves (17.75 / plant), annual leaf production (7.25 / plant). TretmentT_5 (100% RDF fertigation) and T4 (75 % RDF through fertigation) produced highest number of inflorescence with 9 inflorescence per plant. Similarly number of fruit per bunch and nut yield per plant was also highest with T_5 (100% RDF fertigation) with 10.5 nuts per bunch and nut yield of 70.2 nuts per palm. It was followed by T_4 (75 % RDF through fertigation). Effect of winter was more severe in control and minimum severity of cold injury was noted in 100% fertigation level. It was observed that after winter, inflorescence emergence was earlier in treatment T_5 (100% RDF fertigation) that started in 1st week of June and it was last in T_1 (without fertigation) in which inflorescence emergence started at the end of July. The maximum number of leaves showed injury symptoms in palms without fertilizer (27%) and minimum (10%) was noted in T_5 (100% RDF fertigation). Similarly maximum leaf recovery of 64% was observed in T_5 (100% RDF fertigation) as against 38% in T_1. Early flower initiation was also noted in T_5 (100% RDF fertigation) (Table 1).

Table. 1: Effect of different levels of fertigation on winter injury and nut yield

Treatments	No of leaves showing winter injury (%)	No of leaves recovered from winter injury (% of injured leaves)	Initiation of new inflorescence	Nut Yield/ plant
T1	27.0	38	1st week August	37.0
T2	24.0	42	1st week August	45.5
T3	19.0	47	1st week July	50.5
T4	12.0	58	2nd week July	62.4
T5	10.0	64	1st week July	70.2
T6	17.0	50	2nd week July	62.0

Coc./Agron. 10 A: Development of coconut based farming systems

Expt. 1: Integration of cows in coconut based farming system

Centre: Arsikere

The experiment was laid out during September 2013 to compare Coconut + Fodder crops – Cows based integrated farming system with coconut monocrop. Each treatment had 0.4 ha area and there were 5 cows in IFS. Rooted slips of Napier grass (Co-3) were planted in the inter space of coconut at a spacing of 90 cm × 60 cm. Fodder legume (*Stylosanthesh amata*) was sown in the intra space of coconut during 2013. Fodder trees *viz*. Drumstick and *Sesbania grandiflora* were planted in the border of the plot. Coconut based IFS with cow's recorded higher number of nuts (7,576 per ha) and higher copra content (150.9 g/ nut), 45000 kg of fodder, 6658 L milk, 38 tons of cow dung and 7250 L of cow urine. In IFS model, organic carbon (0.60-0.98 %), Nitrogen (229.1 to 230.12 kg/ha), Phosphorus (15.50 to 17.13 kg/ha) and Potash (142.10 to 151.50kg/ha) concentration in soil showed increase over those observed in mono crop. A total of 5 calves were produced during this year. Integrated farming system was more remunerative over coconut monocropping as higher net returns of Rs. 3,61,540/-per acre were obtained as compared to Rs.82,260/- in coconut sole cropping.

Expt. 2: Integration of sheep in coconut based cropping system

The experiment was laid out during May 2014 to compare Coconut + Pasture crops – Sheep system with monocrop of coconut. Each treatment had 0.4 ha and there were 20 sheep in IFS. Pasture crops viz. Anjan grass (*Cenchrus ciliaris*) and stylo (*Stylosanthesh amata*) were sown in the inter spaces of coconut. Sheep were allowed to graze the pasture from November 2014. Productions of pasture, sheep and sheep manure have been quantified.

Coconut based Integrated Farming System with sheep recorded higher number of nuts (3680 nos in 0.40 ha), fodder yield (6250 kg), sheep manure (6900kg) and 16 new lamb. Further, in IFS model, Organic carbon (0.60-0.96 %), Nitrogen (190.5 to 227.4 kg/ha), Phosphorus (15.25 to 17.21 kg/ha) and Potash (139.89 to 147.28kg/ha) concentration in soil showed increase when compared to coconut monocropping. Integrated farming system recorded higher net returns of Rs.1,07,390/-when compared to Rs. 40,180/- in monocrop of coconut.

Expt. 3: Integration of goat in coconut based cropping system

Centres: Aliyarnagar and Veppankulam

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. Results revealed that 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. Total of 19,720 nuts/ha/year and 17,400 kg/ha of fodder, 9500 kg of goat manure (9500kg) and 13 new lambs were produced. Coconut based Integrated Farming System with goats recorded higher net income of Rs. 2,19,855/- per ha as compared to Rs. 1,19,700/- 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 IFS trial employing IFS– GHG Estimation Tool obtained from Project Directorate of Cropping Systems Research, Modipuram. GHG emission from IFS was negative and hence it is environmentally safe (Table 2 & 3).

Table 2: Nutrient monitoring employing NUT MON Tool box (Aliyarnagar)

System	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 3: Green House Gas Emission from Integrated Farming System with goat (Aliyarnagar)

Carbon	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 under 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. During the year, nut yield recorded in IFS model was higher (12,705 nuts /ha/year) than that observed in monocrop (11,042 nuts/ha/year). Hence, there was a yield increase of 11.5 % in IFS crop as compared to monocrop of coconut. Number of inflorescence showed an increase of 10.89 % in IFS plot as compared to monocrop of coconut. During the period, 10 lambs were born and totally 16 goats were sold with a live weight of 395.25 kg. A total of 6,150 kg pasture from *Sesbania grandiflora*, *Leucaenea leucocephala* and Glyricidia and 3,850 kg of goat manure was realized, which was applied to the IFS plot.

Total cost of cultivation of IFS was Rs. 1,50,480/- per ha and the gross income and net income were Rs. 2,82,810/- per ha and 1,32,330/- per ha, respectively. In case of monocrop of coconut, gross income (Rs. 1,32,504/- per ha) and net income (Rs. 22,154/-per ha) were reported.

Coc./Agron. 11: Coconut based cropping systems for different agro-climatic regions

Expt. 5: Evaluation of coconut based cropping system models

Centres: Port Blair

Port Blair

In order to evaluate performance of improved varieties/ hybrids of black pepper and identify superior variety as an intercrop in coconut (ADOT) plantation, the experiment was taken up. 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 trailed on glyricidia standards planted at 2 m × 2 m in the coconut interspaces in RBD and growth parameters recorded after one year of planting. Vine length varied between 132.8 cm (Subhakara) and 328.0 cm (Panniyur-6), while collar thickness varied from 4.89 mm (Sreekara) to 7.60 mm (IISR-Girimunda). Number of leaves per vine varied from 25.1 (Subhakara) to 112.4 (Panchami). Highest number of branches (4.78) were reported in Panniyur-5, while vines of variety Subhakara produced the lowest number of branches (1.75).

Bhubaneswar

The experiment was initiated in littoral sandy soil at Coconut Research Station, Konark during January, 2016. The palms in the trial were affected by cyclone "FANI" on 3rd May 2019. Though the effect of cyclone may persist for next one and half year, the palms are gradually recovering. The result of the current year revealed that, there was significant

Expt. 7: 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		

variation among the palms under different nutrient management practices. Maximum number of leaves per palm (28.17), rate of production of leaves (8.06/palm/year), no. of inflorescences (7.14/palm/year), no. of female flowers (130.27/palm/year) and nut yield (20.08/palm) were recorded in the treatment N_2 (Green manuring + biofertilizers + organic recycling + soil test based nutrient (chemical fertilizers) application. Whereas, in case of cropping systems, only numbers of functional leaves was significant. The interaction effect of cropping system and nutrient management was significant only for number of functional leaves per palm. The yield of pineapple (7920.00 kg/ha) as well as cowpea (4714.00 kg/ha) was maximum in plots receiving soil test based NPK nutrients (N_2). The sapota plants in the cropping systems started yielding in the current year and the maximum yield (52.66 kg/ha & 56.19 kg/ha) was obtained in the treatments CS1N2 & CS2N2, respectively. The net return was drastically reduced due to cyclone effect, however, the maximum net return (Rs. 1,86,572.00/ha) was obtained from the treatment CS2N2 . Though there was marginal profit in cropping system of Coconut + Sapota +Vegetable (cowpea), negative net return was obtained in solo cropping of coconut.

Kasaragod

This experiment was started with the objective to develop coconut based multispecies cropping system model for coastal littoral sandy soil. The experiment was laid out in split plot design. The cropping systems (CS-1: Coconut+ Sapota + Vegetable crops, CS-2: Coconut+ Sapota + Flower crops, CS-3: Coconut+ Sapota + Fodder crops and CS-4: Coconut Monocrop) were taken as main plot and the nutrient management (N-1: Green manuring + biofertilizers + organic recycling + FYM @10t/ha+ 50% RDF , N2: Green manuring + biofertilizers + organic recycling + FYM @10t/ha+ 100% RDF and N3: Green manuring + biofertilizers + organic recycling + FYM @10t/ha+ 150% RDF) was taken as sub plot. Since the canopy of sapota covered the maximum interspaces available in between coconut palms, only sapota is being maintained in all the systems and continued with nutrient management practices. The application of 150% RDF along with organic nutrients resulted in higher fruit yield of 47 kg per tree (7332 kg/ha) and the yield was significantly different from other treatments. Quality parameters viz., pH, TSS (Brix), titrable acidity (% citric acid), reducing sugar (%), sucrose (%), total sugar (%) and total carbohydrate (%) analysed and it was observed that no significant difference observed among the treatments. Coconut yield recorded and analyzed and it was observed that, treatment N3 recorded higher nut yield and significantly differ from other treatments.

Ratnagiri

The experiment was initiated during 2015-16 in split plot design with three replications. Planting of Kokum has been done as per treatment details. The highest mean number of leaves (30.01/ palm) and yield (72.60 nuts/palm, 12,605 nuts/ha) of coconut were recorded in treatment CS2N2. Vegetable yield was maximum (6,488 kg/ha) in CS1N2. The highest pineapple yield of 10,633 Kg/ha was recorded in CS2N2 and maximum *Garcinia indica* height (178.26 cm) was recorded in CS2N2.

Table 4: Growth and yield performance of coconut based multispecies cropping systems under coastal littoral sandy soil (Ratnagiri)

Treatments	No. of leaves/ Palm	No. of Female buttons/ Palm	Coconut Yield (nuts/ha)	Vegetable yield (kg/ ha)	Pineapple Yield (kg/ ha)	*Garcinia indica* Height (cm)	Biomass production (kg/ha)
CS_1N_1	29.6	187.7	11,877	5,233.0	-	146.6	10,423
CS_1N_2	30.1	193.4	12,563	6,488.7	-	156.0	10,648
CS_1N_3	29.1	172.5	12,243	5,826.7	-	147.0	10,372
CS_2N_1	28.3	188.3	11,739	-	8,333.3	152.6	9,568
CS_2N_2	30.1	197.6	12,605	-	10,633.0	178.3	9,756
CS_2N_3	29.0	166.2	11,926	-	10,166.0	174.3	9,653
CS_3N_1	26.4	145.1	10,797	-	-	-	8,306
CS_3N_2	27.1	151.9	11,302	-	-	-	8,421
CS_3N_3	26.7	158.7	11,697	-	-	-	8,387
SEm	**1.2**	**6.7**	**247.1**				**486.7**
CD (5%)	**3.8**	**18.2**	**741.0**				**1,459.3**

Coc./Agron. 14: Soil and nutrient management in coconut

Expt. 1: Integrated nutrient management technologies to enhance the productivity and quality of tender nut in dwarf coconut

Aliyarnagar

An experiment to elicit the impact of Integrated Nutrient Management Technology on the productivity and quality of tender nut in Chowghat Orange Dwarf variety (COD) was initiated during 2014-15 in a 10 year old coconut garden at Avalchinnampalayam village of Pollachi taluk, Coimbatore district with 3 treatments *viz.*, T_1: Recommended package of practice (560:320:1200 g NPK/palm + FYM- 50 kg/palm + TNAU Micronutrient Mixture - 1 kg/palm + Neem cake-5 kg/palm /year), T_2: Biomanures and biofertilizers and T_3: Biomanures and biofertilizers + soil test based NPK and micronutrient application. The experiment was laid out in RBD with each treatment replicated five times. Growth parameters *viz.*, palm height, palm girth, total number of leaves, annual leaf production and yield attributes *viz.*, and number of inflorescence and tender nut yield per palm per year were recorded. Although differential effect of treatments did not exert spectacular influence on the growth attributes, nut yield was significantly higher in soil test based fertilizer application integrated with biomanures and biofertilizers (T_3). Also Integrated Nutrient Management Strategy (T_3) registered its positive impact on the quality of tender coconut water (Table 5). Monthly variation in nut yield was spectacular with December favouring higher nut yield @ 25 nuts per palm and the lowest was obtained during March and April with 10 nuts per palm. On the contrary, nut weight was higher during April with 2000 g per nut and was the lowest during November with 1500 g per nut **(Fig. 1)**.

Table 5: Effect of INM on quality of tender nut water in dwarf coconut variety

Treatments	Volume of tendernut water (ml)	pH	Sodium (ppm)	Potassium (ppm)	TSS (°Brix)
T_1: Farmer's Practice	315	5.12	22.2	2250	5.40
T_2:Biomanures + Biofertilizers	310	5.08	20.1	2262	5.54
T_3: Biomanures + Biofertilizers + Soil test based nutrient application	320	5.10	23.9	2254	5.42
Mean	**315.0**	**5.10**	**22.09**	**2255**	**5.45**

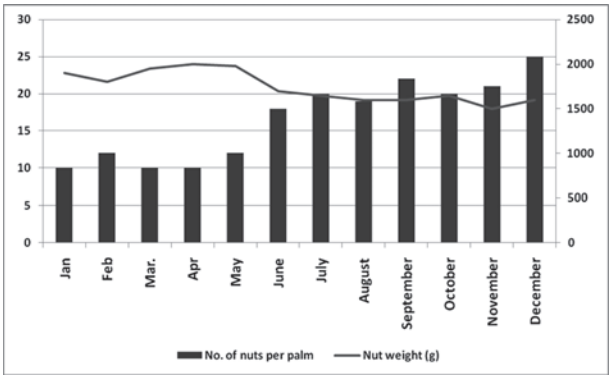

Fig. 1. Monthly variation in nut yield and nut weight of the dwarf coconut COD

Expt. 3: Organic farming in coconut based farming system

Centres: Aliyarnagar, Ambajipeta and Arsikere

A field experiment was initiated during 2014-15 in Aliyarnagar, Ambajipeta and Arsikere centers with five treatments *viz.*, T_1 - In situ organic matter recycling + PGPR consortia + In situ green manuring + Husk burial, T_2 - T_1 + 25 kg cow dung per palm, T_3 - T_1 + 50% recommended K_2O through the application of Sulphate of Potash, T_4 - T_2 + 50% recommended K_2O through the application of sulphate of potash T_5 - Conventional method (Fertilizer application) and five replications to bring out the influence of organic treatments on the growth attributes and system productivity of coconut palms

Aliyarnagar

Biomass added across different treatments varied from 22,750 to 23,150 kg per hectare. Nutrient addition across different treatments is presented in Table 6. 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 rest of the treatments. Highest nut yield was realized in T_4 with 183 nuts per palm per year, while it was the lowest in T_1 (Table 8). 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 6). Physical properties *viz.* porosity and soil moisture content enhanced on addition of organic manures compared to sole chemical fertilization (Table 7).

Table 6: Differential effect of treatments on the growth and yield of coconut (Aliyarnagar)

Treatments	Total biomass (kg)	N	P	K
		(kg per ha)		
T_1	22750	175 - 200	46 - 60	132 - 160
T_2	23150	175 - 200	46 - 60	132 - 160
T_3	22750	175 - 200	46 - 60	132 – 160
T_4	23150	175 - 200	46 - 60	132 – 160
T_5	-	-	-	-

Table7: Influence of Organic Farming on soil fertility parameters (Aliyarnagar)

Treatments	pH	EC (dSm^{-1})	$KMnO_4$ N	Olsen P	$1NNH_4OAc$ K	Organic C ($g\ kg^{-1}$)
			(ppm)			
T_1	7.24	0.54	124.2	5.71	80.8	0.41
T_2	7.18	0.58	128.4	6.32	91.4	0.44
T_3	7.32	0.62	132.6	6.28	96.8	0.34
T_4	7.28	0.60	136.4	6.41	100.5	0.38
T_5	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 8: Differential effect of treatments on the yield of coconut (Aliyarnagar)

Treatments	Nut yield (No.s/palm/year)	
	2014-15	2020-21
T_1	157	150
T_2	145	152
T_3	160	174
T_4	148	183
T_5	149	160
S.Ed	**12.4**	**6.12**
CD (P=0.05)	**NS**	**12.4**

Ambajipeta

The trial was initiated during 2015 in 30 years old coconut plantation of East Coast Tall with four replications. Cocoa (Forestero) and banana (Tellachakkarkeli) were planted as intercrops. Growth and yield parameters of coconut were recorded and presented in Table….. Cocoa crop is five years old and is in bearing stage. Maximum number of inflorescence produced per plant per year was recorded in T_4 (11), which remained statistically similar with all other treatments except T_3 (9.16). However, nut yield per palm differed significantly among the treatments. Treatment T_4 recorded the highest yield (79.5 nuts/ palm/ year), followed by T_5 (75.3 nuts/ palm/ year). Further, the pooled data on nut yield from 2015 to 2021 revealed that T_5 and T_4 had a high nut yield of 117 and 114 nuts/ palm/year, respectively (Table 9).

Table 9: Influence of different treatments of organic farming on yield of coconut over the period of 2015-16 to 2021-22

Treatment	Coconut yield (nuts/ palm/ year)							
	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Pooled
T_1	117.4	120.4	122.5	121.2	116.0	81.5	62.1	106
T_2	118.1	124.5	126.8	120.3	113.5	87.6	75.4	109
T_3	115.8	118.5	120.4	116.5	118.0	83.0	60.6	105
T_4	121.3	126.5	128.9	127.3	121.4	92.2	79.5	114
T_5	132.6	130.5	131.8	121.3	124.2	105.4	75.3	117
SEm±	**13.73**	**0.30**	**9.0**	**1.87**	**1.35**	**3.38**	**4.74**	
CD at 5 %	**N.S.**	**0.96**	**28.17**	**5.75**	**4.17**	**10.42**	**14.61**	

Different treatment had no significant influence on cocoa with regard to plant height, girth height at first branching, number of pods per plant and number of beans per pod. However, treatment T_2 recorded significantly the maximum plant girth (39.39 cm). Treatment T_4 had high number of beans per pod (24.69). Further, the dry bean yield was high in T_4 (0.86 kg), which was on a par with T_5 (0.78 kg) (Table ….).The field was inundated for more than 40 days, so replanting was done in banana and plants are in vegetative stage.

Arsikere

The experiment was initiated during 2015-16 with Coconut + custard apple + Lime + Drumstick cropping system to study the effect of different organic nutrients on component crops. Growth parameters such as plant height, plant girth, number of branches, canopy spread were significantly higher in T_4 followed by T_3 and T_2, while the lowest values were recorded in T_6 involving chemical fertilizer application. Significantly higher yield of coconut (80.16 nuts/ palm/ year), lime (5.71 kg/ plant/ year) and drumstick (7.43 kg/ plant) were recorded T_4, which was followed by T_3 and T_2.

Expt. 4: Management of root (wilt) disease in coconut (farmer's garden)

Centre: Aliyarnagar

Following practices were proposed for management of root (wilt) disease in coconut 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), single super phosphate (2.0 kg) and Muriate of Potash (3.0 kg)
- Addition of zinc sulphate @ 50 g per palm
- Application of $MgSO_4$ @ 1 kg per palm
- Excavation of trenches and providing subsurface drainage.

Management practices as per the package described above were continued in root (wilt) affected gardens at two locations in Tamil Nadu (Manakkadavu, Coimbatore and Kanakkapillaivalasai, Tirunelveli) based on soil nutrient status. The pH of samples from all the sites was in alkaline range. Organic carbon content was low and DTPA Zn was deficient in all the locations. Based on the soil nutrient status, the aforesaid 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 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 (2020-21) in Coimbatore district and 16.34 (2015-16) to 7.44 (2020-21) in Tirunelveli district. Nut yield in demonstration plot was higher (82 nuts /palm /year) in Manakkadavu village, while in Kanakkapillaivalasai, nut yield remained in the range as that of 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 10:Pre and post treatment root wilt disease index in Manakkadavu, Coimbatore, Tamil Nadu (Aliyarnagar)

Particulars	Demonstration plot	
	2015-16	2020-21
	Pre treatment	Post treatment
Range of disease index	4 to 44	0 to 40
Average disease index*	15.86	5.64
Nut yield per palm	80	82

Table 11: Pre and post treatment root wilt disease index in Kanakkapillaivalasai, Tirunelveli, Tamil Nadu (Aliyarnagar)

Particulars	Demonstration plot	
	2015-16	2020-21
	Pre treatment	Post treatment
Range of disease index	0 to 40	0 to 30
Average disease index*	16.34	7.44
Nut yield per palm	84	86

4.3 DISEASE MANAGEMENT

Coc/Path. 1: Survey and surveillance of coconut diseases

Centres: Aliyarnagar, Ambajipet, Arsikere and Veppankulam

Expt. 1: Roving survey of coconut diseases

Aliyarnagar

A roving survey has been taken up in major six coconut growing districts of Tamil Nadu namely Coimbatore, Tirupur, Dindigul, Theni, Tirunelveli and Kanyakumari to ascertain the damage due to various diseases affecting coconut. The survey was taken up in February 2021 and September 2021 and observations on the incidence and intensity of major diseases of coconut namely Bud rot, Basal stem rot, Stem bleeding, Leaf Blight and Leaf Spot were recorded.

The survey on the incidence of basal stem rot revealed a significant disease incidence in the Tirupur district (5.79±1.98) followed by the Kanyakumari district (2.57 ±0.59). Stem bleeding is another important disease of coconut and the symptoms have been observed in selected districts. The survey results indicated that the disease is predominant in Tirupur and Kanyakumari districts with a mean Disease Index of 2.85 ±1.41 and 0.85±0.52 respectively. The survey also found that considerable damage due to stem bleeding has been noticed in the Palani block of the Dindigul district (Disease Index ranged from 1.31 to 1.47). Bud rot incidence was on the higher side in the Coimbatore district when compared to other districts. A conspicuous observation in all the districts, including Coimbatore which topped the incidence was that the incidence was more pronounced during September 2021 rather than February 2021. It could be supported by the mean incidence data which was 2.14±0.79 in September 2021 whereas it was 2.01± 0.80 during February 2021. Yet another district which had seen significant incidence of bud rot in coconut garden is Thirupur district where the mean disease incidence was found to be 1.19±0.42.

The mean average incidence of leaf spot disease in selected blocks were worked and it was found that the mean PDI was higher in four districts namely Coimbatore, Theni, Tirupur and Dindigul where the mean PDI was 9.21± 1.27, 9.23±2.41, 6.08± 0.77 and 6.69±1.5 respectively. During the survey, it was found that Avalchinampalayam village of Pollachi south and Devemapadivalasu of Pollachi North were heavily infected with leaf spot disease and PDI was recorded in the range of 13.60 and 8.34 respectively. Further, Periyakulam and Bodinayakanur blocks of the Theni district have witnessed a heavy incidence of leaf spots in the range of 15.62 to16.06 and 10.25 to 11.25 respectively.

Even though the Leaf blight incidence was observed in almost all districts during the survey the severity was considerably high in four districts namely Coimbatore, Dindigul, Tirupur and Theni districts. The mean of the PDI in these districts were 14.88±0.24, 10.26±1.87, 9.89±0.41 and 6.63±0.70 respectively. In Coimbatore, the coconut gardens in all the selected four blocks exhibited a significant incidence of leaf blight when compared to any other blocks in all the six districts selected.

Ambajipeta

Surveys have been conducted in different blocks/mandals of East Godavari, West Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts of Andhra Pradesh during 2021. Major diseases observed in coconut gardens were basal stem rot, stem bleeding and bud rot along with the minor incidence of grey leaf spot. The pooled mean incidence of basal stem rot, stem bleeding and bud rot diseases were 6.78, 3.58 and 0.77 respectively in the surveyed districts (Table 2).. Minor diseases like leaf spot and leaf blight were found in traces only.

The survey has been conducted in five districts of Andhra Pradesh *viz*., East Godavari, West Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts for assessing the incidence of coconut diseases. The high basal stem rot disease was noticed in Srikakulam (9.87 %) district followed by East Godavari [8.20%], Vishakapatnam [6.12%], West Godavari [5.35%] and Vizianagaram [4.35%] respectively. The stem bleeding disease is more severe in Srikakulam district (7.33%) followed by Vishakhapatnam [3.22], West Godavari [2.91] and Vizianagaram [2.69] respectively. Further, the highest bud rot disease incidence was observed in West Godavari (1.07%) district and the remaining minor diseases has been recorded in traces only.

Table 1 District-wise average coconut disease incidence as per survey of Februvary and September 2021

Districts	Coconut Disease Status (DI/PDI)				
	Basal stem rot (DI)*	Stem bleeding (DI)*	Bud rot (DI)*	Leaf blight (PDI)**	Leaf spot (PDI)**
Coimbatore	1.50±0.80	0.53±1.16	2.08±0.34	14.45±1.22	8.86±0.32
Tirupur	5.62±0.34	2.73±1.89	1.02±1.36	9.51±0.53	5.84±0.60
Dindigul	0.81±0.17	0.64±0.19	0.44±0.24	10.08±1.25	6.19±1.79
Theni	0.42±0.43	0.35±0.16	0.57±0.09	6.39±.55	8.99±0.81
Tirunelveli	0.56±0.09	0.44±0.09	0.32±0.20	3.40±0.14	1.90±0.44
Kanyakuamri	2.30±0.15	1.77±0.69	0.69±0.60	5.11±0.67	3.92±0.86
Mean	**1.87**	**1.07**	**0.85**	**8.15**	**5.95**

Values are mean ± Standard error; DI-Disease Incidence; PDI-Percent Disease Index

Table 2. District wise scenario of coconut diseases in Andhra Pradesh during-2021

District	Basal Stem Rot (DI)%?	Stem Bleeding(DI)	Bud rot (DI)	Leaf blight(PDI)	Leaf spot(PDI)
East Godavari	8.20 + 0.54	1.64 + 0.27	0.68 + 0.06	0.052±0.06	0.08±0.05
West Godavari	5.35 + 0.76	2.91 + 0.32	1.07 + 0.26	0.051± 0.02	0.43+0.01
Vishakhapatnam	6.12 + 1.02	3.22 + 0.59	0.56 + 0.07	0.026±0.026	0.32±0.06
Vijayanagaram	4.35 + 0.29	2.69 + 0.25	0.77 + 0.14	0.040+0.04	0.00+.0.0
Srikakulam	9.87 + 0.77	7.33 + 0.66	0.73 + 0.07	0.04+0.03	0.29+0.01
mean	6.78	3.58	0.77	0.05	0.19

Data presented is mean ± standard deviation; DI-Disease Incidence; PDI-Percent Disease Index

Arsikere

The roving survey on major coconut diseases *viz*., basal stem rot, stem bleeding, bud rot, leaf blight and leaf spot were conducted in four major coconut growing districts of Karnataka namely Hassan, Tumkur, Shivamogaa and Chickmagalur from September to October, 2021 The basal stem rot disease was noticed in all the four districts and the disease incidence ranged from 0.00 to 4.57 per cent. The maximum incidence of 4.57 per cent was recorded in Turvekere taluk of Tumkur district. However, the incidence of stem bleeding ranged from 0.00 to 12.5 per cent. A maximum incidence of 12.50 per cent was recorded at Kadur taluk of Chickmagalur district.

With respect to bud rot disease incidence, the incidence ranged from 0.28 to 4.58 per cent. Maximum disease incidence of 4.58 per cent was noticed in Shivamogga taluk from September to October 2021 (Table 3)

The foliar diseases of coconut namely leaf blight and leaf spot were separately recorded. The incidence of leaf blight ranged from 1.25 to 11.25 per cent during September to October 2021. Maximum incidence was recorded at Chikkanayakanahally taluk in the Tumkur district. The other important leaf disease named leaf spot was also documented during survey. The disease incidence ranged from 5.31 to 13.31 per cent during September to October, 2021. Maximum incidence was recorded at Hosanagara taluk in the Shivamogga district.

When we considered the district average (Table 3), the basal stem rot (3.29) and stem bleeding (6.87) incidence as recorded highest in Tumkur district followed by Hassan district (2.91 and 6.83) respectively. However, the bud rot, leaf blight and leaf spot disease were found high in the Shivamogga district.

Table 3. Disease status of coconut in major growing districts of Karnataka during September to October, 2021

District	Basal Stem Rot (DI)	Stem Bleeding (DI)	Bud rot (DI)	Leaf blight (PDI)	Leaf spot (PDI)
Chikkamagalor	0.66±0.42	3.14±1.14	1.71±0.81	7.81±2.10	8.60±2.60
Hassan	2.91±1.10	6.83±1.56	0.80±0.55	7.02±2.98	9.36±2.81
Shimogga	0.94±0.51	1.20±0.36	2.70±0.97	9.04±3.23	10.79±2.18
Tumkur	3.29±1.00	6.87±1.67	0.23±0.16	7.96±3.46	9.73±2.11

*Mean of three locations in three villages in each taluk Data presented is mean ± standard deviation

Veppankulam

A roving survey was conducted in Thanjavur, Nagapattinam and Thiruvarur districts block villages to assess the incidence of major coconut diseases *viz.*, basal stem rot, stem bleeding, bud rot, leaf blight and leaf spot in 2020-21 and the results are given in Table 4. In the Thanjavur district, the mean incidence of basal stem rot disease was 0.093% and the maximum incidence of basal stem rot disease was recorded as 1.11 % in Nattuchalai (Pattukkottai block). In Nagapattinam district, the mean incidence of basal stem rot disease was recorded as 2.71% and the maximum incidence of basal stem rot disease was recorded as 5.6 % in Periyakuthagai village. There was no incidence of basal stem rot disease, or bud rot in surveyed block villages of the Thiruvarur district. The incidence of leaf blight, leaf spot and stem bleeding diseases were absent in any of the places where the survey was undertaken in the above said three districts. The incidence of basal stem rot and the bud rot disease was recorded as 0.93% and 1.23% respectively in the east coast region of Tamil Nadu (Table-5).

Expt. 2: Fixed plot survey of coconut diseases

Aliyarnagar

In order to understand the incidence and spread of diseases on a long run basis, a fixed plot survey has been taken up. This will be useful in ascertaining the dynamics of the incidence of coconut diseases over a period of time. On a quarterly basis, the observations have been made to ascertain the incidence of diseases.

This survey was taken in two villages namely Puliyankandi and Aliyarnagar which are situated in the Anamalai block of Coimbatore district. This fixed plot survey was carried out from January 2021 to December 2021 in these villages and observations have been taken for the symptoms of two important diseases namely Leaf Blight caused by *Lasiodiplodia theobromae* and Leaf spots caused by *Pestalotiopsis palmarum*.

TheLeaf Blight was found to be on the higher side in Puliyankandi village than Aliyarnagar. The mean PDI was 20.75±1.3 in Puliyankandi when compared to 18.07±0.044 in Aliyarnagar. Further, it was observed that from April to July 2021 the incidence was more pronounced (PDI-20.05 to 24.5) when compared to the January and October quarters (PDI-18.70 to 19.30) of the year 2021 (Table 6). A positive correlation between leaf blight and temperature was observed i.e as the temperature (give a range of temp rising) rises the leaf blight incidence will also increase. Similarly, the leaf blight had a negative correlation with RH which mean the lower the RH, higher will be the leaf blight incidence and vice versa. (Table 7)

Similarly, the incidence of *Pestalotia* leaf spot also was found to be high in Puliyankandi village than Aliyarnagar as the mean incidence was 10.52±0.95 in the former village whereas it was 8.60±0.88 in the latter village. Among four quarters, the incidence was high during July and October in both the villages. The PDI was 11.8 to 12.50 in Puliyankandi and 10.20 to 11.30 in Aliyarnagar village respectively during these two quarters.

Table 4. Distribution of major diseases of coconut in Thanjavur district during 2021

District	Incidence of major Coconut Diseases (%) during-2021				
	Basal Stem Rot(DI)	Stem Bleeding (DI)	Bud Rot (DI)	Leaf Blight (PDI)	Leaf Spot (PDI)
Thanjavur					
Madukur	00.00	00.00	00.00	00.00	00.00
Pattukkottai	00.37	00.00	00.00	00.00	00.00
Orathanadu	00.00	00.00	00.00	00.00	00.00
Peravurani	00.00	00.00	00.00	00.00	00.00
Mean	**0.093**	00.00	00.00	00.00	00.00
Nagapattinam					
Vedaranyam-1	1.866	00.00	00.00	00.00	00.00
Vedaranyam-2	0.733	00.00	00.00	00.00	00.00
Thalainayir	1.10	00.00	3.66	00.00	00.00
Mean	**2.71**	00.00	**1.22**	00.00	00.00
Thiruvarur					
Mannargudi	00.00	00.00	00.00	00.00	00.00
Muthupet	00.00	00.00	00.00	00.00	00.00
Mean	00.00	00.00	00.00	00.00	00.00

Table 5. Distribution of major diseases of coconut in the East Coast region of Tamil Nadu during-2021

Districts	Incidence of major Coconut Diseases (%) during-2021				
	Basal Stem Rot	Stem Bleeding	Bud Rot	Leaf Blight	Leaf Spot
Thanjavur	0.093	0.00	0.00	0.00	0.00
Nagapattinam	2.70	0.00	3.70	0.00	0.00
Thiruvarur	0.00	0.00	0.00	0.00	0.00
Mean	**0.93**	**00.00**	**1.23**	**00.00**	**00.00**

Data presented is mean ± standard deviation; DI-Disease Incidence; PDI-Percent Disease Index

Table 6. Leaf blight and spot incidences in fixed plot survey

Month	Puliyankandi		Aliyarnagar	
	Leaf blight	*Pestolotia* leaf spot	Leaf blight	*Pestolotia* leaf spot
	PDI	PDI	PDI	PDI
Jan'21	18.70	9.5	17.00	7.50
April'21	24.50	8.30	19.0	8.10
July'21	20.50	11.8	18.20	10.20
Oct21	19.30	12.5	17.40	11.30
Mean	**20.75±1.3**	**10.52±0.95**	**18.07±0.044**	**8.60±0.88**

Table 7. Correlation between weather parameters and leaf blight and leaf spot diseases

Puliyankandi				Aliyarnager			
Correlation coefficient							
Leaf blight		Leaf spot		Leaf blight		Leaf spot	
Temperature	RH	Temperature	RH	Temperature	RH	Temperature	RH
0.95	-.0.71	- 0.75	0.33	0.88	- 0.90	- 0.42	0.53

Ambajipeta

Fixed plot survey has been taken up for stem bleeding and bud rot diseases at Horticulture Research station, Ambajipeta and for basal stem rot disease (*Ganoderma*) disease in farmer's field at Gudapalli village in East Godavari District at quarterly intervals. Per cent disease incidence of basal stem rot during January 2021 was 36.89 % which was increased to 38.54 % by the end of October 2021. Similarly, the disease index of basal stem rot also increased from 58.68 to 60.56 during the year 2021. In the case of stem bleeding disease, the incidence increased from 3.90% to 4.10% during the year 2021. The bud rot disease was not observed during the period (Table 8).

Arsikere

The Fixed plot survey on major coconut diseases was undertaken to assess the disease spread. The experiment was conducted at HREC, Arsikere. The plot is managed as per general management practices and no disease management measures are taken. The observations on basal stem rot, stem bleeding and leaf blight were recorded at the quarterly interval (Table 9&10). The incidences of 41.84 per cent BSR, 25.56 per cent stem bleeding, 11.36 per cent leaf blight was recorded during January 2021. At the end of the October, 2021, the incidences of BSR and stem bleeding diseases increased to 42.97 and 27.31 per cent, respectively. However, the incidence of leaf blight disease decreased to 8.56 per cent.

Table 8. Fixed plot survey on the incidence of coconut diseases in Andhra Pradesh

Month	Disease Incidence /Disease Index			
	Basal Stem Rot (%)	Disease index (PDI)	Stem Bleeding (%)	Bud Rot (%)
January 2021	36.89	58.68	3.90	0.00
April 2021	36.89	59.08	3.90	0.00
July 2021	38.54	60.56	3.90	0.00
October 2021	38.54	60.56	4.10	0.00

Table 9. Fixed plot survey of coconut diseases at HREC, Arsikere

Month	Disease Incidence /Disease Index					
	Basal Stem Rot		Stem Bleeding		Leaf blight	
	DI (%)	PDI	DI (%)	PDI	DI (%)	PDI
January -21	14.98	41.84(40.30)	12.50	25.56(30.37)	15.0	11.36(19.70)
April – 21	15.13	42.20(40.51)	12.50	25.99(30.65)	17.0	11.52(19.84)
July-21	15.13	42.68(40.79)	15.00	26.48(30.97)	16.00	11.84(20.13)
October-21	15.13	42.97(40.96)	15.00	27.31(31.51)	15.66	8.56(17.01)

Table 10. Correlation between weather parameters and basal stem rot and stem bleeding diseases at Arsikere during 2021

Weather parameters	Basal stem rot(PDI)	Stem bleeding(PDI)
Temp-Max	0.063	0.181
Temp-Min	0.806	0.723
Morning-RH(%)	-0.048	-0.962*
Evening-RH(%)	-0.980*	-0.083
Rainfall (mm)	0.333	-0.191

* Significant

Veppankulam

The periodical survey of the fixed plot was done at Mangadu village in Alangudy taluk of Pudukottai district in 2020-21. The total number of palms in the field is 85. Horizontal spread of basal stem rot was recorded at 32.94% in 2012 and it was increased to 95.29 per cent in 2021 and the vertical spread of basal stem rot disease was recorded at 24.76% in 2021 (Table-11). The correlation between the weather parameters *viz.*, temperature, relative humidity, rainfall and soil temperature and the spread and severity of basal stem rot disease of coconut was recorded. There was no significance between the weather parameters and the horizontal and vertical spread of basal stem rot disease of coconut in the fixed plot during 2021.

Table 11. Vertical and horizontal spread of basal stem rot disease of coconut in fixed plot at quarterly interval during 2021

Month	No. of palms infected by BSR	Per cent infection (%)	Basal stem rotDisease Index (%)
January 2021	79	92.94	24.92
April 2021	79	92.94	24.92
July 2021	79	92.94	24.92
October 2021	81	95.29	24.76

Coc./Path. 2: Basal stem rot disease

Centres: Ambajipet, Arsikere and Veppankulam

Expt. 1: Characterization of *Ganoderma* spp. associated with basal stem rot disease of coconut

Ambajipet

Only one isolate of *Ganoderma* spp. was isolated from the samples collected during the survey and the morphological and cultural characteristics were documented. The radial growth of isolates was around 90 mm in 8 days. The colony characters were found as white in colour and leathery in texture.

Morphological and cultural variations of Ganoderma isolates collected during thesurvey conducted in 2021.

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

Arsikere

The roots samples from *Ganoderma* infected coconut palms were collected during the roving survey. The isolation of the pathogen from these samples was done in laboratory using PDA medium. The totals of four isolates (G36, G37, G38 and G39) were isolated from the samples of Koppa, Hosanagar, Channarayapattana and Tiptur regions. 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 12).The colony characters of all isolates were white in colour with cottony growth.

Table 12. 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	
Koppa	G36	Root	7.00	52.00	83.00	90.00	White cottony growth
Hosanagara	G37	Root	9.00	54.00	86.00	90.00	White cottony growth
Channarayapattana	G 38	Root	8.00	61.00	88.00	90.00	White cottony growth
Tipture	G 39	Root	7.00	58.00	87.00	90.00	White cottony growth
CD (P=0.01)			NS	NS	NS	NS	

*Mean of four replications DAI- Days After Inoculation

Veppankulam

Four isolates of *Ganoderma* were collected from the sporophores (three) from CRS, VPM and (one) from Nattuchalai village, for the isolation of fungi and morphological studies in 2021. *In vitro* mycelial growth of the fungus was obtained at 3,5,7 and 9 days after inoculation in the PDA medium and the colony characters were studied (Table 13).The results revealed that *Ganoderma* isolate.-CRS 3 showed maximum radial growth 9 days after inoculation followed by *Ganoderma* isolate CRS-1. All the four *Ganoderma* isolates were showed white cottony growth.

Table 13. Measurement of radial growth of *Ganoderma spp*. in different days after inoculation under Potato Dextrose Agar medium and observation of colony characters

S. No	Place	Isolate Code	Part of collection	Mycelial growth (mm) of *Ganoderma*				Colony characters
				3DAI	5DAI	7DAI	9DAI	
1	CRS, Veppankulam	CRS 1	Sporophore	3.5	4.65	6.63	7.29 [b]	White cottony
2	CRS, Veppankulam	CRS 2	Sporophore	2.6	3.54	4.40	4.90 [c]	White cottony
3	CRS, Veppankulam	CRS 3	Sporophore	4.64	5.95	7.31	9.00 [a]	White cottony
4	Nattuchalai	NCHL 1	Sporophore	2.18	2.43	2.73	3.45 [d]	White cottony
	CD@5%			**0.389**	**0.353**	**0.377**	**0.398**	

DAI-Days After Inoculation

Expt. 2: Epidemiology and disease forecasting

Influence of weather parameters on disease incidence of BSR

Ambajipet

Impact of other palms and intercrops in coconut on the occurrence and spread of disease

The study was initiated in November 2010 to study the impact of other palms and intercrops in coconut on the occurrence and spread of basal stem rot disease. Fifty palms in the field with sole coconut and field with coconut + banana were selected in P.Gannavaram village of East Godavari District. Horizontal and vertical spread of the disease in sole coconut, as well as coconut intercropped with

banana during the time, is being recorded since 2010. Presently the farmer has discontinued the inter cropping with Banana and removed the infected palms. He also used various management practices to control the disease. Hence it was proposed to shift the experiment to another solo coconut field and presented the data (Table.14)

Table 14 : Impact of other palms and intercrops in coconut on occurrence and spread of the disease (2021):

S. No	Month	Temp °C		Relative humidity		Rain fall (mm)	No. of rainy days	Percent disease incidence (PDI) (Horizontal spread)		Mean vertical spread (cm)	
		Min	Max	Min.	Max.			Sole coconut	Coconut + Banana	Sole coconut	Coconut + Banana
1	Jan'21	18.6	31.3	86	68	1.0	1.0	36.02	28.02	119.25	135.28
2	Feb'21	18.1	32.1	86	64	1.0	1.0	36.02	28.02	119.25	135.28
3	March'21	21.5	35.1	85	63	1.0	1.0	36.02	28.02	119.25	135.28
4	April'21	24.0	37.3	78	53	12.4	3.0	36.02	28.02	119.25	135.28
5	May 21	25.0	38.0	81	69	77.8	5.0	36.02	28.02	119.25	135.28
6	June 21	26.1	36.7	88	70	79.2	8.0	36.02	28.02	119.25	135.28
7	July'21	24.4	32.1	89	76	271.3	13.0	36.02	28.02	119.25	135.28
8	Aug'21	25.0	33.2	87	72	102.8	8.0	36.02	28.02	119.25	135.28
9	Sep'21	23.9	32.7	88	75	155.6	8.0	36.02	28.02	119.25	135.28
10	Oct'21	25.2	34.1	71.7	96.3	46	6	36.02	28.02	119.25	135.28
11	Nov'21	30.7	23.6	94.6	74.8	94	9	36.02	28.02	119.25	135.28
12	Dec'21	18.5	29.6	60.5	96.6	-	-	36.02	28.02	119.25	135.28

Arsikere

The study was continued with 76 palms to record the disease incidence at monthly intervals. The weather parameters such as atmospheric temperature, relative humidity, rainfall, and rainy days were recorded to correlate the vertical and horizontal spread of the disease (Table 15). The results revealed that the vertical spread of the disease ranged from 184.8 to 185.7 cm and the horizontal spread from 11 to 12 palms (14.47 to 15.78%) during twelve months.

Correlation of weather parameters with disease incidence

The monthly average of weather parameters such as relative humidity, temperature and rainfall were correlated with the vertical and horizontal spread of Basal Stem rot disease. The result implied that there was a positive correlation between relative humidity (Table 16), rainfall and spread of disease.

Veppankulam

The vertical and horizontal spread of basal stem rot disease of coconut was recorded in the plots of sole coconut and intercropped coconut at CRS, VPM, a quarterly basis. The weather parameters such as relative humidity, atmospheric temperature, rainfall and soil temperature were recorded to correlate the vertical and horizontal spread of disease during 2020-21 (Tables 17). The results revealed that the vertical spread of basal stem rot disease (BSR) in sole coconut crops ranged from 73.05 cm to 78.80 cm and the horizontal spread of basal stem rot disease from 36.5% to 40.30 % in sole coconut crop. Whatis the status in inter cccropped coocnunt garden?

The temperature, relative humidity (RH) and rainfall has a positive correlation with both vertical and horizontal spread of the basal stem rot disease (BSR) in sole coconut crop. Horizontal spread of the basal stem rot disease (BSR) has a negative correlation with soil temperature, in sole coconut (Table 18). The experiment is in progress.

Table 15. Influence of weather parameters on Basal Stem Rot disease incidence

Sl. No.	Month	Temp.(°C)		RH(%)		Rain fall (mm)	Rainy days (No)	**Rate of VS (cm)	*HS	**Rate of HS
		Max	Min	Morning	Evening					
1	January 2021	27.74	21.02	70.68	53.58	-	-	184.8	11(76)	14.47
2	February 2021	31.88	22.39	59.36	41.57	89.1	2.0	184.8	11(76)	14.47
3	March 2021	35.03	27.06	49.84	36.13	-	-	185.1	11(76)	14.47
4	April 2021	37.40	27.17	63.40	42.17	26.0	2.0	185.1	11(76)	14.47
5	May 2021	37.94	26.18	77.61	56.06	173.4	7.0	185.1	11(76)	14.47
6	June 2021	37.40	25.45	81.03	64.93	73.7	7.0	185.1	11(76)	14.47
7	July 2021	39.06	25.19	91.03	79.06	58.80	8.0	185.4	12(76)	15.78
8	August 2021	38.79	26.87	85.77	79.48	63.0	11.0	185.4	12(76)	15.78
9	September 2021	36.52	24.58	86.20	81.10	51.5	4.0	185.4	12(76)	15.78
10	October 2021	38.65	23.98	84.65	83.77	283.1	15.0	185.4	12(76)	15.78
11	November 2021	36.6.	23.10	85.27	83.57	221.9	11.0	185.7	12(76)	15.78
12	December-2021	35.61	22.47	73.03	62.48	31.0	3.0	185.7	12(76)	15.78

RH- Relative Humidity VS- Vertical Spread HS- Horizontal Spread
*Values in Parenthesis are the total number of palms where as outside parenthesis are infected palms
**Mean of ten palms

Table 16. Correlation between weather parameters and BSR Disease

Parameter	VS	HS
Morning RH (%)	0.689	0.770
Evening RH (%)	0.816	0.907
Max.Temp.°C	0.698	0.509
Min. Temp.°C	0.220	-0.034
Rainfall(mm)	0.507	0.426

VS- Vertical Spread HS- Horizontal Spread

Expt 3: Management of coconut basal stem rot disease through biological control agents

Ambajipet

The bacterial endophytes were isolated from healthy coconut plant materials and screened for their antagonistc properties against BSR pathogen *Ganoderma* sp. (isolate no.). One among them was found effective against *Ganoderma*, and the endophyte isolate was kept for dual culture studies against different *Ganoderma*. Among all the endophytes tested EP4 isolate showed 51.11 per cent inhibition remaining isolates showed 90 mm growth after 8 days after inoculation.The effective endophyte was sequenced on outsourcing basis and identified as *Bacillus amyloliquefaciens* .

Field experiment: The selected effective B.*amylolequefcains* isolate was taken to field conditions to test the 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, whereas the bacterial broth was fed through roots and root-feeding of Hexaconazole was used as a standard check. The results revealed that among all the treatments, there was a significant variation with respect to disease index at three months after treatment. At 24 months after treatment the positive check recorded 36.85% of reduction over initial followed by treatment T1-Soil application of 100g talc formulation of *Bacillus amyloliquefaciens* along with 50kg FYM water found effective by recorded the 20.73 per cent of reduction over initial where the disease index reduced from 38.48 to 30.50 (Table 19).

Arsikere

The bacterial bioagent named EP10 was found to be promising in arresting the 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 the soil along with FYM 50Kg whereas the bacterial broth was fed through roots and root-feeding of Hexaconazole

Table 17. Horizontal and Vertical spread of basal stem rot disease and disease incidence in Sole coconut crop @ CRS, VPM during 2021

Period	*Vertical spread of BSR (VS in cm)		Horizontal spread of BSR (%)
	VS (cm)	DI (%)	
21-Jan	73.05	34.52	36.50
21-Feb	73.05	34.52	36.50
21-Mar	73.05	34.52	37.26
21-Apr	74.80	35.05	37.26
21-May	74.80	35.05	37.64
21-Jun	77.55	35.56	37.64
21-Jul	78.80	35.87	38.40
21-Aug	78.80	34.52	38.40
21-Sep	78.80	34.52	38.40
21-Oct	78.80	34.52	38.40
21-Nov	78.80	34.94	38.40
21-Dec	78.80	34.94	40.30

BSR-Basal Stem Rot**, HS**-Horizontal spread**, VS**-Vertical spread**, DI**-Disease Incidence
** Coconut + Pepper + Banana + Cocoa

Table 18. Correlation of weather parameters with the horizontal and vertical spread of basal stem rot disease in coconut @ CRS, VPM during 2021

Weather parameters	Horizontal Spread of BSR	Vertical Spread ofBSR
Temp-Max	0.02	0.15
Temp-Min	0.34	0.53
Morning-RH(%)	**0.63***	0.42
Evening-RH(%)	**0.58***	0.52
Rainfall (mm)	0.09	0.27
Morning-Soil temp.	-0.05	0.24
Evening-Soil temp.	-0.04	0.21

BSR-Basal Stem Rot ***Significant (P= (or) less than 0.05)**

was used as a standard check. The result revealed that among all the treatments there was no significant variation (Table 20) with respect to disease index at 30 month after treatment. The experiment is in progress.

Veppankulam

Based on the *in vitro* evaluation of bio-control agents, the effective bacterial strain *Bacillus subtilis* EPC5 was selected for the management of basal stem rot under field conditions. The trial was laid out in randomized block design with the following four treatments and five replications. For each replication, four coconut palms were selected. The trial was initiated in 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 50 ml of *Bacillus subtilis* EPC5 (nutrient broth) /100 ml of water at 3 months intervals was found superior in containing the disease by registering 26.82 per cent reduction over initial as compared to other treatments (Table 21). The experiment is in progress.

Table19 Influence of bacterial bio-agents on Basal stem rot disease of coconut (2021):

Treatments	Disease index									
	Before treatment	3 MAT	6 MAT	9 MAT	12 MAT	15 MAT	18 MAT	21 MAT	24 MAT	Reduction over initial
T_1- Soil application of 100g talc formulation of *Bacillus amyloliquefaciens* along with 50kg FYM	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)	20.73
T_2 -Root feeding of bacterial strain 50 ml broth (10^8 cfu/ml) in 100 ml water	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)	19.68
T_3- Root feeding of Hexaconazole 3 ml in 100 ml water	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)	36.85
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)	0.00
S.Em±	**6.14**	**6.01**	**5.75**	**5.60**	**1.19**	**1.20**	**1.45**	**1.96**	**1.93**	
CD (P=0.05)	**NS**	**NS**	**17.73**	**17.27**	**3.59**	**3.63**	**4.39**	**5.92**	**5.84**	

Table 20. 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	
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)	9.75
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)	7.62
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)	11.82
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)	-17.09
SEm±	0.42	0.65	0.65	0.67	0.64	0.80	
CD@5 %	1.30	1.99	2.01	2.06	1.97	2.46	

*Mean of six replications MAT- Months After Treatment

Expt 4: Management of coconut basal stem rot disease through fungicides

Ambajipeta

An experiment on-field evaluation of Azoxystrobin 11% + Tebuconazole 18.30% SC and Hexaconazole 5% + validamycin 2.5%SC fungicides at different combinations were initiated against basal stem rot disease of coconut at farmer's coconut garden at Peddapatnamlanka village of East Godavari district during October,2020. Pre data was recorded on the disease index of basal stem rot disease and three months intervals the scheduled treatments has been followed. [Table.22]

Table 21. Effect of bio-agent *Bacillus subtilis* against BSR of coconut @ CRS, Veppankulam during 2021

Treatments	Initial Disease Index (%)	Basal stem rot disease Index* (%)-2021				%Disease reduction over initial
		Jan-21	Apr-21	21-Jul	21-Oct	
T1-Soil application of 100g talc based formulation of EPC5 along with 50kg FYM at 3 months interval	17.75 (24.92)	29.19 (32.70)	29.08 (32.63)	29.01 (32.59)	20.00 (26.57)	-12.68
T2- Root feeding of 50 ml of EPC5 (nutrient broth)/100 ml of water at 3 months interval	19.13 (25.94)	14.02 (21.99)	13.62 (21.66)	13.38 (21.46)	14.00 (21.97)	26.82
T3-Root feeding of Hexaconazole 3ml/ 100 ml of water at 3 months interval	14.8 (22.63)	15.75 (23.38)	15.74 (23.37)	15.51 (23.19)	15.00 (22.79)	-1.35
T4-Untreated control	11.36 (19.70)	37.26 (37.62)	37.48 (37.75)	38.03 (38.07)	38.20 (38.17)	236.27
SEM	1.72	5.55	5.65	5.82	5.62	
CD@5%	**1.13**	**11.03**	**11.03**	**11.09**	**7.79**	

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

After the 4th quarterly scheduled treatment T6: RF+SD- Hexaconazole + Validamycin recorded a maximum disease reduction of 12.04 per cent over initial followed by the positive control T7: Root feeding of only Hexaconazole (4 ml in 100 ml of water/Palm) with 11.55 per cent reduction over initial. The next best treatment was T4: Root feeding of Hexaconazole + Validamycin 4 ml in 100 ml of water/palm with 8.10 per cent reduction over initial followed by T3: Root feeding +Soil drenching of Azoxystrobin + Tebuconazole with 5.90 per cent reduction over initial .

Arsikere

Based on the *in vitro* evaluation of new systemic fungicides, effective combination fungicides *viz.*, Azoxystrobin 11%+ Tebuconazole18.3% SC W/ W, and Hexaconazole 5% + validamycin 2.5%SC were selected and compared with Hexaconazole 5% for the management of basal stem rot under field condition in 2020-21. The trial was laid out with the following treatments in randomized block design with four replications. For each treatment, four coconut palms were selected. The effective fungicides were given as root feeding and soil drenching at quarterly intervals. The disease index of basal stem rot of coconut was recorded before imposing the treatments (Table 23).

The result at 4th quarter treatments imposition revealed that T6: RF+SD- Hexaconazole + Validamycin recorded maximum disease reduction of 12.08 per cent over initial followed by the positive control T7: Root feeding of only Hexaconazole (4 ml in 100 ml of water/Palm) with 9.60 per cent reduction over initial. The next best treatment was T4: Root feeding of Hexaconazole + Validamycin 4 ml in 100 ml of water/palm with 8.10 per cent reduction over initial followed by T3: Root feeding +Soil drenching of Azoxystrobin + Tebuconazole with 5.90 per cent reduction over initial.

Veppankulam

Based on the *in vitro* evaluation of new systemic fungicides, effective combination fungicides *viz.*, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W and Hexaconazole 5% + validamycin 2.5%SC were selected and compared with Hexaconazole 5% for the management of basal stem rot under field condition during 2021. The trial was laid out with the following treatments in randomized block design with three replications. For each replication, three coconut palms were selected. The

Table 22. Evaluation of identified systemic fungicide against basal stem rot disease under field conditions

Treatment details	Disease index					
	Pre-treatment Disease Index	3MAT	6MAT	9MAT	12MAT	Per cent Reduction over initial
T1: Root feeding of Azoxystrobin 11% + Tebuconazole 18.3% SC @4ml in 100 ml of water/palm at quarterly intervals	30.48 (33.49)	30.55 (33.50)	31.05 (33.84)	30.56 (29.02)	28.86 (27.28)	5.31
T2: Soil Drenching of Azoxystrobin 11% + Tebuconazole 18.3% SC @10 ml in 5 Liters of water/palm at quarterly intervals	33.44 (35.32)	33.48 (35.30)	33.71 (35.46)	32.87 (29.90)	32.48 (29.65)	2.87
T3: T1+T2: Root feeding +Soil drenching of Azoxystrobin 11%+Tebuconazole 18.3% SC	34.06 (35.67)	33.96 (35.59)	33.28 (35.18)	32.56 (29.10)	32.05 (28.80)	5.90
T4: Root feeding of Hexaconazole 5% SC + Validamycin 25% sc 4 ml in 100 ml of water/ palm	37.25 (37.60)	37.27 (37.59)	37.6 (37.79)	35.62 (30.66)	34.23 (29.87)	8.10
T5: Soil Drenching of Hexaconazole 5% SC + Validamycin 25% sc 10 ml in 5 Lit of water/ palm	35.58 (36.57)	35.81 (36.71)	36.1 (36.90)	35.71 (30.18)	34.42 (29.69)	3.26
T6: T4+T5 : RF+SD- Hexaconazole 5% SC + Validamycin 25% sc	28.64 (32.29)	28.40 (32.15)	27.38 (31.49)	25.86 (25.06)	25.19 (25.06)	12.04
T7: Root feeding of only Hexaconazole 5% SC (4 ml in 100 ml of water/Palm)	41.96 (40.37)	40.94 (39.76)	39.05 (38.66)	37.23 (31.19)	37.11 (30.24)	11.55
T8: Control	39.07 (38.66)	40.90 (39.75)	41.36 (40.01)	42.69 (32.91)	43.56 (33.48)	-
SEm±	**NS**	**1.39**	**1.18**	**1.11**	**1.04**	
CD (Pd"0.05)	**NS**	**4.04**	**3.43**	**3.20**	**2.99**	

effective fungicides were given as root feeding and soil drenching at the quarterly interval. The disease index of basal stem rot of coconut was recorded before and after imposing the treatments (Table 24). The results revealed that the treatment (T6) comprises root-feeding of Hexaconazole 5%+Validamycin-2.5%SC@4ml in 100ml water combined with soil drenching of Hexaconazole 5%+Validamycin-2.5%SC@ 2ml/ltr (5ltr./palm) at the quarterly interval was the most effective in containing the disease by registering 9.92 per cent decrease in basal stem rot disease (BSR) index over initial disease index as compared to other treatments and followed by the treatment (T3) root feeding of Azoxystrobin11%+ Tebuconazole-18.3%SC@4ml in 100ml water at quarterly interval combined with soil drenching of Azoxystrobin11%+ (@ 2ml/ltr.) 5ltr./palm was registered as 5.66 per cent decrease in BSR disease index over initial as compared to other treatments disease index in the year 2021.

Coc./Path. 3: Stem Bleeding Disease

Centres: Ambajipet and Arsikere

Expt 1: 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*

Table 23. Effect of fungicides against BSR of coconut @ Arsikere (2020-21)

Treatments	*BSR Disease Index (%)					% reduction over initial
	Pre-treatment Oct, 2020	Jan 21 3MAT	April 21 6MAT	July 21 9MAT	Octo-21 12MAT	
T1- Root feeding of Azoxystrobin 11% + Tebuconazole-18.3% SC W/W (CUSTODIA ® 4 ml in 100 ml water/ palm) @ quarterly	22.88 (28.50)	23.09 (28.67)	23.85 (29.20)	22.80 (28.50)	21.64 (27.70)	5.40
T2- Soil drenching of Azoxystrobin 11% + Tebuconazole-18.3% SC W/W (CUSTODIA ® 10 ml in 5 liter water/ palm) @ quarterly	24.80 (29.85)	25.16 (30.10)	25.92 (30.58)	24.58 (29.71)	23.56 (29.02)	4.98
T3- T1 + T2@ quarterly	24.51 (29.65)	24.88 (29.90)	24.94 (29.95)	22.38 (28.22)	22.50 (28.28)	8.20
T4-Root feeding of Hexaconazole 5% + Validamycine 25% SC (Validex ® 4 ml in 100 ml water/ palm)@ quarterly	24.36 (29.56)	24.72 (29.80)	24.98 (29.98)	23.62 (29.07)	22.15 (28.07)	9.10
T5- Soil drenching of Hexaconazole 5% + Validamycine 25% SC (Validex ® 10 ml in 5 liter water/ palm) @ quarterly	23.92 (29.27)	24.28 (29.51)	24.74 (29.79)	23.77 (29.17)	22.35 (28.20)	6.58
T6- T4 + T5 @ quarterly	24.51 (29.65)	24.73 (29.80)	24.82 (29.88)	23.46 (28.93)	21.55 (27.63)	12.08
T7 - Root feeding of Hexaconazole 5% SC (Contaf ® 4 ml in 100 ml water/ palm) @ quarterly	23.73 (29.15)	24.95 (31.27)	25.25 (30.12)	23.25 (28.81)	21.43 (27.55)	9.60
T8 – Control	24.34 (29.56)	25.88 (29.89)	26.34 (30.86)	25.63 (30.41)	26.95 (31.27)	-10.73
SEM+-	0.78	0.80	0.88	0.72	0.76	
CD 5%	2.30	2.37	2.59	2.12	2.24	

MAT-Months After Treatment

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 the 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.25).

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 15.07 was brought down to 0.00 per cent within 50 days

Table 24. Effect of fungicides against BSR of coconut@CRS, Veppankulam during 2021

Treatments	Basal stem rot disease index (%)-2021				% Disease reduction over initial
	Pre-treat	3MAT	6MAT	12MAT	
T1: Root feeding of Azoxystrobin 11% + Tebuconazole 18.3% SC @4ml in 100 ml of water/palm at quarterly intervals	16.21 (23.74)	16.13 (23.68)	16.01 (23.59)	15.85 (23.46)	2.22
T2: Soil Drenching of Azoxystrobin 11% + Tebuconazole 18.3% SC @10 ml in 5 Liters of water/palm at quarterly intervals	16.08 (23.64)	16.10 (23.66)	16.20 (23.73)	16.00 (23.58)	0.50
T3: T1+T2: Root feeding +Soil drenching of Azoxystrobin 11% + Tebuconazole 18.3% SC	24.38 (29.59)	24.00 (29.33)	23.48 (28.98)	23.00 (28.66)	5.66
T4: Root feeding of Hexaconazole 5% SC + Validamycin 25% sc 4 ml in 100 ml of water/palm	30.61 (33.59)	30.50 (33.52)	30.00 (33.21)	29.00 (32.58)	5.26
T5: Soil Drenching of Hexaconazole 5% SC + Validamycin 25% sc 10 ml in 5 Lit of water/palm	35.87 (36.79)	35.89 (36.80)	35.89 (36.80)	35.50 (36.57)	1.03
T6: T4+T5 : RF+SD- Hexaconazole 5% SC + Validamycin 25% sc	14.12 (22.07)	13.60 (21.64)	12.99 (21.13)	12.72 (20.89)	9.92
T7: Root feeding of only Hexaconazole 5% SC (4 ml in 100 ml of water/Palm)	18.94 (25.80)	18.50 (25.47)	18.00 (25.10)	17.98 (25.09)	5.07
T8: Control	40.92 (23.74)	42.30 (40.57)	43.72 (41.39)	44.30 (41.73)	-8.26
SEm±	3.57	3.72	3.88	3.92	
CD (Pd"0.05)	**NS**	**NS**	**NS**	**NS**	

MAT-Months After Treatment

of cake application. Disease index of 19.50 and 22.17 was reduced to 1.66 and 7.33 respectively with paste application of *Trichoderma reesei* and copper oxychloride. However, the treatments differ significantly at 50 DAT.

Expt. 2: Management of stem bleeding disease in coconut through fungicides

Ambajipeta

An experiment on-field evaluation of Azoxystrobin 11% + Tebuconazole 18.30% SC and Hexaconazole 5% + Validamycin 2.5%SC fungicides at different combinations were initiated against basal stem rot disease of coconut at farmer's coconut garden at Dagalavaripalem village of East Godavari district. Pre data was recorded on the disease index of stem bleeding disease. The positive control has been maintained with root feeding of Hexaconazole 5% SC (4 ml in 100 ml of water/ Palm) to compare the efficacy of the testing fungicides. The treatments have been given at quarterly intervals (Table.26).

After 12 months of quarterly treatment with T6 : RF+SD- Hexaconazole + Validamycin has been recorded 20.67 per cent reduction over control followed by T7- Root feeding with Hexaconazole @4 ml in 100 ml of water/Palm) with 17.04 per cent reduction over the initial. The next best treatment was T4 Root feeding of Hexaconazole + Validamycin 4 ml in 100 ml of water/palm showed 16.17 per cent followed by T3: Root feeding +Soil drenching of Azoxystrobin + Tebuconazole recorded 14.26 per cent reduction over initial.

Table 25 Field evaluations of cake and paste formulations of *Trichoderma* species against stem bleeding disease of coconut

S. No	Treatment	At HRS Ambajipet,Variety Gangabondam	
		Disease index(DI)	
		BT	3 MAT
1	*T.reesei* cake	15.07 (21.35)	0.00 (0.00)*
2.	*T.reesei* paste	19.50 (25.88)	1.66 (6.39)
3	COC Paste	22.17 (27.97)	7.33 (15.49)
4	Control	15.63 (22.18)	21.16 (27.79)
	SE(m)±	**NS**	**2.28**
	C.D.@5%	**NS**	**6.90**

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

Arsikere

Based on the *in vitro* evaluation of new systemic fungicides, effective combination fungicides *viz.*, Azoxystrobin 11%+ Tebuconazole18.3% SC W/W, and Hexaconazole 5% + validamycin 2.5%SC were selected and compared with Hexaconazole 5% for the management of Stem bleeding under field condition in 2020. The trial was laid out with the following treatments in randomized block design with four replications. For each replication, four coconut palms were selected. The effective fungicides were given as root feeding and soil drenching at quarterly intervals. The disease index of Stem bleeding of coconut was recorded before imposing the treatments (Table 27). The result revealed that among all the treatments there was no significant variation with respect to disease index at 12 months after treatment.

Coc./Path 4. Leaf Blight Disease

Centres: Aliyarnagara and Arsikere

Expt 1. Characterization of leaf blight disease in coconut

Aliyarnagar

Expt 1. Yield loss assessment in coconut due to leaf blight disease

Twenty-five healthy and 25 leaf blight infected palms were selected in Puliankandi village, Anamalai Block Coimbatore district and nut yields were recorded from Jan 2021–Dec 2021. From the results, it was found that the per cent reduction in nut yield due to leaf blight disease in coconut ranged from 8.19 to 22.20 per cent with an average nut yield loss of 14.01 per cent(Table 28)

Expt. 2: 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 2021 to December 2021 in order to understand the pattern on incidence in correlation with weather parameters prevailing in different seasons. The weather parameters namely temperature, rainfall, morning and evening relative humidity and evaporation prevailed in standard Meteorological Weeks were recorded and the respective incidence of Leaf Blight during these weeks were also recorded. The observations are presented in following Table 29.

The results given in the above table 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 2021 it got decelerated during October, November, December months of 2021.

The correlation results given in Table 30 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 . 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 29 that the months coinciding the increased RH experienced lesser incidence of Leaf blight.

Expt. 3: Management of leaf blight Disease in coconut

Aliyarnagar

Management of Leaf blight disease using chemicals has been one of the pragmatic option and

Table 26. Evaluations of identified systemic fungicides against stem bleeding disease under field conditions

Tr. No.	Treatment details	Disease Index (DI)					
		Pre treat mental data	3 MAT	6 MAT	9 MAT	12 MAT	Per cent reduction overinitial
T1	Root feeding of Azoxystrobin 11% + Tebuconazole 18.3% SC @4ml in 100 ml of water/palm at quarterly intervals	22.96 (28.62)	22.51 (28.29)	24.21 (29.44)	23.61 (24.57)	21.45 (23.25)	6.57
T2	Soil Drenching of Azoxystrobin 11% + Tebuconazole 18.3% SC @10 ml in 5 Liters of water/palm at quarterly intervals	22.06 (27.99)	23.01 (28.64)	23.45 (28.95)	22.19 (23.02)	22.01 (23.02)	0.22
T3	T1+T2: Root feeding +Soil drenching of Azoxystrobin 11% + Tebuconazole 18.3% SC	25.03 (30.02)	25.13 (30.04)	25.63 (30.40)	23.27 (23.80)	21.46 (23.80)	14.26
T4	Root feeding of Hexaconazole 5% SC + Validamycin 25% sc 4 ml in 100 ml of water/palm	23.56 (29.03)	24.56 (29.68)	25.21 (30.13)	22.67 (23.90)	19.45 (21.85)	16.17
T5	Soil Drenching of Hexaconazole 5% SC + Validamycin 25% sc 10 ml in 5 Lit of water/palm	26.08 (30.71)	26.08 (30.69)	27.94 (31.90)	25.56 (25.97)	23.32 (24.57)	10.58
T6	T4+T5 : RF+SD- Hexaconazole 5% SC + Validamycin 25% sc	24.52 (29.68)	23.56 (29.02)	25.01 (29.99)	22.67 (23.02)	19.45 (20.89)	20.67
T7	Root feeding of only Hexaconazole 5% SC (4 ml in 100 ml of water/Palm)	26.10 (30.72)	26.9 (31.23)	27.31 (31.82)	24.32 (24.55)	21.65 (24.55)	17.04
T8	Control	26.22 (30.79)	27.14 (31.38)	28.32 (32.15)	31.25 (28.78)	32.56 (29.55)	0.00
	SEm±	NS	0.61	0.46	1.47	1.45	
	CD (Pd"0.05)		1.79	1.35	4.23	4.16	

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 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 31.

The results in the above table 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 29.95 to 2.98 which was calculated to be 26.97 percent reduction. In terms of severity of the disease, the treatment was reported to effect 66.9 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 139 nuts have been harvested with a benefit cost ratio of 1:1.39. Next best treatment was Root feeding of tebuconazole @ 5ml + 100 ml water which has resulted in 21.72 percent reduction in the Leaf Blight disease and the severity was reduced to

Table 27. Effect of fungicides against stem bleeding disease of coconut @ Arsikere (2021)

Treatments	PDI					% reduction over initial
	Pre-treatment Oct-20	Jan-21	April 21	July-21	Octo-21	
T1- Root feeding of Azoxystrobin 11% + Tebuconazole-18.3% SC W/W (CUSTODIA ® 4 ml in 100 ml water/ palm) @ quarterly	26.72 (31.12)	26.81 (31.17)	27.32 (31.51)	26.77 (31.15)	25.69 (30.45)	3.85
T2- Soil drenching of Azoxystrobin 11% + Tebuconazole-18.3% SC W/W (CUSTODIA ® 10 ml in 5 liter water/ palm) @ quarterly	26.01 (30.65)	26.37 (30.89)	26.84 (31.20)	25.98 (30.65)	25.46 (30.30)	2.11
T3- T1 + T2@ quarterly	25.82 (30.54)	26.25 (30.82)	26.13 (30.74)	25.09 (30.06)	23.18 (29.45)	10.22
T4- Root feeding of Hexaconazole 5% + Validamycine 25% SC (Validex ® 4 ml in 100 ml water/ palm) @ quarterly	26.88 (31.23)	27.00 (31.30)	27.45 (31.59)	26.79 (31.17)	25.42 (30.27)	5.45
T5- Soil drenching of Hexaconazole 5% + Validamycine 25% SC (Validex ® 10 ml in 5 liter water/ palm) @ quarterly	27.72 (31.76)	27.93 (31.89)	28.35 (32.16)	27.85 (31.85)	26.38 (30.89)	4.85
T6- T4 + T5 @ quarterly	25.64 (30.42)	25.86 (30.57)	26.03 (30.68)	25.22 (30.13)	22.71 (28.44)	11.45
T7 - Root feeding of Hexaconazole 5% SC (Contaf ® 4 ml in 100 ml water/ palm) @ quarterly	28.43 (32.20)	28.69 (32.37)	28.97 (32.55)	27.92 (31.88)	26.41 (30.92)	7.11
T8 – Control	27.42 (31.57)	28.86 (32.48)	29.14 (32.66)	29.40 (32.83)	29.66 (32.98)	-8.52
SEM	0.57	0.61	0.47	0.49	0.51	
CD 5%	1.66	1.78	1.38	1.45	1.49	

MAT-Months After Treatment

Table 28. Assessment of yield loss due to leaf blight disease

S. No	Date of harvest	Nut yield (Mean of 25 palms)		% reduction in Nut yield
		Healthy Palms	Infected Palms	
1.	18.01.2021	21.05	16.23	11.21
2.	08.03.2021	17.60	14.80	18.91
3.	26.04.2021	21.40	19.78	8.19
4.	11.06.2021	21.09	18.58	13.50
5.	29.07.2021	18.44	15.09	22.20
6.	13.09.2021	20.40	19.30	13.11
7.	23.10.2021	21.02	18.52	13.49
8.	14.12.2021	19.80	18.76	11.48
			Mean	**14.01**

Table 29Monthwise weather data and intensity of leaf blight during Jan 2021 to Dec 2021

S. No.	Month	Leaf blight	Temperature (°C)		Rainfall (mm)	Relative Humidity (%)		Evaporation (mm)
			Max. Temp (°C)	Min. Temp (°C)		Morning	Evening	
1.	January '21	26.0	28.8	22.99	2.09	90.8	76.3	2.52
2.	February	26.1	32.2	22.5	0.0	90.8	65.7	4.76
3.	March	27.5	34.72	24.52	0.97	86.6	77.38	5.04
4.	April	27.8	35.0	26.4	3.01	84.7	82.9	3.74
5.	May	27.9	35.3	22.0	4.05	86.8	82.3	5.07
6.	June	26.9	34.0	23.2	18.7	82.4	76.2	3.3
7.	July	27.1	31.7	26.5	12.36	85.3	80.3	2.82
8.	August	25.3	32.02	26.72	3.35	85.02	77.7	3.08
9.	September	26.2	26.2	32.0	4.61	86.07	80.8	3.57
10.	October	26.0	32.28	26.66	8.37	91.06	82.54	2.46
11.	November	24.4	26.67	23.55	12.11	82.9	65.85	1.76
12.	December	19.9	32.66	17.88	1.86	95.44	90.24	3.44

Table 30. Correlation between leaf blight incidence and weather parameters

	Weather parameters	Correlation coefficient
Leaf blight incidence	Temperature (Maximum)	0.81
	Temperature (Minimum)	0.67
	RH (Morning)	-0.61
	RH (Evening)	-.042
	Rainfall	0.21
	Evaporation	2.34

the level of 56.56 percent with the nut yield of 127/ tree/year and benefit cost ratio of 1:1.28.

Expt.3 Sequential use of fungicides against leaf blight disease in coconut

Aliyarnagar

An *in vitro* evaluation to identify the effective systematic fungicide against the Leaf blight of coconut *Lasiodiplodia theobromae* has been planned. The following fungicides and their combination were tried in different concentrations namely 50,100, 250, 500, 750,1000 and 1500ppm *in vitro* conditions using poisoned food technique

- Tebuconazole - 25.9%EC
- Propiconazole - 25.9% EC
- Penconazole -10% EC
- Carbendazim - 50% WP
- Kresoxym methyl - 44.3% SC
- Azoxystrobin - 23% SC
- Thiophanate methyl 70 % WG
- Debacarb+Carbendazim -1.7 % +0.3 %, Mycobutanol - 10 % WP,
- Tebuconazole+ Zineb - 2% +75 % WP

The results revealed that propiconozole was found to inhibit the growth of the fungus from 250 ppm concentration and it was effective upto 1500 ppm. When compared to propiconozole, the tebuconozole was found to be effective from 1000 ppm onwards only and penconazole was found to control the fungus from 1250 ppm onwards. As propiconozole, tebuconozole and penconazole did

Table 31. Evaluation of systemic fungicides against leaf blight disease

Treatment No.	Treatment details	Leaf blight intensity (PDI			Leaf blight incidence (%)			Nut yield	C:B ratio
		0 MAA	36 MAA	Diseaser eduction	0MAA	36 MAA	Disease reduction		
1.	Root feeding of tebuconazole @ 2ml + 100 ml water	31.97	20.16	11.81	100	54.5	45.5	115	1:1.24
2.	Root feeding of tebuconazole @ 5ml + 100 ml water	32.56	10.84	21.72	100	43.44	56.56	127	1:1.28
3.	Root feeding of tebuconazole @ 10ml + 100 ml water	33.33	17.78	15.55	100	55.1	44.9	125	1:1.20
4.	Root feeding of propiconazole @ 2ml + 100 ml water	37.93	19.93	18.00	100	43.0	57.0	128	1:1.29
5.	Root feeding of propiconazole @ 5ml + 100 ml water	29.95	2.98	26.97	100	33.1	66.9	139	1:1.39
6.	Root feeding of propiconazole @ 10 ml + 100 ml water	36.71	18.71	19.00	100	44.2	55.8	118	1:1.27
7.	Sed	-	-	0.92	-	-	-	1.65	
	CD(P=0.05)	-	-	2.12	-	-	-	3.49	

MAA-Months after application Values are mean of three replications.

inhibit the growth of fungus causing leaf blight when they were used with the concentration of 250ppm, 1000 ppm and 1250 ppm, the fungicides which were effective with lesser concentration were taken for field study. Thus propiconozole and tebuconozole were selected for evaluating their efficiency when they applied sequentially (table-32&33).

Evaluation of sequential use of fungicides against coconut leaf blight

The results of the *in vitro* screening of systemic fungicides culminated in the field evaluation of two of the effective fungicides namely tebuconozole and propiconozole when they were applied sequentially in different intervals in a year. In order to carry out the experiment, an experimental plot with Randomized Block Design was laid out with five treatments which was replicated four times in Puliyankandi village of Anaimalai block in Coimbatore district. The treatment protocols of five treatments are given below in the table 34. The observations were taken pre and post-experiment and they were recorded using a 0-5 scale based on the severity of the incidence.

The experimental results were analysed and it was found that propiconazole applied @ 5ml in 95 ml water during Jan, July followed by application of tebuconazole applied @ 5ml in 95 ml water during April and October was found to be very effective in arresting the infection of fungi causing leaf blight in coconut. At the end of six months after treatment it was found that the incidence was reduced to the level of 5.58 per cent besides the nut yield got increased to 135 nuts/year/palm as against 99 nuts/palm/year which was recorded in control.

Hence the sequential application of propiconazole followed by tebuconozole in an interval of three months was found to effectively check the growth of mycelium of leaf blight disease.

Table 32. *In vitro* evaluation of fungicides against coconut leaf blight pathogen *Lasiodiplodia theobromae*

S. No	Fungicides	Concentration in ppm								
		50	100	250	500	750	1000	1250	1500	Control
		Diameter of mycelia growth (mm)								
1.	Tebuconazole - 25.9%EC	4.20	3.20	2.00	1.30	1.0	0.00	0.00	0.00	90.0
2.	Propiconazole - 25.9% EC	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	90.0
3.	Penconazole -10% EC	26.00	22.30	7.00	2.50	1.80	1.00	0.00	0.00	90.0
4.	Carbendazim - 50% WP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90.0
5.	Kresoxym methyl - 44.3% SC	69.30	62.50	56.3	54.00	48.50	42.50	35.0	26.0	90.0
6.	Azoxystrobin - 23% SC	72.00	63.30	60.5	60.30	56.00	48.50	40.0	28.5	90.0
7.	Thiophanate methyl 70 % WG	62.40	57.30	56	54.50	52.50	43.00	39.0	33.0	90.0
8	Debacarb+Carbendazim -1.7%+0.3 % WP	14.10	13.0	10.3	10.40	10.00	7.00	4.00	2.5	90.0
9	Mycobutanol - 10 % WP	62.20	54.50	54.0	45.20	42.00	34.00	30.0	29.0	90.0
10	Trifloxystrobin +									
	Propineb - 75 %WP	65.30	46.30	45	31.50	29.50	21.00	16.50	15.0	90.0
	SE.d	1.30	1.30	1.20	1.30	1.00	0.09	0.08	0.07	—
	CD (0.05)	3.10	2.70	2.60	2.40	2.20	2.00	1.90	1.70	—

Table 33. *In-vitro* evaluation of fungicides against *Lasiodiplodia theobromae*

S. No	Fungicides	Concentration in ppm								
		50	100	250	500	750	1000	1250	1500	Control
		Per cent inhibition over control								
1.	Tebuconazole - 25.9%EC	95.33	96.40	97.70	98.6	98.8	100.00	100.00	100.00	0.00
2.	Propiconazole - 25.9% EC	96.70	97.80	100.00	100.00	100.00	100.00	100.00	100.00	0.00
3.	Penconazole -10% EC	71.11	75.22	92.22	97.2	98.00	98.8	100.00	100.00	0.00
4.	Carbendazim - 50% WP	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00
5.	Kresoxym methyl - 44.3% SC	24.11	30.60	37.4	40.00	46.10	52.80	61.10	71.10	0.00
6.	Azoxystrobin - 23% SC	20.00	29.70	32.7	33.00	37.80	46.10	55.60	68.30	0.00
7.	Thiophanate methyl 70 % WG	30.70	36.30	37.8	39.40	41.70	52.20	56.70	63.33	0.00
8	Debacarb+ Carbendazim-1.7%+0.3% WP	84.33	85.60	88.6	88.50	88.90	92.20	95.60	97.20	0.00
9	Mycobutanol - 10 % WP	30.80	39.40	40.00	49.70	53.30	62.20	66.70	67.80	0.00
10	Trifloxystrobin + Propineb - 75 %WP	27.40	48.50	50.00	65.00	67.20	76.70	81.70	83.33	0.00

Coc./Path.6: Root (Wilt) Disease of Coconut

Centers: Aliyarnagar

Expt 1. Assessing the incidence of root (wilt) disease in Tamil Nadu

Aliyarnagar

Roving survey was carried out during Jan 2021 – Dec 2021 to assess the incidence of root (wilt) in different villages of Coimbatore, Tirupur, Dindigul, Theni, Tirunelveli and Kanyakumari

Table 34. Evaluation of sequential use fungicides against leaf blight disease

Trt. No	Treatment details	Leaf blight intensity (PDI)			Leaf blight incidence (%)			Nut yield	C:B ratio
		0 MAA	6 MAA	Disease reduction	0 MAA	6 MAA	Severity reduction		
1.	Effective fungicide A (Tebuconazole) @ 5ml in 95 ml water during Jan, April, July and October months	24.49	21.80	2.69 (9.4)	100	82.5	17.5	110	1:1.1
2.	Effective fungicide B (Propiconazole) @ 5ml in 95 ml water during Jan, April, July and October months	27.78	24.74	3.04 (10.0)	100	82.5	17.5	119	1:1.3
3.	Effective fungicide A (Tebuconazole) @ 5ml in 95 ml water during Jan, July and Effective fungicide B (Propiconazole) @ 5ml in 95 ml water during April and October	32.49	28.61	3.88 (11.7)	100	82.5	17.5	123	1:1.37
4.	Effective fungicide B (Propiconazole) @ 5ml in 95 ml water during Jan, July and Effective fungicide A (Tebuconazole) @ 5ml in 95 ml water during April and October	31.95	26.37	5.58 (13.2)	100	74.5	25.5	135	1:1.41
5.	Untreated Control	33.45	33.68	-0.23 (2.6)	-	-	-	99	-
	Sed			0.77				3.12	
	CD(P=0.05)			1.66				6.57	

MAA-Months after application Values are mean of three replications. Values in Parentheses are arcsine transformed values

districts. The highest root wilt incidence of 55.8 per cent was recorded in Gudalore village, Cumbum block, Theni District followed by Maninagaram (55.3%) and Samiandipuram villages (53.9%) (Table 35).

In Coimbatore district, among the four blocks surveyed the root (wilt) incidence was observed in three blocks *viz.*, Pollachi South, Pollachi North and Anamalai and it was not found in surveyed villages of Kinahthukadavu block. The root wilt incidence of Coimbatore district ranged from 3.80 to 53.5 per cent and the maximum incidence of 53.5 per cent was recorded in Amrapalayam village of Pollachi South block. The block average for the Anamalai and Pollachi (South) blocks were 15.55 and 11.62 per cent respectively. The district average of root wilt incidence was 7.01 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 1.68 per cent. The root (wilt)

incidence was not recorded in surveyed villages of Dindigul district.

In Theni district severe incidence of root (wilt) was recorded in Gudalore (55.8%), Maninagarm (55.3%), Samiandipuram (53.9 %) villages of Cumbum block. The mean root (wilt) incidence of Uthamapalayam block was found to be 13.63 per cent. The root (wilt) incidence was not found in surveyed villages of Periyakulam and Bodi blocks. Among the surveyed districts and blocks, the highest district average of 17.07 per cent and the highest block average of 54.67 percent were recorded in Theni district and Cumbum block respectively.

A total of five blocks were surveyed for assessing the status of root (wilt) incidence in Kanyakumari district. Among these, the disease was recorded in four blocks *viz*., Kuruhencode, Rajaakkamangalam, Thiruvattaru and Moonjerai blocks and it was not observed in surveyed villages of Thovali block. The maximum incidence of 38.05 per cent was recorded in Kunthukulam village of

Table 35. Incidence of coconut root (wilt) disease in different districts of Tamil Nadu (Jan 2021 - Dec 2021)

Districts	Blocks	Root (wilt) incidence (%)	Root wilt severity (Disease Index)
Coimbatore	Pollachi North	1.25	30.0
	Pollachi South	11.62	42.0
	Anaimalai	15.55	44.0
	Kinathukadavu	0.0	0.0
	Mean	**7.01± 2.87**	**29.00**
Tirupur	Udumalpet	5.50	30.0
	Gudimangalam	0.00	0.0
	Tirupur	1.25	30.0
	Avinashi	0.0	0.0
	Mean	**1.68 ± 0.00**	**15.00**
Dindigul	Palani	0.00	0.0
	Ottenchithiram	0.00	0.0
	Reddiyarchathiram	0.00	0.0
	Nilakottai	0.00	0.0
	Mean	**0.0± 0.00**	**0.0**
Theni	Cumbum	54.67	60.0
	Uthamapalayam	13.63	55.0
	Periyakulam	0.00	0.0
	Bodi	0.00	0.0
	Mean	**17.07 ± 1.03**	**28.75**
Tirunelveli	Thenkasi	31.88	58.5
	Kadaiyanallur	15.20	45.0
	Vasudevanallur	0.00	0.0
	Shenkottai	19.40	51.0
	Mean	**16.62± 1.31**	**38.63**
Kanyakumari	Rajakkamangalam	5.40	25.0
	Thiruvattaru	10.0	30.0
	Kurunthancode	20.67	48.0
	Munjerai	23.99	50.0
	Thovalai	0.00	0
	Mean	**12.01 ± 1.44**	**30.60**

Kuruthencode block. In Munjerai block the disease was observed in all the four villages surveyed with the block average of 23.99 per cent .The district average of Kanyakumari district was 12.01 per cent.

Among the 25 blocks of Coimbatore, Tirupur, Dindigul, Theni, Tirunelveli and Kanyakumai districts surveyed for the incidence of root (wilt) incidence. Cumbum block recorded the highest mean incidence of 54.67 per cent followed by Thenkasi block (31.88 %) (Table.35). Among the districts surveyed for the occurrence of root wilt incidence, Theni district recorded the highest mean incidence of 17.07 per cent followed by Tirunelveli district (16.62 %).

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.

Table 36. Awareness programme for root wilt disease in coconut

S. No	Date	Venue	Organized by	No. of Beneficiaries
1.	30.09.2021	Tiruppur	ADA, Tiruppur	52
2.	05.10.2021	Kaniyalayampalayam	ADA, Kinnathukadavu	50
3.	10.11.2021	Sri Saraswathi Thiyagaraja College, Pollachi	TNAU and CRS, Aliyarnagar	102
4.	18.11.2021	Udumalai	ADA, Udumalai	50
5.	01.12.2021	C. Arthanaripalayam, Pollachi	CRS, Aliyarnagar	55

Five awareness programmes (Table 36) 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 Tirupur, Kaniyalayampalayam, Pollachi, and Udumalai in which totally 309 farmers have participated and benefited. The awareness creation will further trickle down to other farmers through the participants of these programmes.

4.4. INSECT –PEST MANAGEMENT

Coc./Ent. 1 : Pest Surveillance in Coconut

Centres: Aliyarnagar, Ambajipeta, Arsikere and Ratnagiri

Aliyarnagar

Roving survey

Roving survey was carried out in seven districts of Tamil Nadu *viz.*, Coimbatore, Tiruppur, Dindigul, Theni, Tirunelveli, Kanyakumari and Thanjavur during 2021. The extent of damage caused by major pests of coconut were recorded in terms of incidence (%) and intensity (%) (Table 1**)**. Among the districts surveyed Thanjavur recorded higher damage of rhinoceros beetle in terms of percent incidence (28.14%) and intensity (32.18 %) followed by Kanyakumari (26.14 and 20.17 %) and Tirunelveli (21.68 and 16.51 %). Eriophyid mite nut damage was higher in Thanjavur (48.64 %) followed by Tiruppur (42.18 %),Tirunelveli (41.76 %), Theni (40.59 %) and Kanyakumari (40.52 %). Rugose spiralling whitefly incidence was more in Tiruppur (31.47 %) and Coimbatore (28.62) followed by Thanjavur (27.38 %) and Kanyakumari (23.74 %). Highest percent parasitism was 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 is inferred that the 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 in Tamil Nadu.

Table 1. Survey on incidence of major pests of coconut in Tamil Nadu during 2021

Districts	Rhinoceros beetle			Eriophyid mite		Rugose spiralling whitefly			Black headed caterpillar		Red palm weevil
	Mean incidence (%)	Leaf damage (%)	Spindle damage (%)	Nut damage (%)	Grade index	Incidence (%)	Intensity (%)	Parasitism (%)	Incidence (%)	Larvae/ 100	Leaf let Incidence (%)
Coimbatore	19.26 ± 2.52	11.17 ± 3.42	2.24 ± 1.98	31.61 ± 2.64	0.68 ± 0.13	28.62 ± 1.85	25.23 ± 3.45	63.82 ± 4.82	-	-	0.31 ± 0.15
Tiruppur	14.74 ± 1.87	10.38 ± 2.84	3.89 ± 1.13	42.18 ± 2.89	0.92 ± 0.27	31.47 ± 2.33	28.62 ± 4.15	60.37 ± 3.77	4.52 ± 0.53	0.32 ± 0.09	-
Dindugul	12.16 ± 2.11	10.94 ± 2.19	2.53 ± 1.87	35.81 ± 3.44	1.12 ± 0.21	17.33 ± 1.67	24.31 ± 3.67	52.47 ± 3.18	5.23 ± 0.82	0.40 ± 0.14	-
Theni	17.16 ± 2.52	12.65 ± 3.07	5.38 ± 1.65	40.59 ± 3.26	0.83 ± 0.18	15.67 ± 1.89	26.54 ± 3.11	59.36 ± 4.54	-	-	-
Tirunelveli	21.68 ± 1.94	16.51 ± 2.51	7.41 ± 2.21	41.76 ± 4.12	1.07 ± 0.31	22.72 ± 2.15	30.25 ± 3.64	67.41 ± 4.09	-	-	0.44 ± 0.22
Kanniyakumari	26.14 ± 3.72	20.17 ± 2.45	14.52 ± 2.88	40.52 ± 2.92	1.34 ± 0.20	23.74 ± 2.11	30.63 ± 2.94	51.93 ± 4.38	3.47 ± 0.44	0.28 ± 0.12	-
Thanjavur	28.14 ± 2.89	32.18 ± 2.84	12.27 ± 3.12	48.64 ± 3.46	1.29 ± 0.33	27.38 ± 2.62	32.11 ± 3.82	54.45 ± 3.22	-	-	2.42 ± 0.87
MEAN	**19.70 ± 2.53**	**16.11 ± 2.83**	**7.15 ± 2.17**	**40.60 ± 3.29**	**1.03 ± 0.23**	**23.43 ± 2.14**	**27.81 ± 3.66**	**59.24 ± 3.94**	**4.41 ± 0.60**	**0.33 ± 0.12**	**1.06 ± 0.41**

(Mean ± Standard Error)

Fixed plot survey

Fixed plot survey were conducted in two locations, *viz.*, nearby plot (Location: Angalakuruchi; Anaimalai block, Coimbatore Dt.) and endemic plot (Location: Puliyankanti, Anaimalai block, Coimbatore Dt. for all the pests except black headed caterpillar and Nadupunni, North pollachi Coimbatore Dt. for black headed caterpiller). Observations were recorded on 25 year old Local tall variety at Nadupunni, 10 years old hybrid (GBGD X WCT) at Angalakurichi and 12 years old ALR 1 variety at Puliyankandi. The results of the fixed plot survey revealed that, the incidence of rhinoceros beetle was high during December (16.00 %) to February (17.67 %) and low during the month of June (11.67 %) and August (10.00 %) in Angalakuruchi location and same trend was noticed in the endemic plots (Table 2). Incidence of

eriophyid mite was high during June and August which starts declining later. Mean per cent leaf damage and spindle damage were 8.25 and 1.67 per cent at nearby plot and 11.04 and 2.22 per cent in endemic plot. Eriophyid mite nut damage was fluctuating between 29.33 per cent to 51.00 per cent with a mean of 38.28 percent in nearby plot. However, the eriophyid mite damage in endemic plot ranged between 45.00 per cent to 62.00 per cent with a mean of 50.33 per cent. Mean grade index of eriophyid mite damage is low in nearby plot and mild in the endemic plot. The incidence of RSW was 14.20 to 25.41 per cent with a mean of 19.15 per cent in the nearby plot and it was 21.85 to 34.98 per cent with a mean of 27.22 per cent in the endemic plot. Mean intensity of RSW was 28.57 and 35.71 per cent at nearby and endemic plots respectively. Mean per cent parasitism was 52.72 per cent in nearby plot and 42.17 per cent in endemic plot. Incidence of BHC was not noticed in the nearby plot where as 13.49 per cent incidence was noticed in the endemic plot with mean larval count of 1.01 larvae per 100 leaflets. Red palm weevil incidence was very low at both locations.

Table 2. Per cent Infestation of major pests of coconut in Fixed Plot Survey at Tamil Nadu during 2021

Period	Rhinoceros beetle			Eriophyid mite		Rugose spiralling whitefly			Black headed caterpillar		Red palm weevil
	Mean incidence (%)	Leaf damage (%)	Spindle damage (%)	Nut damage (%)	Grade index	Incidence (%)	Intensity (%)	Parasitism (%)	Incidence (%)	Larvae/ 100 Leaf let	Incidence (%)
Nearby plot (Location: Angalakuruchi; Anaimalai block, Coimbatore Dt.)											
February 2021 17.67 ± 1.53	10.56 ± 1.03	1.67 ± 0.58	34.00 ± 2.65	0.72 ± 0.18	23.09± 1.60	27.26 ± 1.16	53.95 ± 2.98	- -	-	April	2021
14.00 ± 1.73	8.82 ± 0.71	1.67 ± 1.15	34.67 ± 4.16	0.73 ± 0.09	25.41± 2.93	28.90 ± 1.28	42.85 ± 4.37	- -	-	June	2021
11.67 ± 2.08	6.91 ± 1.34	1.33 ± 0.58	51.00 ± 3.61	1.03 ± 0.14	20.19± 1.40	32.24 ± 3.07	46.91 ± 2.62	- -	-	August	2021
10.00 ± 1.00	7.06 ± 1.47	2.67 ± 1.15	43.00 ± 4.58	0.78 ± 0.32	16.79± 3.63	33.91 ± 2.61	59.17 ± 4.23	- -	-	October	2021
13.33 ± 3.06	6.65 ± 1.65	1.33 ± 0.58	37.67 ± 6.03	0.90 ± 0.03	15.23± 2.90	26.19 ± 2.33	60.82 ± 3.43	- -	0.67	December	2021
16.00 ± 1.73 9.47 ± 1.01	1.33 ± 0.58	29.33 ± 3.06	0.76 ± 0.07	14.20 ± 1.38	22.91 ± 2.61	52.61 ± 3.06	- -	-	**MEAN**	**13.78 ±**	**1.86**
8.25 ± 1.20	**1.67 ± 0.77**	**38.28 ± 4.02**	**0.82 ± 0.14**	**19.15 ± 2.31**	**28.57 ± 2.18**	**52.72 ± 3.45**	- -	**0.11**		**Endemic**	**plot**
	(Location: Puliyankanti, Anaimalai block, Coimbatore Dt. and Nadupunni, North pollachi Coimbatore Dt.)										
February 2021	21.33 ± 1.53	12.88 ± 1.40	2.67 ± 1.15	45.00 ± 3.00	1.13 ± 0.13	31.91 ± 2.41	34.07 ± 1.44	43.16 ± 2.38	14.52 ± 2.15	1.17 ± 0.35	-
April 2021	19.67 ± 2.08	10.98 ± 1.62	2.33 ± 0.58	47.00 ± 4.58	1.08 ± 0.14	34.98 ± 2.63	36.12 ± 1.61	34.28 ± 3.49	16.73 ± 1.92	1.53 ± 0.21	-
June 2021	15.33 ± 0.58	8.71 ± 0.56	1.67 ± 1.15	62.00 ± 5.57	0.95 ± 0.09	26.91 ± 2.78	40.30 ± 3.84	37.53 ± 2.10	18.54 ± 1.83	1.83 ± 0.31	0.67
August 2021	16.00 ± 1.73	9.02 ± 1.25	2.00 ± 1.00	56.33 ± 6.81	0.96 ± 0.10	25.62 ± 1.88	42.39 ± 3.26	47.33 ± 3.38	13.16 ± 1.63	0.83 ± 0.15	-
October 2021	20.33 ± 2.08	11.54 ± 0.81	2.33 ± 1.15	49.00 ± 3.61	1.11 ± 0.13	22.04 ± 2.18	32.74 ± 2.92	48.65 ± 2.74	10.48 ± 1.41	0.50 ± 0.20	1.33
December 2021	23.00 ± 2.65	13.08 ± 1.43	2.33 ± 1.53	42.67 ± 2.52	1.17 ± 0.15	21.85 ± 1.94	28.63 ± 3.27	42.09 ± 2.44	7.51 ± 1.16	0.17 ± 0.15	-
MEAN	**19.28 ± 1.78**	**11.04 ± 1.18**	**2.22 ± 1.09**	**50.33 ± 4.35**	**1.07 ± 0.12**	**27.22 ± 2.30**	**35.71 ± 2.72**	**42.17 ± 2.76**	**13.49 ± 1.68**	**1.01 ± 0.23**	**0.33**

(Mean ± Standard Error)

Ambajipeta

Roving survey

Roving survey was carried out in East Godavari, West Godavari, Vishakapatnam, Vizianagaram and Srikakulam districts. 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 (19.12%) in West Godavari district and low incidence of 11.38% was recorded in Visakhapatnam district. The leaf damage by the beetle was 14.52, 8.96 per cent and spindle damage was 4.35, 1.53 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 0.88 per cent and was high in Vizianagaram (0.88 %) and low (0.56 %) in East Godavari district. The infestation of eriophyid mite recorded from all the plantations observed in the surveyed districts was in the range of 35.48 (in Vizianagaram) to 83.95 (in East Godavari) per cent. Intensity of mite was moderate to high in all districts surveyed. The incidence of black headed caterpillar was recorded in all surveyed districts. An incidence of 4.12% was recorded in East Godavari district and 5.23 % incidence was noticed in Srikakulam district and no incidence of pest was recorded in other districts. The infestation of rugose spiralling whitefly was recorded from all the surveyed districts and it is in the range of 13.58 to 35.12 per cent and very low incidence of pest was recorded in West Godavari district. However as compared to other districts, a high incidence (26.32%) of Bondar nesting white fly was recorded in this district.

BNW was recorded in all the surveyed districts of Andhra Pradesh and it is in the range of 4.48 to 26.32. Low incidence (4.48%) of BNW was observed in Srikakulam with intensity of 2.79 %. High incidence (26.32%) was recorded in West Godavari. During roving survey low termite incidence was observed in Vizianagaram (4.1%) and Srikakulam (3.4%) (Table 3).

Table 3: District wise pest situation in Andhra Pradesh during the year 2021-22 (Roving survey)

District	Rhinoceros beetle			Red palm weevil Mean incidence (%)	Eriophyid mite		Black headed caterpillar Mean incidence (%)	Rugose spiralling white fly(%)			Bondar nesting white fly(%)	
	Incidence (%)	Intensity (%)			Infested nuts (%)	Grade index		Incidence	Intensity	Parasitisation	Incidence	Intensity
		Leaf damage	Multiple cut damage									
West Godavari	19.12 ± 2.14	14.52 ± 3.09	4.35 ± 1.63	0.76± 0.17	82.57 ± 3.31	1.64 ± 0.4	4.12± 0.23	-	-	18.12	26.32± 1.64	19.46± 1.64
East Godavari	12.32 ± 1.89	9.37± 2.18	2.12 ± 1.19	0.56 ± 0.15	83.95± 3.92	1.52 ± 0.4	-	35.12 ± 1.56	43.83 ± 1.12	28.56	21.03 ±1.54	14.18 ±2.49
Visakha patnam	11.38± 2.01	8.96± 2.74	1.53± 1.50	0.63 ± 0.21	41.13± 6.19	1.23± 0.3	-	17.11± 1.24	23.27 ± 1.25	12.34	19.18 ±1.25	15.12 ±2.26
Vizianagaram	13.69± 2.11	9.80± 2.34	2.62± 1.56	0.88 ± 0.67	35.48± 2.51	0.98± 0.2	-	15.96± 2.22	12.12 ±0.53	15.62	16.57 ±2.38	9.61 ±1.55
Srikakulam	15.75± 0.39	10.12± 2.38	3.68± 1.71	0.62 ± 0.06	55.43± 4.16	1.09± 0.3	5.23± 0.58	13.58± 0.17	12.24± 0.11	17.25	4.48 ±0.21	2.79± 0.13
Mean±SD	14.45± 1.71	10.55± 2.54	2.86± 1.52	0.69± 0.25	59.71± 4.02	1.29± 0.32	1.87± 0.16	16.35± 1.04	18.29± 0.60	18.38± 2.73	17.52± 1.40	12.23± 1.61

Fixed Plot Survey

Fixed plot survey was carried out in two selected villages of East Godavari district i.e., Samanthakuru of Allavaram mandal and Munganda of P. Gannavaram mandal to record the incidence and intensity of infestation by different pests of coconut. Among the insect pests, rhinoceros beetle, eriophyid mite and black headed caterpillar damage was observed in both the villages. High leaf damage of 17.69% due to rhinoceros beetle was recorded in Samanathakurru village during April compared to Munganda. Eriophyid mite damage was high in both the villages, and an incidence of 83.96% was recorded with a grade index of 1.72, in case of Samamthakurru, where as in Munganda an incidence of 82.18 % with a grade index of 1.46 was

recorded. Black headed caterpillar incidence was absent in Samanthakurru as well as Munganda village. No incidence of red palm weevil and slug caterpillar was observed. Rodent damage was recorded under storage condition in coconut godowns, built and maintained at farm level in Samanthakurru village (Table 4).

Incidence of rugose spiralling white fly was recorded from October onwards with a mean value of 40.18 and 30.36 per cent in Samanthakurru and Munganda villages respectively. Bondar nesting white fly was recorded only in December in both the villages with incidence of 25.48 per cent in Samanthakurru and 14.48 per cent in Munganda (Table 5).

Table 4: Average per cent infestation by different pests in fixed plot survey at Andhra Pradesh during 2021 (Fixed plot survey)

Month	Rhinoceros beetle (% leaf damage & Per cent Infestation)				Eriophyid mite (% nut damage & intensity)				Red palm weevil Incidence (%)
	Samanthakurru		Munganda		Samanthakurru		Munganda		
	Leaf damage	Per cent Infestation	Leaf damage	Per cent Infestation	Incidence	Grade index	Incidence	Grade index	
February 2021	17.38± 2.26	45	15.61± 2.24	29	80.62 ± 2.29	1.44 ± 0.04	79.51 ± 1.59	1.42 ± 0.13	No incidence was observed
April 2021	17.69± 2.64	48	15.59± 2.23	26	81.01 ± 2.52	1.41 ± 0.03	78.15 ± 1.22	1.31± 0.11	
June 2021	14.27± 1.35	33	12.68± 1.33	23	83.96± 1.20	1.72± 0.15	82.18± 1.01	1.46± 0.24	
August 2021	15.82± 0.98	35	13.09 ± 0.94	29	82.66 ± 2.33	1.47 ± 0.05	81.96 ± 1.89	1.57± 0.14	
October 2021	16.16 ± 1.09	38	14.75 ± 1.75	31	81.61 ± 2.59	1.61 ± 0.09	81.45 ± 2.86	1.38 ± 0.13	
December 2021	15.95± 1.48	36	12.45± 2.85	24	81.72 ± 2.89	1.67 ± 0.13	81.87 ± 1.78	1.46± 0.12	
Mean±SD	15.63± 1.63	33.16	13.98± 1.89		81.93± 2.58	1.55± 0.08	80.85± 1.74	1.43± 0.15	

Table 5: Average per cent infestation by different pests in fixed plot survey at Andhra Pradesh during 2021 (Fixed plot survey)

Month	Rugose spiralling whitefly (%) *A. Rugioperculatus*				Bondar nesting whitefly (%) *P. bondari*			
	Samanthakurru		Munganda		Samanthakurru		Munganda	
	Incidence (%)	Intensity (%)	Incidence (%)	Intensity (%)	Incidence (%)	Intensity (%)	Incidence (%)	Intensity (%)
February 2021	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
April 2021	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
June 2021	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
August 2021	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
October 2021	34.12± 1.56	43.72± 1.12	25.48 ± 0.21	29.79± 0.13	Nil	Nil	Nil	Nil
December 2021	46.23± 1.72	59.23± 1.23	35.24± 1.34	48.73± 1.42	25.48 ± 0.21	29.79± 0.13	14.48 ± 0.21	22.79± 0.13
Mean±SD	40.18± 1.64	51.48± 1.18	30.36± 0.78	39.23± 0.76	25.48 ± 0.21	29.79± 0.13	14.48 ± 0.21	22.79± 0.13

Arsikere

Roving Survey

The Roving survey was carried out in Chikkamagaluru, Tumkur, Mysore, 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 the gardens in the age group of 2 to 48 years. The highest incidence of 15.6 per cent was noticed in Mandya and lowest incidence of 11.5 per cent was recorded in Mysore. The incidence of red palm weevil was maximum (up to 0.7 %) in Chikkamagaluru followed by 0.5 % infestation in Tumkur, Mandya (0.2 %), Mysore (0.3%) and Hassan (0.4 %).

The infestation by Coconut black headed caterpillar was noticed in all the 5 major coconut growing districts of Karnataka, with a highest incidence of 9.32 per cent in Chikkamagaluru throughout the year. The incidence recorded in other districts was to the tune of 4.1 per cent in Mysore, 3.4 per cent in Mandya, 2.6 per cent in Hassan and 0.5 per cent in Tumkur. 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 was recorded in Tumkur (23.4 %) followed by Hassan (18.9 %), Chikkamagaluru (17.6 %), Mysore (12.5%) and Mandya (8.2 %) (Table 6).

Table 6: Mean Incidence of major coconut pests in important districts of Karnataka 2021-22

District	Black headed caterpillar Mean Incidence (%)	Rhinoceros beetle Mean Incidence (%)	Red palm weevil Mean Incidence (%)	Eriophyid mite Mean Incidence (%)
Chikkamagaluru	9.32 ± 2.2	6.2 ± 0.8	0.7 ± 0.3	17.6 ± 2.3
Mysore	4.1 ± 0.5	11.5 ± 1.2	0.3 ± 0.1	12.5 ± 2.1
Mandya	3.4 ± 0.2	15.6 ± 2.6	0.2 ± 0.1	8.2 ± 1.1
Tumkur	0.5 ± 0.1	7.3 ± 1.7	0.5 ± 0.2	23.4 ± 3.1
Hassan	2.6 ± 0.8	9.5 ± 2.1	0.4 ± 0.1	18.9 ± 2.5

* Values expressed are Mean ± Standard error

The leaf damage by rhinoceros beetle ranging from 7.4 to 12.8 per cent was noticed in all the 5 major coconut growing districts of Karnataka. The highest leaf damage (12.8 %) was noticed in Mysore followed by Mandya (11.3 %), Hassan (10.7 %) Tumkur (8.5%) and Chikkamagaluru (7.4%). The mean grade index of mite damage ranged from 0.8 to 2.5 with highest MGI of 2.5 observed in Tumkur followed by Chikkamagaluru (2.0), Hassan (1.9) Mysore (0.8) and Mandya (1.1).

The leaf damage by coconut black headed caterpillar ranged between 1.5 to 7.9 per cent in all 5 districts, with highest leaf damage (7.9%) in Chikkamagaluru with 2.5 larvae per 100 leaflets (Table 7).

Table 7: Mean Intensity of major coconut pests in important districts of Karnataka 2021-22

	Rhinoceros beetle		Eriophyid mite	Black headed caterpillar	
Months	Leaf damage (%)	Spindle damage	Mean Grade Index	Active larvae/ leaf let	Leaf damage (%)
Chikkamagaluru	7.4 ± 1.5	0.5 ± 0.2	2.0 ± 0.5	2.5 ± 1.2	7.9 ± 1.3
Mysore	12.8 ± 2.7	1.4 ± 0.5	0.8 ± 0.3	1.1 ± 0.6	6.2 ± 1.5
Mandya	11.3 ± 2.5	1.1 ± 0.4	1.1 ± 0.4	0.8 ± 0.3	4.4 ± 0.8
Tumkur	8.5 ± 2.1	0.7 ± 0.2	2.5 ± 0.7	0.6 ± 0.2	1.5 ± 0.5
Hassan	10.7 ± 1.8	0.9 ± 0.3	1.9 ± 0.5	0.5 ± 0.2	3.2 ± 0.6

Minor pests

Mealybug, termite and scale were noticed as a spot occurrence in different districts. The infestation of mealybug, *Pseudococcus* spp. was documented in spindle leaf and harvested bunches to the extent of 9 per cent in Chikkamagaluru . In Tumkur, incidence of scales was noticed in the range of 1.4 to 11.3 per cent, and white fly incidence was noticed up to 12 per cent (Table 8).

During surveys in Mangala village of Mandya district, incidence of invasive rugose spiralling whitefly (19%) was noticed in coconut during November 2021. Observations on the natural enemy fauna in the infested gardens revealed a diverse array of coccinellids along with an aphelinid parasitoid, *Encarsia guadeloupae* and few numbers of Chrysopa. Parasitization by *E. guadeloupae* was observed to an extent of 36.4 per cent.

Table 8: Occurrence of Minor pests in coconut gardens in Karnataka 2020-2021

District	Pest	Age of palms (in years)
Chikkamagaluru	Mealybug (9%), scale (1.5%),	10-53
Tumkur	Mealybug (8%), scale (11.3 %), Whitefly (12 %),	4-35
Mysore	Whitefly (14 %), scale (9 %),	8-50
Mandya	Spiralling whitefly (19 %), scale (14 %)	15-45
Hassan	Mealybug (8 %), scale (11 %),	8-51

* Values expressed are Mean ± Standard error

Table 9: Mean Incidence of minor coconut pests in important districts of Karnataka 2021-22

District	Rat damaged (%)	Termite infested palms (%)
Chikkamagaluru	9.4 ± 0.8	16.3 ± 2.1
Mysore	14.5 ± 1.3	4.2 ± 1.6
Mandya	10.3 ± 0.6	2.2 ± 0.6
Tumkur	5.3 ± 0.5	6.4 ± 1.2
Hassan	6.1 ± 0.3	5.8 ± 0.9

* Values expressed are Mean ± Standard error

The infestation of rat damage was noticed in all the age group of palms ranging from 2 to 45 years. The highest incidence of 14.5 per cent was noticed in Mysore followed by Mandya (10.3 %), Chikkamagaluru (9.4%), Hassan (6.1%) and Tumkur (5.3%). The incidence of termite was maximum (16.3 %) in Chikkamagaluru followed by Tumkur (6.4 %) . The incidence of termite was also noticed in Hassan (5.8 %), Mandya (2.2%) and Mysore (4.2%).

Fixed Plot Survey

Fixed plot survey was carried out at two months intervals from January 2021 to December 2021 in farmer's field at Habbanghatta and Bendekere villages of Hassan district to record the incidence and intensity of infestation of different pests of coconut. The palms were in the age group of 14 to 40 years. The highest incidence of rhinoceros beetle (21.5 %) was observed in Habbanghatta whereas the incidence of coconut black headed caterpillar (7.3 %), eriophyid mite (24.6 %) and red palm weevil (0.5%) were more in Bendekere village (Table 10).

The infestation by major pests was recorded 6 times in a year. The leaf damage by rhinoceros beetle increased from 13.5 in Feb 21 to 24.2 per cent in Oct 21 in Habbanghatta. However, the spindle damage was similar in all the months except in Feb 21. At Bendekere village, the leaf damage was less compared to Habbanghatta and increased from 7.2 to 13.1 per cent as year advanced. However, the spindle damage was similar among different months ranging from 3.1 to 5.1 per cent. The mite infestation though decreased over months, the infested nuts were more than 10 per cent in

Habbanghatta, whereas in Bendekere the nut infestation was below 10 per cent even though the trend of infestation was similar. Similar trend was recorded in terms of mean grade index of mite infestation.

The leaf damage by coconut black headed caterpillar was low in Habbanghatta ranging from 1.2 to 3.1 per cent compared to Bendekere. The leaf damage in Bendekere ranged from 3.6 to 8.6 per cent. Similar trend was observed for active larvae per leaf let. (Table 11).

Table 10: Extent of infestation by different pests in fixed plot surveys in Karnataka (2020-21)

District	Black headed caterpillar Mean Incidence (%)	Rhinoceros beetle Mean Incidence (%)	Red palm weevil Mean Incidence (%)	Eriophyid mite Mean Incidence (%)
Habbanghatta	3.8 ± 1.3	21.5 ± 4.4	0.2 ± 0.1	15.6 ± 3.8
Bendekere	7.3 ± 2.6	15.6 ± 5.6	0.5 ± 0.2	24.6 ± 4.7

*Mean values are expressed

Table 11: Extent of infestation by different pests in fixed plot surveys in Karnataka (2020-21)

Months	Rhinoceros beetle		Eriophyid mite		Black headed caterpillar	
	Leaf damage (%)	Spindle damage (%)	Infested Nuts (%)	Mean Grade Index	Active larvae/ leaf let	Leaf damage (%)
			I. Habbanghatta			
February-21	13.5 ± 2.4	4.9 ± 1.3	20.3 ± 1.8	2.1 ± 0.4	0.3 ± 0.1	1.2 ± 0.4
April-21	16.2 ± 2.8	7.5 ± 1.2	28.8 ± 2.2	2.3 ± 0.8	0.5 ± 0.1	3.1 ± 0.7
June-21	18.7 ± 3.7	9.7 ± 1.8	9.1 ± 1.8	0.7 ± 0.3	0.8 ± 0.3	1.3 ± 0.6
August-21	19.5 ± 2.4	7.2 ± 1.7	12.4 ± 1.2	1.1 ± 0.5	1.0 ± 0.2	1.9 ± 0.8
October-21	24.2 ± 3.8	8.1 ± 1.2	13.6 ± 0.8	1.6 ± 0.4	1.4 ± 0.3	2.1 ± 0.7
December-21	20.4 ± 3.6	7.4 ± 0.8	14.4 ± 1.2	1.7 ± 0.3	1.5 ± 0.4	2.8 ± 0.9
			II. Bendekere			
February-21	7.4 ± 1.3	3.1 ± 1.2	14.3 ± 0.5	1.5 ± 0.2	3.1 ± 0.7	7.8 ± 0.5
April-21	9.3 ± 1.5	4.4 ± 1.1	19.3 ± 0.3	2.2 ± 0.3	3.5 ± 0.4	8.6 ± 1.3
June-21	7.2 ± 1.3	3.5 ± 1.2	4.1 ± 0.8	0.6 ± 0.2	1.5 ± 0.6	3.6 ± 1.1
August-21	10.8 ± 2.0	4.6 ± 0.9	5.6 ± 1.5	0.9 ± 0.3	2.2 ± 0.8	4.7 ± 1.2
October-21	12.5 ± 1.4	5.1 ± 1.3	7.2 ± 2.1	1.1 ± 0.4	2.5 ± 0.7	5.2 ± 1.3
December-21	13.1 ± 2.2	3.3 ± 0.8	8.4 ± 2.2	1.6 ± 0.3	3.1 ± 0.8	6.6 ± 0.8

* Values expressed are Mean ± Standard error

Ratnagiri

Roving Survey

Roving survey was carried out in Ratnagiri, Sindhudurg, Raigad and Palghar districts and the extent of damage in terms of incidence and intensity were recorded for major pests of coconut during these surveys. The data presented in Table 12 revealed that the mean incidence of rhinoceros beetle, red palm weevil, black headed caterpillar, eriophyid mite, rugose spiralling whitefly 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 12: 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/ 100 leaflets	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
SindhuDurg	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

Table 13: Infestation of minor pests in coconut during roving survey in Konkan region of Maharashtra

Pests	Arecanut black fly	Bondar nesting whitefly	Scale	Mealy bugs	Termites	Rats
Infestation (%)	3.06	37.5	2.55	4.08	2.58	3.07

The minor pests of coconut *viz.*, arecanut blackfly (3.06 %), bondar nesting whitefly (37.5 %), scale insect (2.55 %), mealy bug (4.08 %), termites (2.58 %) and rats (3.07 %) were also observed (Table 13). The survey also indicated infestation of cocoa by stem borer (2.9 %), fruit damage by squirrel (11.7 %), mealy bug (2.5 %), rugose spiraling whitefly (9.8 %) and leaf eating caterpillar (11.2 %) (Table 14).

Table 14: Incidence of pests in cocoa in Konkan region of Maharashtra

Pests	Stem borer (%)	Fruit damage (%)	Mealy bug (%)	RSW (%)	Leaf eating caterpillar (%)
Infestation (%)	2.92	11.7	2.5	9.8	11.2

Fixed plot survey

The major pest incidence and intensity on coconut was recorded during fixed plot survey. It was carried out at bimonthly interval from January 2021 to December 2021 at Regional Coconut Research Station, Bhatye, Ratnagiri. The data from fixed plot at Karla Village (Table 15) revealed that the maximum incidence of rhinoceros beetle (9.23%) with 6.4 per cent leaf damage and 0.76 per cent spindle damage were recorded in December, 2021. Whereas, minimum incidence (6.91%) with 2.8 per cent leaf damage was observed in February, 2021. No incidence of red palm weevil and black caterpillar was found in fixed plot at Karla village.

Table 15: Extent of Infestation by Pests during Fixed Plot Survey in Karla village of Maharashtra

Month	Rhinoceros beetle			Eriophyid mite		Rugose spiralling whitefly		
	Incidence (%)	Leaf damage (%)	Spindle damage (%)	Infestation (%)	MGI	Incidence (%)	Intensity (%)	*Encarsia* parasitism (%)
Feb., 21	6.91	2.8	0.76	13.5	0.17	20.7	2.91	55.0
April, 21	7.69	2.8	0.0	20.4	0.24	0.0	0.0	0.0
June, 21	8.46	3.2	0.0	23.6	0.27	0.0	0.0	0.0
Aug., 21	6.92	3.6	0.0	14.4	0.19	0.0	0.0	0.0
Oct., 21	8.46	2.8	0.0	16.2	0.26	12.2	18.7	35.8
Dec., 21	9.23	6.4	0.76	27.2	0.32	17.1	20.3	44.1
Mean ± SE	7.9 ±0.4	3.6 ± 0.6	0.76 ± 0.1	19.2 ±2.3	0.25 ± 0.02	16.6 ± 3.6	13.9 ±4.7	44.9 ± 9.0

The eriophyid mite infestation was noticed in the range of 13.5 to 27.2 per cent. The highest nuts damaged by eriophyid mite was 27.2 per cent in December, 2021. Whereas, least incidence (13.5%) was noticed in February, 2021. However, low grade index was observed during the year. The maximum incidence (20.7%) and intensity (20.3%) of whitefly complex were noticed in February, 2021 and December, 2021, respectively. The maximum *Encarsia* parasitism (55%) was observed in February, 2021. The average incidence of rhinoceros beetle, eriophyid mite and rugose spiralling whitefly were 7.9, 19.2 and 16.6 per cent.

Table 16: Extent of Infestation by Different Pests in Fixed Plot Survey in Someshwar village of Maharashtra

Month	Rhinoceros beetle			RPW incidence (%)	Eriophyid mite		Rugose spiralling whitefly		
	Incidence (%)	Leaf damage (%)	Spindle damage (%)		Infestation (%)	MGI	Incidence (%)	Intensity (%)	*Encarsia* parasitism (%)
Feb., 21	9.1	4.4	0.5	0.5	30.5	0.65	0.0	0.0	0.0
April, 21	11.0	5.6	0.5	1.0	28.4	0.35	0.0	0.0	0.0
June, 21	10.5	6.4	1.1	1.5	32.3	0.45	0.0	0.0	0.0
Aug., 21	9.5	5.2	0.5	0.0	41.0	0.70	0.0	0.0	0.0
Oct., 21	13.0	4.5	0.7	0.0	22.8	0.45	12.8	15.0	33.3
Dec., 21	14.0	9.2	1.0	0.0	60.5	1.23	20.4	21.9	40.0
Mean ± SE	11.2 ± 0.9	5.8 ± 0.8	0.74 ± 0.1	0.5 ± 0.3	35.9 ± 6.6	0.63 ± 0.1	16.6 ±4.2	18.4 ±4.6	36.6 ±9.0

The data presented in Table 16 from fixed plot at Someshwar Village revealed that the highest rhinoceros beetle incidence was 14 per cent with 9.2 per cent leaf damage in December, 2021. Whereas, lowest incidence (9.1%) and leaf damage (4.4%) was found in February, 2021. The maximum spindle damage (1.1%) was found in June, 2021. The red palm weevil incidence was 1.5 per cent in

June, 2021. However, no record of RPW was seen in August to December, 2021. The black headed caterpillar was not observed. The nut damage by eriophyid mite was noticed in the range of 22.8 to 60.5 per cent. The maximum nut damage (60.5 %) due to eriophyid mite was observed with moderate grade index (1.23) in December, 2021. Whereas, minimum nut damage (22.8%) with low grade index (0.45) was noticed in October, 2021. The maximum rugose spiralling whitefly incidence and intensity were 20.4 and 21.9 per cent, respectively during December, 2021. No record of rugose spiralling whitefly was observed during February to August, 2021. The observed mean incidence of rhinoceros beetle, red palm weevil, eriophyid mite and rugose spiraling whitefly were 11.2, 0.5, 35.9 and 16.6 per cent, respectively.

Coc./Ent 4. Production and supply of parasitoids

Centres: Aliyarnagar, Ambajipeta, Arsikere and Ratnagiri

Aliyarnagar

The parasitoid, *Bracon brevicornis* for the management of coconut black headed caterpillar, *Opisina arenosella* was mass cultured at biocontrol unit of CRS, Aliyarnagar and the same was distributed to the needy farmers. Coconut fronds or leaflets containing *Encarsia* parasitized puparia were collected from the RSW infested palm and released in newer areas of infestation. The details of supply of parasitoids are given in the Table 17. During 2021, 1267 packets of *Bracon brevicornis* and 3856 packets of *Encarsia* parasitoids were distributed to the coconut growing farmers for the management of black headed caterpillar and RSW. Each packet contains 100 numbers of parasitoids.

Table 17: Production and supply of parasitoids for the management of coconut pests in Aliyarnagar centre during 2021

MONTH	*Bracon brevicornis* No. of packets	*Encarsia* parasitoids No. of packets
January 2021	0	650
February 2021	50	955
March 2021	272	640
April 2021	0	435
May 2021	65	50
June 2021	0	0
July 2021	505	290
August 2021	10	340
September 2021	105	287
October 2021	100	100
November 2021	10	52
December 2021	150	57
TOTAL	**1267**	**3856**

Ambajipeta

Bio control Laboratory, HRS, Ambajipeta produced and distributed a total of 3,233,804 parasitoids *viz.*, *Bracon hebetor* (4,07,150), *Goniozus nephantidis* (1,88,900), *Pediobius imbrues* (100), *Apertochrysa astur* eggs (26,33,000), *Chrysoperla zastrowi* eggs (3300) and *Trichogramma chilonis* cards (582). The farmers of East Godavari, West Godavari, Vizianagaram, Visakhapatnam and Srikakulam districts of Andhra Pradesh were benefitted for the control of black headed caterpillar, slug caterpillar, rugose spiralling whitefly. The technology of bio control based pest management has been demonstrated (Table 18).

District	Village
East Godavari	S.Yanam, N.Kothapalli, Gachhakayalapora,, Thalarevu, N.Kothapalli, Thapeswaram, S.Yanam, Mallavarm, Atreyapuram, Komaragiripatnam, Gundipudi, Thurpulanka, Chinthalamori, Samarlakota, Allavaram, Uppalaguptam, Amalapuram, Tuni, Dwarapudi, Mandapeta, Samanthakurru, Turupupalem
West Godavari	Likhitapudi, Digamarru, Pattavala, Kavitam lakulu, Ramayanapuram, Zinnuru, Nalapogula, Agarthapalem, Veerupadu, Konithiwada, Komatithippa, Mathsyapuri, Pulapalli, Purushothampalli, Darbarevu, Korukollu,Kalavapudi, Saripalli, Paszaladeevi, Poduru, Mathyapuri, Nowduru, Palakollu, Nelapogula, Badava, polamuru, Mattaparru, Panjavemavaram, Vedangi, Ullaparru, Mattaparru, Penumadam, Zunnur, LRpeta, Uootada.

Table 18: Production and supply of natural enemies and surrogate host *Corcyra* eggs at Ambajipeta during 2021

Month	No. of *Bracon hebetor* sold	No. of *Goniozus nephantidis* sold	No. of *Pediobius imbreus*sold No.of	*Chrysoperla zastrowi* eggs sold No.of	*Apertochrysa astur*eggs sold	No. of *Trichogramma chilonis* cards sold	Quantity of*Corcyra* eggs sold (cc)
Jan., 21	1,100	15000	100	—	224000		198
Feb., 21	—	10,300	—	—	250000	—	—
March 21	80000	5000	—	—	1251000	300	85
April 21	1000	30,400	—	—	309000	—	—
May 21	50000	34,600	—	—	13000	52	
June 21	50000	34600	—	—	13000	—	185
July 21	—	21000	—	—	47000	40	—
Aug., 21	—	10000	—	—	30000	30	—
Sept., 21	—	—	—	—	—	—	—
Oct., 21	250	15000	—	—	115000	2	182
Nov., 21	210000	—	—	3300	211000	—	—
Dec., 21	14800	13000	—	—	1,70,000	158	122
Total	4,07,150	1,88,900	100	3300	26,33,000	582	772

Arsikere

Wide spread incidence of coconut black headed caterpillar infestation was recorded in Chikkamagaluru, Tumkur, Mysore, Hassan 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 1,300 *Bracon brevicornis* and 25,600 *Goniozus nephantidis* parasitoids were supplied for release in approximately 52 Palms (*Bracon*) + 640 Palms (*Goniozus*) of black headed caterpillar infested coconut palms (Table 19).

Table 19: Production and supply of parasitoids for the management of coconut black headed caterpillar in Arsikere centre (2021-22)

Months	*Bracon brevicornis*	*Goniozus nephantidis*
January 2021	0	3000
February 2021	0	1000
March 2021	0	0
April 2021	0	0
May 2021	500	4000
June 2021	100	2300
July 2021	200	1000
August 2021	150	3000
September 2021	200	2000
October 2021	100	3000
November 2021	50	2500
December 2021	0	3800
Total	**1300**	**25600**

Table 20: Production and supply of natural enemies

Months	*Bracon hebetor*		*Goniozus nephantidis*		Reduvid Bug
	No. of Parasitoids mass multiplied	Sale (Rs.)	No. of Parasitoids mass multiplied	Sale (Rs.)	No. of Bugs Produced
Jan., 21	6700	5500	400	-	50
Feb., 21	1750	1000	700	1000	50
Mar., 21	1900	7000	800	1200	80
April, 21	750	-	300	-	110
May, 21	650	-	350	-	110
June, 21	600	-	350	-	110
July, 21	500	-	300	-	160
Aug., 21	600	-	300	-	160
Sept., 21	700	-	300	-	160
Oct., 21	2500	1500	700	1000	210
Nov., 21	3950	3000	900	1500	250
Dec., 21	900	150	400	-	350
Total	**27500**	**18150/-**	**5800**	**4700/-**	**1800**

Ratnagiri

The mass multiplication of *Bracon hebetor* and *Goniozus nephantidis* was carried out at Bio-control laboratory of Regional Coconut Research Station, Bhatye Dist. Ratnagiri and a total of 27500 nos. of *B. hebetor* and 5800 nos. of *G. nephantidis* parasitoids were mass multiplied and supplied for release in RCRS, Bhatye farm and farmers fields. The reduvid bugs (1800 nos.) were also produced at Biocontrol laboratory, RCRS, Bhatye (Table 20) for the effective management of leaf eating caterpillar and mealy bugs. AICRP-RCRS, Ratnagiri has also generated receipt of Rs. 22850 by selling of parasitoids to the farmers.

Parasitoids release against CBHC in coconut garden of Maharashtra

Impact of parasitoids on CBHC in Maharashtra

Before treatment | After release of parasitoids

Coc./Ent. 6: Surveillance, assessment of natural enemies and management of whitefly complex in coconut

Centres: Aliyarnagar, Ambajipeta, Arsikere and Ratnagiri

Exp. No. 1. Surveillance and assessment of natural enemies

Aliyarnagar

Observations on RSW incidence has been made at monthly intervals from three pest infested gardens *viz.*, CRS, Aliyarnagar (Var: COD, 12 years) Angalakuruchi, Anaimalai block (10 years old hybrid (GBGD X WCT)) and Puliyankandi (ALR 1, 12 years old). The mean data were given in the Table 21. The results of infestation of rugose spiralling whitefly in coconut and their natural enemies revealed that the RSW incidence high (45.2 %) during June 2021, after the starting of South West Monsoon the incidence started declining and reached 18.8 % during November 2021. The mean incidence recorded was 29.63 per cent. Similarly the intensity of infestation and the grade of pest intensity also decreased after the South West Monsoon. The highest intensity was recorded during June 2021 (42.7 %) and it was declined to 18.6 % during December 2021. The grade of pest intensity was high (1.6) during June 2021. The mean intensity of infestation and grade of pest intensity were 26.76 per cent and 0.93 respectively. The parsitisation by *Encarsia* was varied from 42.7 to 64.5 per cent in August and January 2021 respectively. The highest percent of parasitism was recorded in the month of January 2021 (64.5 %). Besides *Encarsia* parasitoid, meager number of predators was also observed.

Table 21: Infestation of rugose spiralling whitefly in coconut and incidence of their natural enemies during 2021

Months	Rugose spiralling whitefly			Live colony*			**Natural enemies		Parasitization (%)
	Incidence (%)	Intensity (%)	Grade	Eggs	Nymphs	Adult	Spiders	Predators	
January 21	25.8	22.5	0.7	17.5	15.2	15.7	0.2	0.5	64.5
February 21	30.2	25.5	1.0	18.2	18.7	18.2	0.3	0.1	60.8
March 21	35.2	28.2	1.2	20.5	23.5	25.8	0.5	0.3	62.7
April 21	38.7	33.5	1.0	22.7	27.2	27.2	0.2	0.5	58.2
May 21	42.8	40.4	1.5	25.8	28.5	28.5	0.0	1.0	56.7
June 21	45.2	42.7	1.6	23.7	29.5	27.2	0.7	1.2	50.5
July 21	30.5	28.2	1.0	20.5	20.5	28.5	0.5	0.8	48.7
August 21	25.7	23.5	0.8	18.5	13.5	29.5	0.7	0.7	42.7
September 21	20.4	18.5	0.5	16.7	17.7	20.5	0.8	0.1	50.5
October 21	22.1	18.9	0.8	15.2	14.8	22.7	0.7	0.3	54.4
November 21	18.8	20.6	0.6	12.8	15.2	16.7	0.5	0.7	51.6
December 21	20.2	18.6	0.5	12.4	14.4	18.6	0.6	0.5	61.3
MEAN	29.63 ± 9.09	26.76 ± 8.28	0.93 ±0.36	18.71 ±4.16	19.89 ±5.88	23.26 ±5.11	0.48 ±0.25	0.56 ±0.34	55.22 ±6.60

Mean = Mean ± standard error; *Live colony/ four leaflets /palm; **Natural enemies/ four leaflets/ palm

Table 22: Incidence of rugose spiraling whitefly in alternate hosts during 2021

Months	Per cent incidence		
	Banana	Cocoa	Custard apple
January 2021	14.8	3.4	13.0
February 2021	18.2	5.6	16.4
March 2021	18.4	5.7	16.3
April 2021	23.6	7.7	22.1
May 2021	22.4	7.2	20.7
June 2021	20.4	8.6	22.8
July 2021	17.8	7.6	20.2
August 2021	12.1	4.9	13.6
September 2021	20.2	5.2	20.6
October 2021	18.9	6.3	22.7
November 2021	21.6	5.8	21.4
December 2021	19.5	5.5	23.5
MEAN	**18.99 ± 3.17**	**6.13 ± 1.44**	**19.44 ± 3.66**

(Mean ± standard error)

The per cent incidence of rugose spiraling whitefly was recorded in the alternates host like banana, cocoa and custard apple (Table 22). In banana RSW incidence was high (23.6 %) during April 2021, after South West Monsoon it was declined and reach low incidence of 12.1 per cent during August 2021 and gradually start increasing. Similar trends were observed in cocoa and custard apple. It was observed that banana and custard apple was more preferred host than cocoa.

Ambajipeta

Rugose spiralling whitefly incidence was observed at monthly interval from three pest infested gardens. Five palms were selected at random in each garden for observation. High incidence of rugose spiraling whitefly incidence was observed in the month of December (92.33%) and November (87.8%) with grade intensity of 2.6 and 2.5 respectively. Mean no. of different stages of RSW was recorded high in the month of December followed by November. Natural enemy population observed in December, 2021 was 0.98 followed by 0.86 in November, 2021. *Encarsia guadelopae* parasitisation was observed high in the month of December, 2021 (22.56%) followed by November, 2021 (19.35%). Predator *A. astur* population was 0.83, 0.75 per four leaflets in the month of December and November respectively. Spider population was 0.68, 0.56 per four leaflets in the month of December and November respectively (Table 23).

The rugose spiraling whitefly was also recorded in banana, cocoa and mango (Table 24). In banana RSW incidence was high (23.9 %) during December 2021, low (11.9 %) during April 2021. Similar trends were observed in cocoa and mango. It was observed that banana was more preferred host than cocoa and mango.

Table 23: Extent of infestation of rugose spiralling whitefly in coconut and their natural enemies of Ramachandrapuram during 2021

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade pest intensity	Mean no. of pest stages / four leaflets			Natural enemies / four leaflets		
				nymph	Pupae	adult	*E. guadelopae* parasitism (%)	Predators	
								Spiders	*A.astur*
January2021	24.61	21.02	0.4 (Low)	0.00	0.00	1.00	6.61	0.21	0.26
February2021	21.53	19.10	0.3 (Low)	0.10	0.10	0.73	3.52	0.19	0.24
March2021	20.02	15.14	0.2 (Low)	0.00	0.00	0.51	2.34	0.17	0.23
April 2021	18.48	16. 20	0.4 (Low)	0.12	0.10	0.00	2.02	0.16	0.22
May 2021	16.61	27.48	0.3 (Low)	0.25	0.00	0.50	1.13	0.14	0.20
June 2021	16.39	22.56	0.9 (Low)	0.69	0.00	1.00	3.34	0.18	0.21
July 2021	15.25	25.51	0.7 (low)	1.21	0.82	1.00	7.12	0.15	0.23
August 2021	17.85	39.74	0.5 (low)	2.89	1.48	5.24	6.87	0.29	0.34
September 2021	46.1	59.47	1.8 (Medium)	7.13	3.29	9.53	10.68	0.34	0.56
October 2021	66.43	79.09	2.3 (High)	17.39	10.87	12.68	13.79	0.44	0.69
November 2021	87.8	90.23	2.5 (High)	32.1	22.6	20.42	19.35	0.56	0.75
December 2021	92.33	93.12	2.6 (High)	44.8	36.7	31.9	22.56	0.68	0.83
Mean±SD	36.958± 8.39	42.39± 8.63	Medium	8.89± 4.31	6.33± 3.38	7.04± 2.91	8.28± 2.06	0.29± 0.05	0.39± 0.06

Arsikere

The infestation of rugose spiraling whitefly was gradually increased from Jan 2021 (10.2 %) to April 2021 (24.6 %) and declined thereafter till Oct 2021. Again the infestation increased in Nov and Dec 2021. Maximum incidence and intensity and grade pest intensity were 24.6 per cent, 22.3 per cent and 1.1, respectively in April, 2021 (Table 25). The same trend was observed in intensity of the RSW and grade pest intensity. With regard to parasitization, the number of parasitized puparia, spiders and other predators showed increasing trend as months passed i.e. from Jan to Dec 2021.

The incidence of rugose spiraling whitefly was also noticed on major fruit crops like banana (11.8%), guava (10.2 %), mango (10.2 %), jackfruit (9.6 %) sapota (8.1 %) and papaya (9.4 %). The average incidence was between 8.1to 11.8 per cent during the year 2021-22 (Table 26).

Table 24: Incidence of rugose spiraling whitefly in alternate hosts during 2021

Months	Per cent incidence		
	Banana	Cocoa	Mango
January 2021	18.2	4.1	12.1
February 2021	17.1	3.9	9.4
March 2021	15.4	3.7	6.8
April 2021	11.9	3.3	4.1
May 2021	12.7	3.6	4.5
June 2021	12.9	3.9	4.9
July 2021	13.3	4.9	5.5
August 2021	14.9	5.2	7.3
September 2021	15.3	6.1	10.1
October 2021	16.4	7.2	13.7
November 2021	18.2	8.6	14.3
December 2021	23.9	9.8	18.6
MEAN	**15.85± 0.95**	**5.36 ± 0.53**	**9.28±1.23**

(Mean ± standard error)

Table 25: Extent of infestation of rugose spiralling whitefly in coconut and their natural enemies in Karnataka during 2021-22

Months	% leaf	Intensity of RSW (%)	Grade Pest Intensity	Adult	Nymph	Eggs	No. of colonies (egg spirals) / leaf let	No. puparia/ 10 cm	No. parasitized puparia/10 cm	Spiders	Other predator
Jan.,21	10.2	9.2	0.4	3.2	2.6	0.5	2.1	1.4	0.3	0.7	2.1
Feb.,21	13.5	10.1	0.6	4.3	2.7	0.8	2.4	1.5	0.6	1.2	2.5
March 21	21.4	19.4	0.8	8.7	7.1	1.2	2.7	2.5	1.2	0.9	1.6
April 21	24.6	22.3	1.1	9.5	7.5	1.5	3.2	2.8	1.5	1.4	3.3
May -21	13.4	7.5	0.6	12.1	8.4	5.9	3.7	2.9	1.7	2.8	3.5
June-21	11.5	7.1	0.5	9.1	5.6	5.0	3.5	2.6	1.3	2.3	3.3
July-21	9.6	6.8	0.4	7.3	4.2	3.4	3.1	1.8	1.9	2.1	3.8
August-21	7.8	6.3	0.3	4.7	3.8	1.5	2.0	1.4	2.9	1.4	4.1
Sept.,21	3.9	1.5	0.2	3.2	2.5	1.2	1.6	0.9	2.4	1.8	3.8
Oct.,21	3.2	1.1	0.1	2.1	1.3	0.8	0.8	0.6	1.8	1.6	3.7
Nov.,21	14.5	8.2	0.6	10.7	6.1	3.3	2.8	1.9	2.7	1.7	4.1
Dec., 21	16.4	10.1	0.8	11.8	6.9	3.9	3.3	2.3	3.1	1.9	3.8
Mean	12.5± 0.5	9.1± 0.5	0.5± 0.02	7.2± 0.30	4.9± 0.20	2.4± 0.15	2.6± 0.07	1.9± 0.06	1.8± 0.07	1.7± 0.05	3.3± 0.07

Average means ± standard error

Table 26: Extent of infestation of rugose spiralling whitefly on fruit crops in Karnataka during 2021-22

Month	Banana	Guava	Mango	Jackfruit	Sapota	Papaya
Jan.,21	10.5	9.3	8.6	7.6	6.5	7.8
Feb.,21	13.1	10.4	10.2	10.8	8.3	9.6
March 21	20.4	13.6	11.4	11.4	10.4	11.1
April 21	22.3	22.5	21.6	19.6	21.8	18.8
May -21	12.7	11.5	10.4	9.5	8.5	11.8
June-21	11.4	10.7	9.8	9.1	7.1	10.4
July-21	9.2	9.1	9.5	8.4	6.4	8.8
August-21	6.5	5.8	6.7	7.1	5.2	5.3
Sept.,21	3.8	4.2	5.3	6.2	3.9	4.5
Oct.,21	2.7	2.3	4.1	3.4	2.1	2.1
Nov.,21	14.2	11.1	11.7	10.5	7.5	10.5
Dec., 21	15.1	12.2	12.8	11.8	8.9	11.8
Mean	11.8 ± 0.49	10.2 ± 0.43	10.2 ± 0.37	9.6 ± 0.33	8.1 ± 0.41	9.4 ± 0.36

Average means ± standard error

Ratnagiri

The data presented in Table 27 indicated that the incidence of rugose spiralling whitefly (RSW) was in the range of 10.4 to 38.8 per cent. However, intensity of RSW was 1.54 to 44.8 per cent from January to December 2021. The maximum incidence (38.8%) and intensity (44.8%) of RSW were recorded respectively in July, 2021. Whereas, minimum incidence (10.4%) and intensity (1.54%) was observed in June 2021. The average RSW pest records *viz.*, incidence, intensity, grade index, no. of live colonies of eggs, nymphs and adults were 21.6%, 21.5%, 0.85, 3.8, 15.7 and 8.9/leaflet, respectively. The mean population of natural enemies

Table 27: Extent of infestation of rugose spiralling whitefly (RSW) in coconut and their natural enemies in Maharashtra

Months	Incidence of RSW (%)	Intensity of RSW(%)	Grade Index	No. of live colonies			*Encarsia* parasitism (%)	Natural Enemies	
				Eggs	Nymphs	Adults		Spiders	Predators
Jan., 21	18.8	8.2	0.41	3.4	7.6	5.8	40.3	1.7	0.2
Feb., 21	21.6	6.8	0.37	2.0	3.8	5.6	72.0	0.8	0.3
Mar., 21	19.1	23.2	0.90	4.0	8.0	8.4	68.0	0.6	0.0
April, 21	17.0	22.9	0.40	0.8	31.0	9.0	71.0	1.0	0.4
May, 21	13.0	15.2	0.65	4.2	10.4	9.4	75.0	0.8	0.2
June, 21	10.4	1.54	0.35	0.8	0.00	3.8	0.00	0.8	1.2
July, 21	38.8	44.8	1.20	9.8	30.5	8.1	32.0	0.6	0.0
Aug., 21	27.9	38.0	1.04	7.5	19.8	16.5	37.5	0.4	0.2
Sept., 21	31.3	39.7	1.75	2.6	42.2	5.8	33.3	0.6	0.2
Oct., 21	21.9	26.1	0.77	4.1	6.73	12.4	29.0	1.6	0.6
Nov., 21	18.9	20.0	0.51	3.4	13.6	19.0	57.0	1.6	0.6
Dec., 21	20.5	12.1	0.93	3.5	15.8	3.9	27.3	0.2	0.2
Mean ± SE	21.6 ± 2.3	21.5 ± 4.1	0.85 ± 0.1	3.8 ± 0.7	15.7 ± 4.0	8.9 ± 1.4	45.2 ± 7.0	0.89 ± 0.1	0.34 ± 0.1

like spiders and predators were 0.89 and 0.34 per leaflet. However, maximum *Encarsia* parasitization (45.2%) was observed during the period. The median grade index was noticed in July & September, 2021. Whereas, low grade index was recorded in rests of the months.

Table 28: Rugose spiralling whitefly (RSW) incidence (%) on other crops

Months	Banana	Mango	Cashew nut	Cocoa
Jan., 21	12.6	9.9	6.3	11.7
Feb., 21	8.1	7.2	1.8	7.2
Mar., 21	6.3	4.5	2.7	5.4
April, 21	5.4	5.4	3.6	4.5
May, 21	5.4	3.6	0.0	3.6
June, 21	10.8	6.3	5.4	9.0
July, 21	11.7	6.3	4.5	9.9
Aug., 21	10.8	7.2	1.8	9.0
Sept., 21	9.9	5.4	2.7	8.1
Oct., 21	9.0	6.3	2.7	7.2
Nov., 21	7.2	4.5	0.9	6.3
Dec., 21	6.3	3.6	0.9	4.5
Mean ± SE	**8.62 ± 0.7**	**5.85 ± 0.5**	**2.77 ± 0.6**	**7.20 ± 0.8**

Exp. No. 2. Integrated pest management of rugose spiraling whitefly (RSW)

IPM Strategies

- Installation of yellow sticky traps in the garden ,
- Three rounds of neem oil spray 0.5% at 15 days interval,
- Three rounds of jet water spray 10 days after spraying neem oil

The incidence of whitefly complex was also noticed on banana, mango, cashew nut and cocoa which recorded 8.62, 5.83, 2.77 and 7.20 per cent, respectively. However, maximum RSW population was observed during January, 2021 which were on Banana (12.6%), Mango (9.9%), Cocoa (11.7%) and Cashew nut (6.3 %) (Table 28).

Aliyarnagar

The IPM strategies for the management of rugose spiralling whitefly was started during the month of November 2018, in the COD palms (15 years old). The recommended IPM strategies were followed till date as per the approved AICRP (palms) technical programmes. The results revealed that in the IPM strategies adapted plot the incidence and intensity of RSW was significantly reduced from 33.2 % to 15.7 % and 30.8 % to 12.5 % respectively when compared to the natural control were the per cent incidence and pest intensity was recorded as 62.7 & 60.5 % and 57.4 & 59.2 % respectively in the pre and post treatment observations (Table 29). Similarly the live colonies of egg, nymphs and adults was also significantly reduced in the IPM plots. The grade of pest intensity was significantly reduced from 1.2 (medium) to 0.6 (low) in IPM plot and it was 1.3 to 1.5 in natural control. In both the plots the spiders and predator population was observed. The natural control registered slow decline of incidence, intensity and grade pest intensity of RSW compared to IPM plots.

Ambajipeta

The experiment was conducted in Ramachandrapuram village in Andhra Pradesh. A total of 50 palms of the variety Godavari Ganga (5 years old) juvenile palms in continuous area were considered for the experiment. The IPM strategy and natural control were adopted in 25 palms each. IPM package was implemented in the field as per

Table 29. Integrated pest management of rugose spiraling whitefly during 2021

Months	Incidence (%)	Intensity (%)	Grade	Live colony*			**Natural enemies		Parasitization (%)
				Eggs	Nymphs	Adult	Spiders	Predators	
Pre - treatment observations									
T1-IPM	33.2	30.8	1.2	20.7	18.5	20.7	0.7	1.0	52.7
T2-Natural control	62.7	57.4	1.3	23.7	21.4	20.4	0.2	0.7	50.7
Sig. (P= 0.1)	NS	NS	NS	NS	NS	NS	NS	NS	NS
't' value	0.4	0.5	0.7	0.3	0.5	0.2	0.03	0.2	0.7
Post - treatment observations									
T1-IPM	15.7	12.5	0.6	12.7	9.7	8.5	1.2	1.5	78.5
T2-Natural control	60.5	59.2	1.5	20.6	20.5	18.7	1.7	1.2	48.5
Sig. (P= 0.1)	*	*	*	*	*	*	NS	NS	*
't' value	0.8	14.5	0.5	3.8	7.9	8.5	0.2	1.0	8.5

***Live colony/ four leaflets /palm; **Natural enemies/ four leaflets/ palm**

the experimental protocol. Pre experimental data on the leaf infestation and intensity of pest was 94.21%, 81.12 in IPM garden and the mean no. of adults, nymphs and pupae per four leaflets per palm was 15.62, 18.86 and 8. 98 respectively in IPM garden (Table 30).

Table 30: Integrated pest management of rugose spiraling whitefly at Ramachandrapuram during 2020-21

Integrated pest management of rugose spiraling whitefly at Ramachandrapuram during 2020-21								
Treatments	**Pre-treatment observations**							
	Incidence of RSW (%)	**Intensity of RSW (%)**	**Grade**	**Mean no. of pest stages per 4 leaflets**			**Mean no. of natural enemies per 4 leaflets**	
				Adults	**Nymphs**	**Pupae**	**Spider**	**Predator *A.astur***
T1-IPM	94.21 ± 2.89	81.12 ± 3.13	1.40 ± 0.21	15.62 ± 1.89	18.86 ± 3.26	8.98 ± 0.96	—	0.86 ± 0.26
T2-Natural control	96.99 ± 0.61	89.72 ± 0.94	1.32 ± 0.29	10.98 ± 1.23	20.73 ± 1.21	4.75 ± 0.67	—	0.98 ± 0.57
T value	0. 5	1.9	0.5	2.3	2.1	2.2	0.2	0.7
P value	NS	NS	NS	NS	NS	NS	NS	NS

Post experimental data on the leaf infestation and intensity of pest was 83.32%, 71.32 in IPM garden and the mean no. of adults, nymphs and pupae per four leaflets per palm was 11.65, 12.79 and 5.87 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 31).

Arsikere

The experiment was carried out at Hulukatte village of Tiptur taluk. IPM strategies and natural control were adopted in 25 palms each of GBGD variety. IPM package for Rugose spiralling whitefly was implemented in the plot as per the experimental protocol. Pre experimental data on the incidence and intensity of whitefly was recorded in the month

Table 31: Integrated pest management of rugose spiraling whitefly at Andhra Pradesh during 2020-21

Integrated pest management of rugose spiraling whitefly at Ramachandrapuram during 2020-21								
Treatments	Post-treatment observations							
	Incidence of RSW (%)	Intensity of RSW (%)	Grade	Mean no. of pest stages per 4 leaflets			Mean no. of natural enemies per 4 leaflets	
				Adults	Nymphs	Pupae	Spider	Predator *A. astur*
T1-IPM	83.32 ± 2.45	71.32 ± 3.13	1.11 ± 0.11	11.65 ± 1.89	12.79 ± 1.26	5.87 ± 0.86	—	1.25 ± 0.32
T2-Natural control	98.99 ± 0.82	79.02 ± 0.94	1.08 ± 0.09	12.98 ± 1.23	19.73 ± 1.18	6.23 ± 0.98	—	0.64 ± 0.67
T value	7.30	5.46	6.58	6.42	4.03	8.95	1.45	1.88
P value	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig

of October 2021. Post experimental observations were recorded on incidence and intensity of whitefly. Simultaneous observations were also made in control plot. After imposition of treatments, the whitefly infestation gradually decreased from 22.5 per cent to 8.3 per cent with IPM strategy and in control plot the whitefly infestation increased from 22.8 to 33.5 per cent (Table 32). The IPM treatment recorded minimum adult population (1.5), nymph (1.9) and egg (0.3) which was significantly superior over natural control. The IPM treatment also registered the highest predator population (10.6) over the control (2.4).

Table 32: Integrated pest management of rugose spiralling whitefly in Karnataka 2021-22

Treatments	Pre-treatment observations								
	Incidence of RSW (%)	Intensity of RSW (%)	Live colony /four leaflet			Grade pest intensity	Spider/ four leaflet	Predators/ four leaflet	Encarsia parasitization (%)
			A	N	E				
T1-IPM	22.5 ± 2.3	23.7 ± 1.6	7.6 ± 2.2	9.4 ± 1.9	4.2 ± 0.6	1.3 ± 0.15	3.8 ± 0.47	4.9 ± 0.3	13.1 ± 0.8
T2-Natural control	22.8 ± 2.1	23.4 ± 1.5	7.8 ± 2.1	9.1± 1.7	4.1 ± 0.7	1.4 ± 0.16	3.6 ± 0.36	4.5 ± 0.2	13.8 ± 0.7
Sig. (P= 0.1)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	NS
't' value	2.2	1.8	1.3	2.1	0.4	0.8	1.1	0.5	0.8

Average means ± Standard Error

Ratnagiri centre

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 in Table 33 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

Treatments	Post treatment observations								
	Incidence of RSW (%)	Intensity of RSW (%)	Live colony /four leaflet			Grade pest intensity	pider/ four leaflet	Predators/ four leaflet	Encarsia parasitization (%)
			A	N	E				
T1-IPM	8.3 ± 1.3	7.1 ± 1.4	1.5 ±0.4	1.9 ± 0.3	0.3 ± 0.1	0.3± 0.1	8.6 ± 0.5	10.6 ± 1.1	29.5± 1.2
T2-Natural control	33.5 ± 1.1	31.4 ± 2.1	20.5± 2.3	21.4 ± 2.5	4.7 ± 0.6	2.1 ± 0.4	0.9 ± 0.2	2.4 ± 0.3	15.4 ± 0.9
Sig.(P= 0.1)	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	Sig
't' value	4.2	2.4	1.1	1.4	0.2	0.1	1.1	0.9	1.5

Average means ± Standard Error

(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).

Table 33: Impact of IPM treatment on rugose spiralling whitefly (RSW) in coconut

Treatments	Pre-treatment observations									Post treatment observations								
	Incidence of RSW (%)	Intensity of RSW (%)	No. of live colonies			Grade pest Index	Natural Enemies		*Encarsia* parasitism (%)	Incidence of RSW (%)	Intensity of RSW (%)	No. of live colonies			Grade pest Index	Natural Enemies		*Encarsia* parasitism (%)
			Eggs	Nymphs	Adults		Spiders	Predators				Eggs	Nymphs	Adults		Spiders	Predators	
T1-IPM	41.9 ± 2.7	43.7 ± 3.3	18.6 ± 1.6	17.4 ± 1.4	13.8 ± 1.7	2.25	1.2 ± 0.2	0.8 ± 0.2	51.5 ± 2.5	23.0 ± 2.7	22.5 ± 4.0	6.8 ± 1.1	5.6 ± 1.1	5.0 ± 0.6	0.75	0.8 ± 0.2	0.6 ± 0.2	47.5 ±2.6
T2-Natural control	40.0 ± 1.6	44.9 ± 3.2	18.0 ± 1.7	11.4 ± 1.5	15.2 ± 1.4	2.1	1.0 ± 0.4	0.6 ± 0.3	54.3 ± 4.3	55.1 ± 3.1	58.4 ± 4.6	18.4 ± 1.9	8.8 ± 1.4	12.4 ± 3.4	1.75	1.2 ± 0.2	0.8 ± 0.4	58.0 ± 3.2
Sig. (P= 0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	Sig.	Sig.	Sig.	N.S.	Sig.	N.S.	N.S.	N.S.	N.S.
't' value	0.02	0.57	0.73	0.07	0.67	0.31	0.39	0.63	0.57	3.37	8.25	2.92	0.12	3.33	0.50	0.09	0.33	0.49

Averages mean ± Standard Error

V. EXPERIMENTAL RESULTS IN OIL PALM

5.1 CROP IMPROVEMENT

OP/GEN 8 C: Evaluation of new cross combinations in oil palm

Center: Pattukkottai

Ten oil palm hybrids developed from ICAR - IIOPR, Regional Station, Palode were planted during September, 2007 by adopting RBD with 3 replications and 6 palms per treatment. Soil of the experimental field was red sandy loam. Among the 10 hybrids evaluated for growth and yield parameters, 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 girth was recorded in the hybrid NRCOP-1 (3.59 m). The lowest number of male inflorescence (7.22) was recorded in NRCOP 5. 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%). Data on yield attributes of oil palm revealed that the highest FFB yield per palm of 182.58 kg and FFB yield per hectare of 26.11 tonnes was registered in the hybrid NRCOP- 9 which was closely followed by NRCOP-10 (23.39 t/ha) for the period of April 2020 to March 2021.

Table 1. Growth performance of oil palm hybrids (2020-2021) – 13 years old

Name of the Hybrid	Palm Height (m)	Palm girth (m)	No of Leaves produced/ palm /year	No of male inflores-cence	No of female inflores-cence	Total number of inflores-cence	Sex-ratio
NRCOP - 1	5.15	3.59	24.50	**8.32**	**12.38**	**20.70**	0.60
NRCOP - 2	5.25	3.88	**25.60**	7.90	10.27	18.17	0.57
NRCOP - 3	4.99	3.76	24.30	8.20	10.84	19.04	0.57
NRCOP - 4	**5.29**	3.88	24.80	7.47	10.24	17.71	0.58
NRCOP - 5	5.14	3.79	25.40	7.22	11.25	18.47	**0.61**
NRCOP - 6	4.99	3.78	24.20	8.03	11.61	19.64	0.59
NRCOP - 7	5.20	**3.90**	24.50	7.68	11.01	18.69	0.59
NRCOP - 8	5.16	3.63	24.80	7.97	10.76	18.73	0.57
NRCOP - 9	4.77	3.63	24.80	8.00	10.83	18.83	0.58
NRCOP - 10	4.74	3.81	23.80	8.11	10.97	19.08	0.57
S Ed	0.12	0.23	0.36	0.21	0.41	0.86	0.11
CD 5%	0.24	0.64	0.72	0.42	0.82	1.72	0.22

OP./Gen. 8C (I): Evaluation of new cross combinations in North East regions

Pasighat

Ten hybrid combinations were planted during August 2010. The growth of the palms with respect to stem height was maximum (2.71 m) in NRCOP-29 and at par with NRCOP-23, NRCOP-24 and NRCOP-27, NRCOP-22. Maximum number of leaves (23.33) was produced by the cross combination NRCOP-22 which was significantly higher than any other treatment. Minimum number of leaves (19.73) was produced by NRCOP-30.

Number of male flowers produced by the palms was non significant. Maximum number of female flowers (10.7) were produced by the cross NRCOP-22 which was significantly higher than the female flowers produced by other cross combinations. Minimum number of female flowers (7.05) were produced by the cross NRCOP-30.

Table 2. Yield performance of oil palm hybrids (2020-2021) - 13 years old

Hybrids	No. of bunches/ palm	Average bunch weight (Kg/palm)	FFB yield (kg/ palm)	FFB Yield (t/ha)
NRCOP -1	10.22	13.75	140.53	20.10
NRCOP -2	8.82	16.95	149.50	21.38
NRCOP -3	9.40	16.22	152.47	21.80
NRCOP -4	8.95	15.45	138.28	19.77
NRCOP -5	9.70	15.60	151.32	21.64
NRCOP -6	9.90	14.35	142.07	20.32
NRCOP -7	**10.35**	14.68	151.94	21.73
NRCOP -8	10.22	15.95	163.01	23.31
NRCOP -9	10.20	**17.90**	**182.58**	**26.11**
NRCOP -10	9.90	16.52	163.55	23.39
S Ed	1.13	1.23	1.33	1.12
CD 5%	2.26	2.46	2.66	2.24

The sex ratio was recorded highest (0.75) in NRCOP-22 which was statistically at par with NRCOP-30, NRCOP-27 and NRCOP-26. Maximum number of Fresh Fruit Bunches (10.44) was produced by NRCOP-22 which was significantly higher than in any other cross combination except NRCOP- 27, and NRCOP-21 where as the NRCOP-29 produced the least number of FFB (6.69) per palm. The average bunch weight was recorded in NRCOP-22 (13.44Kg) which was significantly higher than any other cross combination and the lowest bunch weight was recorded NRCOP-23 (10.35Kg). The highest yield (20.07 t/ha) was recorded in NRCOP-22, which was significantly higher, and the lowest yield (11.07 t/h) was observed in NRCOP-29. In comparison to other cross combinations, the performance of NRCOP-22 is the best in North Eastern Indian conditions.

Table 3: Growth and yield parameters of Oil palm hybrids

Hybrids	Palm Height (m)	Palm girth (m)	No of Leaves produced/ palm /year	No of male inflores-cence	No of female inflores-cence	Sex Ratio	No. of FFB/ plant	Bunch weight/ Palm (Kg)	Yield	
									Kg/ palm	t/ha
NRCOP-21	2.19	2.56	21.63	4.60	9.56	0.67	9.47	11.64	110.22	15.76
NRCOP-22	2.32	2.62	23.33	3.49	10.70	0.75	10.44	13.44	140.36	20.07
NRCOP-23	2.69	2.67	19.86	4.65	9.03	0.66	8.52	10.35	89.61	12.82
NRCOP-24	2.62	2.63	20.50	4.55	7.86	0.63	7.80	11.42	89.10	12.74
NRCOP-25	2.08	2.75	20.60	4.38	8.54	0.66	8.21	12.40	101.96	14.58
NRCOP-26	2.17	2.79	22.03	4.63	9.38	0.68	9.19	12.43	114.26	16.34
NRCOP-27	2.59	2.54	22.00	4.40	9.70	0.69	9.68	11.70	113.41	16.21
NRCOP-28	2.28	2.74	21.26	4.77	8.43	0.64	8.33	12.06	100.48	14.04
NRCOP-29	2.71	2.74	19.80	5.52	7.18	0.56	6.69	11.60	77.42	11.07
NRCOP-30	2.17	2.79	19.73	3.11	7.05	0.69	6.78	11.54	78.84	11.27
CD at 5%	**36.34**	**NS**	**0.83**	**NS**	**0.86**	**0.07**	**0.99**	**0.64**	**12.28**	**1.72**
CV (%)	**8.90**	**4.28**	**2.31**	**17.44**	**5.73**	**6.50**	**6.80**	**3.16**	**7.05**	**6.94**

OP./Gen. 8D (I): Evaluation of new progeny cross combinations in oil palm

Centres: Pasighat, Mulde, Pattukkottai and Vijayarai

Pasighat (10 year old palms)

The growth of the plants with respect to plant height, collar girth and number of leaves produced over a period of one year was statistically at par, in all the cross combinations. Least number of male flowers (4.80) was produced by NRCOP-32 and maximum (6.83) by NRCOP- 40. Maximum female flowers (7.73) were recorded in NRCOP-31 which was statistically at par with NRCOP-32, NRCOP-37, NRCOP-33, NRCOP-34 and NRCOP-36. Sex ratio was highest (0.60) in NRCOP-22 and lowest (0.48) in NRCOP-39 and NRCOP-40. The number of FFB/ palm was recorded maximum (7.50) in NRCOP-31which was at par with NRCOP-37, NRCOP-33, NRCOP-32 and NRCOP-34. FFB was observed to be least (5.66) in NRCOP-39. The average bunch weight did not vary significantly in the cross combinations. The mean yield/palm and yield t/ha was maximum (55.30kg/palm and 7.9 t/ha) in NRCOP-33 which was at par with NRCOP-37 (Table 4).

Table 4 : Growth and yield parameters of Oil palm hybrids

Hybrids	Palm height (cm)	Palm girth (cm)	No. of leaves/ Palm/Year	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	62.33	165.66	19.90	5.86	7.73	0.57	7.50	6.93	52.20	7.46
NRCOP-32	70.13	176.00	19.93	4.80	7.53	0.60	7.16	7.28	52.13	7.40
NRCOP-33	70.00	175.96	19.93	5.26	7.33	0.58	7.33	7.53	55.30	7.90
NRCOP-34	70.30	179.56	19.43	6.46	6.83	0.51	6.76	6.96	45.16	6.44
NRCOP-35	70.56	172.83	18.96	6.16	6.50	0.51	6.43	7.06	45.77	6.72
NRCOP-36	70.00	182.16	19.50	6.60	6.66	0.50	6.43	7.13	45.83	6.55
NRCOP-37	70.53	175.40	20.20	6.23	7.50	0.54	7.36	7.33	53.95	7.71
NRCOP-38	71.00	175.36	19.33	5.83	6.33	0.51	5.83	7.50	43.88	6.27
NRCOP-39	69.73	168.00	18.43	6.26	5.83	0.48	5.66	7.11	40.28	5.76
NRCOP-40	68.03	123.63	19.06	6.83	6.33	0.48	6.00	6.83	41.50	5.93
CD at 5%	**NS**	**NS**	**NS**	**1.06**	**1.161**	**0.06**	**1.05**	**NS**	**8.94**	**1.24**
CV (%)	**4.27**	**18.09**	**3.14**	**10.27**	**9.86**	**6.94**	**9.18**	**4.06**	**10.94**	**10.57**

Table 5: Growth and yield parameters of Oil palm hybrids

Hybrids	Palm height (cm)	Palm girth (cm)	No. of leaves/ Palm/Year	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	3.15	3.10	29.66	4.34	10.28	0.70	10.09	15.25	154.01	22.02
NRCOP-32	3.43	3.07	28.96	4.84	7.29	0.60	7.33	13.26	96.44	13.79
NRCOP-33	3.87	3.05	27.96	5.44	6.64	0.54	5.88	14.12	82.69	11.83
NRCOP-34	2.97	3.20	27.13	5.07	6.50	0.56	6.04	13.75	83.23	11.90
NRCOP-35	3.31	3.15	27.29	5.33	6.41	0.54	6.14	12.98	78.85	11.28
NRCOP-36	3.06	3.27	28.68	6.04	7.51	0.55	6.80	14.65	99.95	13.99
NRCOP-37	3.39	3.02	27.51	5.66	8.64	0.59	7.89	12.14	96.67	13.82
NRCOP-38	2.95	3.22	26.91	5.11	8.13	0.61	6.95	13.97	96.96	13.87
NRCOP-39	3.13	3.21	29.76	5.72	7.11	0.55	7.11	14.11	100.42	14.34
NRCOP-40	3.58	3.29	28.14	5.19	6.83	0.56	7.39	12.76	94.10	13.45
CD at 5%	0.12	0.07	1.44	0.27	0.61	0.02	0.60	1.04	9.27	1.33
CV (%)	**0.36**	**NS**	**NS**	**0.77**	**1.77**	**0.06**	**NS**	**NS**	**NS**	**NS**

Mulde

Ten new cross combinations of oil palm (10 years old) showed significant variation for average height and number of female inflorescences. Minimum height (2.95m) was recorded in NRCOP-38. Maximum girth (3.29 m) was recorded in NRCOP-40. Average leaf production ranged from 26.91 to 29.76. Maximum number of female inflorescences (10.28) was produced in NRCOP-31 with sex ratio 0.70. NRCOP-36 produced maximum number of male inflorescences (6.04) which lowered the sex ratio (0.55). New cross combinations of oil palm showed significant variation for yield attributing characters. More number of FFB (15.25) and the highest yield of FFB (22.02 t/ha) were recorded in NRCOP- 31. NRCOP- 34 produced only 6.04 bunches due to production of lower female inflorescences.

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 phase for yield (Table 6 & 7).

Table 6. Growth performance of oil palm hybrids at ARS, Pattukkottai (2020-2021) (8 years old):

Hybrids	Palm height (m)	Palm girth (m)	Total No.of leaves	Leaf length (m)	Leaf breadth (m)	No of leaflets/ leaf	No of male inflores-cence	No of female inflores-cence	Totalno. of inflores-cence	Sex-ratio
NRCOP 31	4.71	2.93	24.60	4.02	1.70	148.33	6.30	11.33	17.63	0.64
NRCOP 32	**5.18**	3.08	24.10	**4.12**	1.79	154.50	5.89	11.28	17.17	**0.66**
NRCOP 33	4.62	3.45	23.80	3.58	1.69	151.93	7.22	10.98	18.20	0.60
NRCOP 38	4.82	**3.55**	24.50	3.85	**1.92**	**162.99**	6.48	**11.75**	18.23	0.64
NRCOP 39	4.61	3.08	**24.90**	3.79	1.80	143.68	**7.23**	11.22	**18.45**	0.61
SE d	0.13	0.85	0.43	0.18	0.12	5.35	0.23	0.46	0.66	0.03
CD at 5%	0.26	1.70	0.86	0.36	0.24	10.70	0.46	0.92	1.32	0.06

Table 7. Yield performance of oil palm hybrids at ARS, Pattukkottai (2020-2021) (8 years old):

Hybrids	No. of bunches/ palm	Average bunch weight (Kg/palm)	FFB yield (kg/ palm)	FFB Yield (t/ha)
NRCOP 31	**9.50**	13.00	123.50	17.66
NRCOP 32	9.45	15.10	142.70	20.41
NRCOP 33	9.25	15.50	143.38	20.50
NRCOP 38	9.40	**17.00**	**159.80**	**22.85**
NRCOP 39	9.30	15.50	144.15	20.61
S Ed	0.17	1.31	4.23	2.21
CD 5%	0.34	2.62	8.46	4.42

Among the replicated hybrids, the palm height ranged from 4.61 to 5.18 m. The hybrid NRCOP -32 recorded significantly the highest palm height of 5.18 m. The lowest palm height (4.61 m) was recorded in the hybrid NRCOP 39. The palm girth ranged between 2.93 m and 3.55 m and the palm girth was higher in the hybrid NRCOP 38 (3.55 m). The lowest palm girth was recorded in the hybrid NRCOP-31 (2.93 m). Number of leaves produced per year was the highest in NRCOP 39. The number of female inflorescence ranged between 10.98 and 11.75, whereas, the percentage of female flowers was high in NRCOP 32 (66.00%). 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).The highest FFB yield per palm of 159.80 kg and FFB yield per hectare of 22.85 tonnes was registered in the hybrid NRCOP 38 which was closely followed by NRCOP 39 (20.61 t/ha).

Vijayarai

The trail was laid out during July, 2011. Among 10 crosses, significant differences were recorded for palm height, palm girth and number of bunches per palm per year. Significantly higher palm height was recorded in the cross NRCOP-40 (3.53 m) which was at par with the crosses NRCOP-32 (3.39m), 33 (3.35m), 35 (3.34m) and 37 (3.29m). Girth of the palm was significantly higher in the palm NRCOP-36 (3.22 m) which was at par with the crosses NRCOP-34 (3.06m), 38 (3.23m) and 39 (3.15m) (Table 8). Number of bunches produced per palm per year was significantly higher in the cross NRCOP-37 (10.83) which was at par with the crosses NRCOP-31 (8.69), 34 (8.27) and 38 (8.82). Annual leaf production per palm, average bunch weight (kg) and fresh fruit bunch yield were not significantly different among the crosses.

Table 8: Growth and yield parameters of new cross combinations of oil palm

Name of the hybrid	Palm height (m)	Annual height increment (m)	Palm girth (m)	Number of leaves/ palm/year	Sex ratio	Numberof bunches/ Palm/year	Average bunch weight (kg)	FFB Yield	
								kg/palm/ year	t/ha/ year
NRCOP-31	2.66	0.70	2.89	24.72	0.57	8.69	14.29	125.02	17.87
NRCOP-32	3.39	0.85	2.82	21.61	0.53	6.50	20.82	139.02	19.88
NRCOP-33	3.35	0.89	2.83	24.85	0.47	4.94	23.19	112.38	16.07
NRCOP-34	2.66	0.57	3.06	24.75	0.46	8.27	17.90	145.36	20.78
NRCOP-35	3.34	0.90	2.92	23.00	0.50	7.61	21.29	163.04	23.31
NRCOP-36	2.29	0.50	3.22	23.80	0.33	7.28	16.44	118.18	16.90
NRCOP-37	3.29	0.97	2.95	23.25	0.64	10.83	18.83	203.97	**29.16**
NRCOP-38	2.64	0.65	3.23	24.50	0.52	8.82	19.85	176.49	25.23
NRCOP-39	2.52	0.55	3.15	24.26	0.46	7.24	20.37	146.52	20.95
NRCOP-40	3.53	1.01	2.83	22.68	0.59	6.5	18.01	120.35	17.21
CD (5%)	**0.461**	**0.11**	**0.236**	**NS**	**NS**	**2.646**	**NS**	**NS**	**NS**
S.Em(±)	0.14	0.05	0.05	0.34	0.02	0.50	0.81	9.20	1.31
CV (%)	9.044	2.55	4.611	7.88	22.28	20.11	15.55	24.97	24.97

High yielding cross NRCOP-37

High yielding cross NRCOP-47

OP./Gen. 8D (II): Evaluation of D x P hybrids for dwarfness and yield in oil palm

Vijayarai

The experiment was laid out during, 2013. Among 11 crosses and one control significant differences were not recorded for palm height, palm girth, number of leaves/ palm/year, sex ratio and number of bunches produced per palm per year and fresh fruit bunch yield (Table 9). Average bunch weight recorded was significantly higher in the cross NRCOP-44 (16.57 kg) followed by NRCOP-43 (13.96kg) and NRCOP-50 (13.47 kg).

Table: 9 Growth 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
NRCOP-41	2.03	0.64	2.89	24.20	0.72	16.10	11.39	182.74	26.13
NRCOP-42	1.96	0.44	2.72	24.80	0.61	11.67	12.63	148.34	21.21
NRCOP-43	1.67	0.39	3.10	23.50	0.57	11.51	13.96	160.15	22.90
NRCOP-44	2.12	0.57	2.85	22.80	0.64	10.21	16.57	168.81	24.14
NRCOP-45	1.80	0.49	3.10	23.75	0.65	13.61	11.90	166.25	23.77
NRCOP-46	1.72	0.41	2.87	23.60	0.61	11.05	10.17	112.17	16.04
NRCOP-47	1.87	0.45	2.82	24.80	0.74	16.27	12.30	**201.64**	**28.83**
NRCOP-48	1.58	0.41	2.68	25.30	0.60	12.00	12.05	145.75	20.84
NRCOP-49	1.58	0.25	2.83	23.40	0.66	12.46	11.53	143.35	20.50
NRCOP-50	1.90	0.62	2.64	23.80	0.55	13.83	13.47	185.22	26.48
NRCOP-51	1.72	0.29	2.81	24.00	0.80	12.52	12.09	151.07	21.60
Control	1.73	0.39	2.84	24.20	0.57	13.16	11.61	151.65	21.68
CD (5%)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**2.442**	**NS**	**NS**
S.Em(±)	0.05	0.03	0.04	0.22	0.02	0.59	0.51	7.42	1.06
CV (%)	18.05	16.25	5.96	10.35	20.76	21.79	11.56	25.22	25.22

5.2 Crop Production

OP./Agron. 12: Nutrient management studies in oil palm under North East region

Pasighat

Planting was done on 09/08/2019 as per the treatment details. The nutrient doses were applied as per the treatment details and growth parameters were recorded. The plant height was recorded to be at par among all the treatments. However the stem girth (55.60 cm) and number of leaves produced (20.00) was recorded maximum in the palms treated with 1500:750:1500 g NPK/ p/yr. which was at par with treatment 1200:600:1200 g NPK/ p/yr

OP./Agron.13: 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.

OP./Agron. 21: Plant Geometry and Optimization of nutrients in Oil palm:

Bavikere

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,

Table :10 Growth performance of oil palm under nutrient management

Treatments	Plant height (cm)	Stem Girth(cm)	No. Leaves produced
900:450:900 g NPK/ p/y	163.60	37.60	17.60
1200:600:1200 g NPK/ p/y	137.40	53.20	19.60
1500:750:1500 g NPK/ p/y	171.20	55.60	20.00
The dose may be fixed based on the existing soil/ leaf analysis report targeting 20t/ha and the dose of different fertilizer may be modified based on the annual analysis report.	146.20	37.80	15.60
CD at 5%	**NS**	**7.66**	**1.25**
CV (%)	**13.04**	**12.06**	**4.99**

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 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.

Table 11: Effect of graded levels of fertilizer dosage on growth parameters of oil palm (Pooled data of 2 years)

Sl.No.	Treatment combination	Plant height (cm)	Plant girth (cm)	No. of leaves
1	N0P0K0	188.36	104.79	20.25
2	N0P0K1	221.35	130.34	23.10
3	N0P0K2	191.00	125.82	21.74
4	N0P1K0	198.96	128.00	20.05
5	N0P1K1	206.25	149.29	21.81
6	N0P1K2	176.40	101.32	19.92
7	N0P2K0	201.21	107.46	22.05
8	N0P2K1	206.11	113.93	21.25
9	N0P2K2	224.71	124.39	22.90
10	N1P0K0	215.99	121.66	21.78
11	N1P0K1	172.39	102.25	21.25
12	N1P0K2	184.82	105.82	20.59
13	N1P1K0	222.43	145.29	23.08
14	N1P1K1	203.36	121.21	22.34
15	N1P1K2	215.25	132.54	22.76
16	N1P2K0	197.02	103.73	21.83

17	N1P2K1	234.14	147.43	22.94
18	N1P2K2	216.68	131.93	21.90
19	N2P0K0	168.82	101.86	19.86
20	N2POK1	188.71	113.92	20.77
21	N2POK2	203.75	113.61	21.47
22	N2P1K0	220.36	150.32	22.89
23	N2PIK1	203.08	112.56	21.86
24	N2PIK2	213.96	131.29	23.72
25	N2P2K0	226.06	138.84	23.47
26	N2P2K1	212.14	143.21	22.44
27	N2P2K2	219.43	132.89	23.32
SEm	14.24	17.13	0.57	
CD	NS	NS	1.65	

Expt. 2: Plant geometry studies in oil palm:

Table 12: Effect of spacing on growth parameters of oil palm (2021-22)

Treatments	Plant height (cm)	Plant girth (cm)	No. of leaves
M1(9m x 9mx 9m)	207.47	126.42	17.35
M2 (9m x 9m)	225.49	139.60	16.64
M3 (10m x10m x 10m)	210.73	134.17	17.84
M4 (10m x10m)	195.63	117.62	16.67
SEm	12.33	11.85	0.46
CD (5%)	NS	NS	NS
CV (%)	11.94	20.27	4.92

VI. EXPERIMENTAL RESULTS IN ARECANUT

6.1 Crop Improvement

Arec./Gen. 4: Evaluation of varieties and establishment of mother blocks for production of quality planting material in arecanut

Activity I: Evaluation of released arecanut varieties in different agro-climatic regions

Centres: Shivamogga and Wakawali

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.

Activity II: Nucleus seed gardens for varieties

Centres: Goa, Port Blair, Shivamogga and Wakawali

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.

Activity III: 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.

6.2 Crop Production

Arec./Agron. 18: Development of arecanut based cropping systems for different agro-climatic regions

Expt. 1: Evaluation of arecanut based cropping system models

Port Blair

Arecanut based cropping system models including herbal spices were evaluated under warm and humid conditions of Andaman Islands. Of the intercrops studied, Burmese coriander was suitable intercrop under the plantation of arecanut variety Samrudhi. Inclusion of Burmese coriander in the interspaces of arecanut could give higher net returns of Rs. 13,03,065/- as against Rs. 9,59,600/- in the arecanut sole crop. The B:C ratio of this treatment was 3.19 and hence, it was recommended for the island farmers.

Arec./Agron. 20: Studies on crown chocking disorder in arecanut (Hidimundige)

Shivamogga

The experiment on management of the Hidimundige disorder was laid out atAnaveri (BhadravathiTaluk). The observation on initial mean number of healthy and affected leaves/plant and healthy primary roots/sq.ft.area in crown chocking affected demonstration garden revealed that, upon imposition of treatments healthy palms produced a mean number of 47.8 primary roots/sq. ft.area, 9.4 healthy leaves/palm and 4.4 bunches/palm. Whereas, affected plants showing partial recovery and produced a mean number of 37.0 healthy primary roots/sq. ft.area, with a mean of 5.1healthy leaves and 2.07 number of bunches/palm.

Table. 1: Effect of integrated management practices on the Population dynamics of biocontrol agents in the rhizosphere soil of crown chocking affected garden.

Place	Biocontrol agents	Date of treatment imposition	Initial population (cfu) (BIT)	Final population (cfu) (AIT)
Anaveri BhadravathiTq.	*Trichoderma* spp.	22.08.2020	1.2	6.0
	Bacillus spp.		1.7	7.5
	Pseudomonas spp.		0.4	0.9

Population dynamics of biocontrol agents (*Trichoderma harzianum*, *Pseudomonas fluorescence*, and *Bacillus megatarium*) in the rhizosphere soils showed a considerable increase in their population after one year of the imposition of the treatments. However, among the biocontrol agents, *Bacillus* sp. showed comparatively higher population enumeration followed by *Trichoderma* and *Pseudomonas* species respectively. Yearly application of biocontrol agents has enhanced better lateral root production resulting in better uptake of nutrients their by improving the crop health.

6.3 Crop Protection

Arec./Path. 8: Survey and surveillance of Arecanut diseases in Shivamogga district

Roving survey was conducted during Kharif and Rabi seasons of 2021in different taluks of Shivamogga district to assess the incidence of different diseases in the arecanut gardens with the crop age ranging between one to fifty years. The survey data revealed that, among 156 areca gardens visited in Shivamogga district, except yellow leaf disease all other diseases were recorded with varied level of disease incidence. However, among the diseases observed, leaf spot and inflorescence die-back were predominant in majority of gardens surveyed.

Table 2: Survey and surveillance of Arecanut diseases inShivamogga district

Taluk	No. of gardens surveyed	Disease Incidence (%)									
		Phyllosticta leaf spot	Bacterial leaf stripe	Fruit rot	Bud rot	Crown rot	Inflorescence die back	Crown chocking	Leaf blight	Ganoderma wilt	Yellow leaf
Shivamogga	32.0	74.5	33.1	15.6	2.9	2.1	91.3	36.4	18.4	4.3	0.0
Thirthahalli	23.0	93.2	0.0	96.2	6.3	4.8	86.4	4.3	72.7	1.8	0.0
Hosanagara	18.0	100.0	0.0	98.7	5.6	3.2	84.8	2.8	82.8	1.4	0.0
Shikaripura	20.0	73.0	19.2	24.7	3.1	0.6	71.5	42.0	11.6	3.2	0.0
Soraba	9.0	46.5	9.8	28.5	2.3	0.0	52.3	26.7	9.5	3.4	0.0
Bhadravathi	32.0	86.4	29.6	14.2	4.4	1.2	85.7	32.6	14.1	10.8	0.0
Sagara	22.0	90.8	0.0	94.3	1.8	3.4	39.9	1.4	76.7	2.6	0.0
Mean		80.6	13.1	53.1	3.7	2.1	73.1	20.8	40.8	3.9	0.0

During the survey, irrespective of the causal agent leaf spot disease incidence was recorded. However, in majority of the gardens surveyed Phyllosticta was found to be predominant whereas, *Colletotrichum* and *Pestalotiopsis* spp. were also noticed specially in Hosanagara Sagara and Thirthahalli taluks.

VII. EXPERIMENTAL RESULTS OF PALMYRAH

7.1. Crop Improvement

Palmy. / Gen.9 : 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.

Palmyrah germplasm fruit data collected in the year 2021

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).

Palmy., / Gen, 10: Survey, *In situ* characterization and conservation of Palmyrah germplasms for special traits.

Centres: KondaMallepally and Sabour

KondaMallepally

Nalgonda district of Telangana state is very popular for palmyrah palm. There is huge number of palms in the region and are being used for tapping since many years. To explore the diverse germplasm in the region, a survey was undertaken for collection of palmyrah germplasm from Nalgonda district with specific focus on dwarf types. A total of 30 accessions were collected in the survey from Ganugubelli, Gundrampally, Udthalapally and Ratnavaram villages in Nalgonda and Suryapet districts during the year 2019 and 2020. The data on unique traits of each accession were documented and are presented in the Table 1.

Among the accessions, Acc No. HRSTSK - 10 had recorded the highest neera yield (23.12 litres per palm per day) followed by Acc No. HRSTSK - 3 (21.37 litres per palm per day).

Table 1: Passport data particulars of palmyrah germplasm

ACC No.	Name of the village	Name of the Mandal	Source (Wild/ Farmers field)	Name of the farmer	Palm height (m)	Collar girth (m)	Leaf number	Male / Female	Average no. bunches / tree	Average no. Fruits / bunch	Average Neera yield / palm (litres)
	1	2	3	4	5	6	7	8	9	10	11
HRSTSK - 1	Ganugubelli	Nampally	Farmers field	KatamSrinu	7.40	1.40	9	Male	-	-	15.12
HRSTSK - 2	Ganugubelli	Nampally	Farmers field	KatamDevaiah	7.90	1.30	11	Male	-	-	10.12
HRSTSK - 3	Ganugubelli	Nampally	Farmers field	KatamSrinu	11.20	1.60	13	Male	-	-	**21.37**
HRSTSK - 4	Ganugubelli	Nampally	Farmers field	KatamNarsima	9.40	1.30	14	Male	-	-	16.37
HRSTSK - 5	Ganugubelli	Nampally	Farmers field	KatamNarsima	9.30	1.30	10	Female	6	14	17.87
HRSTSK- 6	Ganugubelli	Nampally	Farmers field	KatamVenkataiah	9.40	1.50	15	Female	6	16	16.50
HRSTSK– 7	Ganugubelli	Nampally	Farmers field	KatamVenkataiah	12.00	1.60	13	Female	5	16	14.25
HRSTSK– 8	Ganugubelli	Nampally	Farmers field	KatamSrinu	11.04	1.04	13	Female	6	14	17.87
HRSTSK-9	Gundrampally	Chandur	Wild(road side)	Near Katam Venkanna field	7.70	1.5	9	Male	-	-	11.12
HRSTSK- 10	Gundrampally	Chandur	Farmers field	KatamVenkataiah	10.20	1.30	10	Male	-	-	**23.12**
HRSTSK- 11	Udthalapally	Chandur	Farmers field	KaringRamesh	7.20	1.50	12	Male	-	-	13.62
HRSTSK - 12	Udthalapally	Chandur	Farmers field	KaringRamesh	6.40	1.20	10	Male	-	-	8.87
HRSTSK - 13	Udthalapally	Chandur	Farmers field	Cheemala Ramesh	5.00	1.50	13	Male	-	-	14.37
HRSTSK- 14	Udthalapally	Chandur	Farmers field	ChilumullaKondaiah	10.60	1.10	12	Male	-	-	15.25
HRSTSK - 15	Udthalapally	Chandur	Farmers field	KaringAnjaiah	9.80	1.30	10	Male	-	-	13.13
HRSTSK – 16	Udthalapally	Chandur	Farmers field	Cheemala Venkatesham	10.20	1.30	16	Male	-	-	15.88

HRSTSK – 17	Udthalapally	Chandur	Farmers field	SingamEdaiah	7.00	1.20	10	Female	7	12	18.13
HRSTSK – 18	Udthalapally	Chandur	Farmers field	KaringAnjaiah	8.05	1.77	15	Female	6	10	13.88
HRSTSK – 19	Udthalapally	Chandur	Farmers field	KaringRamesh	11.05	1.03	14	Female	4	16	8.88
HRSTSK – 20	Udthalapally	Chandur	Farmers field	KaringRamesh	13.60	1.22	13	Female	7	16	20.63
HRSTSK - 21	Ratnavaram	Nadigudem	Farmers field	Bellamkonda Venkateshwarlu	5.80	1.40	11	Male	-	-	11.13
HRSTSK-22	Ratnavaram	Nadigudem	Farmer field	Bellamkonda Ramaswami	8.00	1.5	9	Male	-	-	10.38
HRSTSK -23	Ratnavaram	Nadigudem	Farmer field	Bellamkonda Rambabu	3.8	1.1	12	Male	-	-	12.50
HRSTSK- 24	Ratnavaram	Nadigudem	Farmer field	GudipoodiNarsaiah	7.6	1.5	13	Male	-	-	9.75
HRSTSK– 25	Ratnavaram	Nadigudem	Farmer field	GudipoodiSrinivas	9.8	1.3	10	Male	-	-	7.62
HRSTSK- 26	Ratnavaram	Nadigudem	Farmer field	Ballamkonda Venkulu	6.2	1.2	8	Male	-	-	9.62
HRSTSK– 27	Ratnavaram	Nadigudem	Farmer field	MandavaVenkati	11.2	1.1	14	Male	-	-	12.25
HRSTSK–28	Ratnavaram	Nadigudem	Farmer field	Gudipoodi Venkateshwarlu	5.6	1.2	12	Male	-	-	9.87
HRSTSK-29	Ratnavaram	Nadigudem	Farmer field	MiryalaSrinu	11.4	1.2	10	Male	-	-	13.12
HRSTSK- 30	Ratnavaram	Nadigudem	Farmer field	MiryalaGuruswami	6.1	1.00	12	Male	-	-	10.25

Sabour Centre

The state of Bihar has a lot of potential for Palmyrah cultivation. Since time immemorial, the tappers (Pasi Community) have relied on the trees for their living. The trees are mostly used to produce and sell fermented neera and tuber-roots. In the years 19-20 and 20-21, a survey was conducted in the blocks of Bhagalpur, Banka, Patna, and Nalanda to record the germplasm with specific features, primarily a dwarf type. In the blocks inspected in Bhagalpur and Banka, no dwarf palmyrah trees were found, however in Nalanda and Patna, just a few dwarf palmyrah trees were observed. The tree was identified, numbered, and passport information was gathered. The tree height ranged from 5.4 to 6.5 metres in these germplasm. The number of leaves at the top varied from 8 to 12 and the collar girth varied from 1.28 to 1.67. In terms of neera yield, it was observed that it produced an average of 8.90- 18.11 lts/ day for only one and a half months during the season.

7.2. Crop Production

Palmy./Agron.23: Standardization of rooting media and containers for palmyrah (*Borassus flabellifer* L.) seedling production

The trial was initiated during the month of November 2020. The existing media viz., Soil, Sand, Farm yard manure, Vermicpost and composed coir pith were selected in 2:1:1 ratio and the four containers namely Black polythene bag (12.5 x 50cm), Bamboo tube (12.5 x 40cm), PVC tube (12.5 x 50cm) and Banana Pseudo stem sheath (12.5 x 50 cm) were used to the selected media by placing uniform seed weight of palmyrah seed as well as by dipping Imdia 6g/kg+ GA_3 1000MG/L to the treatmental requirements.

Table 2: Effect of media on growth and development of palmyrah seed and seedlings

Experiment I	Days taken for sprouting (days)	Percentage of germination (%)	Number of leaves / seedlings @ 210 DAS	Seedling height (cm) @ 210 DAS
T_1 –Soil (Control)+Imida 6g/kg+ GA31000mg/L	120	18	1	70
T_2– Soil + Scarification +Imida 6g/kg+ GA31000mg/L	110	25	1	85
T_3-Soil, sand and FYM mixed in 2:1:1 ratio + Imida 6g/kg+ GA31000mg/L	105	24	1	80
T_4-Soil, sand and vermicompost mixed in 2:1:1 + Imida 6g/kg+ GA31000mg/L	90	55	3	120
T_5-Soil, sand and poultry manure mixed in 2:1:1 Imida 6g/kg+ GA31000mg/L	102	30	1	88
T_6-Soil, sand and composted coir pith mixed in 2:1:1 + Imida 6g/kg+ GA31000mg/L	108	35	2	75
Mean	105.83	31.17	1.5	86.33
C.D (.05)	2.433	3.20	0.20	4.37
CV %	1.53	6.82	9.11	3.36
SEd	1.14	1.50	1.50	2.05

T_4-Soil, sand and vermicompost mixed in 2:1:1 + Imida 6g/kg+ GA31000mg/L taken less number days taken for sprouting (90 days) compared to other treatment and T_1 –Soil (Control)+ Imida 6g/kg+ GA31000mg/L taken 120 days for sprouting. In case of percentage of germination T_4 gave the highest germination rate (55%) while T_1 gave lowest germination rate (18%) compare to T_2 (25%) T_3 (24%), T_5 (30%) and T_6

(35%) respectively. T_4-Soil, sand and vermicompost mixed in 2:1:1 + Imida 6g/kg+ GA31000mg/L had a maximum seedling height of 120cm while those in the T_1 –Soil (Control)+ Imida 6g/kg+ GA31000mg/L had the lowest height at 70cm.with respect to container , T_1 –Black polythene bag (12.5 x 50 cm) gave the highest germination rate (52%) followed by T_2-Bamboo tube(12.5 x 50 cm)at 33%, and T_3-PVC tube (12.5 x 50 cm) at 30%. Similarly t_1 –Black polythene bag (12.5 x 50 cm) recorded maximum seedling height of 125 cm followed byT_2-Bamboo tube (12.5 x 50 cm) 85 cm.

Pandirimamidi

Among the rooting media combinations Soil, sand and vermicompost mixed in 2:1:1 Ratio (T3) and T6 (coir pith) recorded the lowest number of days taken for sprouting (89) whereas highest number of days (106) is recorded in the control (Table 48). Among the treatments highest percent of germination (84) recorded in T4 and lowest in control (67). The more seedling height (63 cm) is recorded in T3 followed by T6.

Among the containers used for nursery planting, lowest number of days(89) taken for the sprouting in polybags whereas highest number of days taken for sprouting (110)in Bamboo tubes which are significantly different (Table 49). Highest per cent of germination of stones (79) is recorded in poly bags (T1) followed PVC tube (61) which are significantly different. Lowest germination is recorded in bamboo tube (38).

Sabour :

The response of different soil mixture and container was evaluated. The germination response in "black polybag", the soil mixture (soil+Sand+Vermi Compost) in the ratio of 2:1:1 (T_4) resulted in 80% germination at 210 DAS. On the contrary T5 & T_6 i.e. the Soil mixture with Poultry manure and composted coir respectively had 50% germination at 210 DAS. In Case of plastic (PVC) pipe all the treatments except T_2 & T_6 i.e. the soil mixture with sand and composted Coir respectively in the ratio of 2:1:1 had germinated at 210 DAS. However with a period of time almost all the seeds germinated in both the containers. The no. of leaves were found to be highest (showing the vigour) in treatment T_3, T_4&T_5 in case of black polythene bag whereas it was highest in treatment T_2, T_3, T_4, T_5&T_6 in PVC pipe with a maximum length of 100 cm. and above, observed at 330 DAS.

7.3. Post Harvest Technology

PHT-1 Standardization and Commercialization of Inflorescence Sap Extraction and Inflorescence Sap Based Products (Jaggery, Palm Sugar and Candy)

Pandirimamidi centre

Inflorescence sap (Neera) collected through CPCRI cool box method processing by pasteurization followed by PET bottle packing and sterilization gives maximum shelf life of 30 days under refrigerated conditions. With sodium benzoate of 0.1 % gives 30 days under room temperature and 120 days at refrigerated conditions (Table 3).

Table 3: Shelf life of neera at different conditions

Particulars		Fresh sap	Lime added
Room temperature	5- 6 hrs	24 hrs	
Refrigerated	12 days	15 days	
SB			
100 ppm		14 days	20 days
500 ppm		20 days	20 days
1000 ppm		30 days	30 days
Sap at deep freezer with 1000 ppm SB more than 120 days.			

Konda mallepally centre

Sap collected through both CPCRI method and traditional pot method with lime and observations as follows. pH was found to be neutral (7.0) in the neera collected in the CPCRI pot and maximum TSS (12 ^{0}B) was recorded in CPCRI pot (Table 4).

Table 4 Quality characters in different neera collection pots

S. No.	Quality characters	Traditional method (clay pot)	CPCRI Neera collection pot
1	P^H	7.60	7.00
2	TSS (^{o}B)	10	12

Pandirimamidi centre

Freeze drying of inflorescence sap was taken up with different concentration of maltodextrin for developing of powder at low temperature (-60°C) and successfully developed the same and the powder had excellent aroma and taste, but shelf life at room temperature is poor and as compared to fresh neera, reconstituted neera prepared by re-dissolving the powder in water, shows no loss of reducing sugars (Table 5). Further studies is in progress The transformation of palmyrah neera into a dry powder by freeze-drying seems to be a useful technique for the preparation of reference materials. The powder obtained is highly hygroscopic and is to be dried below a critical moisture level, and the subsequent exposure to humidity of air has to be restricted to obtain long-term stability.

Table 5 Properties of freeze dried palmyrah sap powder*

Malto dextrin %	Sap powder (%)	Solubility (%)	m.c (%w.b)	pH	TSS, °Brix
0	9.5	97.37	5.26	7.1	10
2.5	10.75	95.35	6.98	7.2	11.5
5	12	93.75	4.17	7	14
7.5	13	92.31	3.85	7.1	16.5
10	14.5	89.66	3.45	7.2	17

Anti fermenting solutions from herbal based was tested for various plant based and found that Jack tree bark based herbal formulation gives positive results to arrest the fermentation in the place of lime for collecting Neera,

PHT-2: Standardization of Tuber Flour Based Food Products (Like Pizza, Bakery items, confectionery, health mix etc.)

HRS Pandirimamidi

Composite flour (CF) was formulated and prepared by mixing 50% palmyrah tuber flour, 25% wheat and 25% millets, effect on dough making and baking qualities. Shelf life studies conducted with packaging materials like LDPE, HDPE and metalized polyester showed no infestation after 60 days in all packaging and flour can be stored in metalized polyester up to 180 days.

PHT-4 Standardization of Preservation Technique for Palmyrah Tender Fruit Endosperm

Pandirimamidi

Shelf life of tender fruit endosperm was evaluated with various brix of sap. Nungu kept in brix of 20 %, and 30 % under refrigeration condition can be stored up to 2 months with slight colour change after 11 months. However, the sweetness was retained.

PHT. 5: Popularization of climbing device

Pandirimamidi

The training on climbing devices (Joseph model) was conducted for tappers during the neera tapping in the month of January to March 2021. The feedback from the climbers was collected which indicated that skilled climbers were not showing interest in climbing device and only young people and unskilled persons have shown interest in climbing device. People suggested some modification to fit to girth of the Palmyrah and same was discussed with manufacturers for modifications. Further studies are in progress to improve the climbing device to suit palmyrah palm.

Kondamallepally centre

The climbing device (Joseph model) were procured to give training to the youths and training programme conducted in the month of March, 2021 and data collected is presented in Table 6.

Table 6: Data on traditional method climbing and Joseph model climbing device.

S. No.	Particulars	Traditional method	Joseph Model device
1	Time taken to climb each tree	3 minutes	10 minutes
2	Ease of the climbing (Easy, Tough)	Easy	Tough
3	Safety features (Good, Average, Poor)	Average	Poor

Sabour centre

The Joseph model of climber was procured in the last year and were used for climbing a palmyrah-tree in a meeting with about 28 local youth farmers. The difficulties in climbing the palmyra tree was felt again. It was concluded that without the correction/ modification, it is not possible to climb and come down on a palmyra tree as the machine is designed for the coconut in which the stumps are found smooth and of the same girth from the bottom to the top of the tree.

PHT. 6: Evaluation of Palmyrah tender fruit processing machine developed by CIAE centre. Pandirimamidi

Palmyrah Endosperm Remover was received from CIAE regional centre, Coimbatore in the month of June 2020 and evaluated for endosperm removal for consumption. The machine was compared with manual extraction of endosperm. Palmyrah Endosperm Remover is manually operated with one person.

The young fruits of 50 numbers collected from germplasm block of HRS Pandirimamidi. The endosperm was collected by both traditional practice as well as manual operated Palmyrah Endosperm Remover.

Time taken for endosperm removal (seconds)				Whole endosperm (Nos)		
	Mean	SD	CV	Mean	SD	CV
Traditional practice	43.76	2.86	0.07	1.10	0.86	0.78
CIAE machine	37.70	2.51	0.07	2.26	0.85	0.38

Time taken for Endosperm removal from fruit was 37.70 seconds for using CIAE manually operated machine and in case of traditional practice it was 43.76 seconds. Endosperm damage or cutting is less by using machine as compared to traditional practice. It is also observed that drudgery was reduced by using the machine. Safety is 100 percent as compared traditional practice and unskilled person can operate the machine, where as traditional practice only skilled person can do. Recovery of whole endosperm is 2.26 using CIAE machine where as only 1.10 for traditional practice.

VIII. EXPERIMENTAL RESULT S IN COCOA

8.1. Crop Improvement

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

Expt. 1: Performance of cocoa varieties/ hybrids as intercrop in coconut garden

Centers: Ambajipeta, Veppankulam and Kasaragod.

Ambajipeta

To evaluate the suitability of cocoa varieties/ hybrids as intercrop under coconut, six varieties/ hybrids were planted as intercrop in coconut during 2008-09. There was no significant difference among the cocoa lines with regard to girth, height at first branching and canopy spread (Table 1). Plant height and stem girth was maximum in VTLCH-2 (314.70 cm and 42.71 cm respectively). With respect to yield for the year 2020-21, VTLCH-2 recorded significantly higher dry bean 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) which was at par with VTLCH-4 (42.10). Single dry bean yield was maximum in VTLCH – 2 (1.23 g) which was on a par with VTLCH-4 (1.14 g)

Table 1: Performance of cocoa clones for growth and yield parameters:

Clones/ varieties	Plant height (cm)	Girth (cm)	Height at 1st branching (cm)	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	282.29	37.48	73.48	403.50	40.40	32.75	1.01	1.14
VTLCH – 1	301.35	38.67	76.79	411.25	39.05	37.83	1.05	1.36
VTLCH – 2	314.70	42.71	79.35	490.00	45.60	46.00	1.23	2.13
VTLCH – 3	274.04	38.44	72.36	412.50	40.44	35.58	1.07	1.31
VTLCH – 4	299.41	39.28	62.97	443.00	42.10	39.41	1.14	1.65
VTLC-1	300.53	37.58	66.03	324.25	39.88	38.58	0.96	1.28
S Em ±	12.40	1.98	10.03	31.63	1.36	2.59	0.03	0.12
CD at 5%	NS	NS	NS	95.34	4.11	7.82	0.10	0.36

Veppankulam

Six clones/ hybrids are being evaluated as intercrop in coconut for yield and quality of cocoa from 2008 at CRS, Veppankualm. The observations on economic traits are presented in Table 2. 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 yield was higher in VTLCH 1 (1.81 kg/tree) which was significantly different from other clones evaluated except VTLCC1 (1.66 kg/tree). The single dry bean weight was significantly higher (1.97 g) in CTLCH1 over all other clones.

Kasaragod

Performance of thirteen cocoa clones/ seedlings was evaluated as intercrop in 54 year old WCT coconut garden in RBD with two replications since 2007-08. The data on mean pod yield (7 years) showed that higher number of pods was recorded in VTLCH2 (46.7 and 39.3 pods for clone and seedlings progeny, respectively) followed by VTLCH 1(401.1 and 40.4 pods) and VTLC 5 (33.0 and 41.3) Similarly data on mean dry bean yield showed that higher dry bean yield was recorded in VTLCH 2 among plants raised from grafts and seeds. Impact of cocoa intercropping on coconut yield was studied and the results revealed

Table 2: Economic traits of cocoa clones at Veppankulam

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

that coconut yield was increased (10.62) % over pre treatment yield.

Expt. 2: Multi-location trial (MLT) of cocoa clones under palms

Centres: Aliyarnagar, Kahikuchi, Ratnagiri and Vijayarai

Aliyarnagar

A total of 13 numbers of cocoa clones/ hybrids along with one check variety (VTLC-9) were established as intercrop in coconut during 2013-14 at a spacing of 3.75 m × 7.50 m with two replications and six cocoa plants per genotype. Data pertaining to the yield and yield components (Table 3) showed 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 yield per plant (2.1 kg) followed by VTLCP-15 which has recorded 1.8 kg dry bean yield plant^{-1}.

Table 3: Yield and its attributes of cocoa clones under palms at Aliyarnagar centre

Clones/ varieties	No of pods/tree	Average pod weight (g)	No. of beans/pod	Pod yield (kg /plant)	Single dry bean weight (g)	Dry bean weight /plant (kg)
VTLCP-1	38.9	415.9	32.8	15.6	1.2	1.4
VTLCP-3	30.4	381.4	36.7	10.8	1.1	1.5
VTLCP-5	36.4	394.2	29.5	13.4	1.0	1.3
VTLCP-6	32.5	396.4	33.8	11.2	1.0	1.0
VTLCP-8	28.9	432.7	35.9	11.8	1.2	1.3
VTLCP-9	34.7	430.8	37.1	13.5	1.3	1.6
VTLCP-10	31.5	450.4	36.4	13.6	1.0	1.3
VTLCP-11	38.9	374.8	33.5	13.2	1.1	1.6
VTLCP-12	36.7	452.8	30.8	15.4	1.2	1.3
VTLCP-13	33.4	444.6	31.9	13.7	1.3	1.2
VTLCP-14	32.8	425.9	34.7	13.2	1.1	1.3
VTLCP-15	39.7	**486.1**	38.9	17.8	**1.4**	**1.8**
VTLCP-16	**45.8**	461.8	**41.7**	**19.2**	**1.4**	**2.1**
VTLC-9 (Control)	32.8	375.9	30.4	12.1	1.0	1.2
SEd	1.6	6.2	1.0	0.6	0.02	0.04
CD (P=0.05)	3.4	13.6	2.2	1.4	0.04	0.1

Kahikuchi

Out of 16 cocoa clones grown as intercrop in coconut garden during 2015-16, the highest plant height (288.0 cm), stem girth (37.8 cm), Jorquette height (0.8 m), plant spread (E-W and N-S) and canopy area (8.95 m^2) were recorded during 2020-21 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 maximum no. of pod/tree (39.0), no. of bean/pod (41.8) and dry bean yield/tree/year (2.28 kg) as against the lowest under EYT (Table 4.

Table 4: Yield attributing characters and yield of cocoa clones and hybrid in coconut garden

Clones/ varieties	No.of pods/ tree/year	Weight ofpod (g)	Wt. of single dry bean (g)	No. of beans/pod	Dry bean yield (kg/tree)
VTLC-13	32.0	397.5	1.1	34.1	1.20
VTLC-15	30.1	391.6	1.1	32.8	1.08
VTLC-17	31.0	406.0	1.2	35.2	1.30
VTLC-18	33.2	460.0	1.2	38.8	1.55
VTLC-20	**39.0**	**492.0**	**1.4**	**41.8**	**2.28**
VTLC-23	29.5	375.0	1.2	38.0	1.34
VTLC-25	30.0	370.3	1.1	36.0	1.18
VTLC-28	28.3	350.0	1.1	35.0	1.09
VTLC-36	30.0	370.5	1.0	35.6	1.07
VTLC-38	28.4	330.4	1.2	36.0	1.21
VTLC-39	31.0	328.0	0.98	34.0	1.03
VTLC-40	32.0	384.8	0.99	37.5	1.19
VTLC128	34.6	410.6	1.0	36.4	1.25
VTLC-4A	29.0	398.5	1.1	34.6	1.10
VTLCH-1	31.1	388.5	1.1	37.0	1.27
EYT	28.2	327.0	0.97	32.0	0.88
S.Em±	1.15	9.42	0.05	0.58	0.17
CD(P=0.05)	**2.43**	**19.81**	**0.11**	**1.22**	**0.35**

Ratnagiri

The experiment was initiated during 2012 in coconut (D x T) to evaluate performance of 21 cocoa clones. The growth and yield attributing characters of cocoa and coconut are recorded and result revealed that at the age of 8th year the clone VTLC-17 has recorded highest plant girth 29.60 cm with height of 2.65 m., 8.38 M^2 canopy area. The same clone has produced highest pod yield (26.14/ tree), single dry beans weight (1.22 g), and there were 58.24 beans per pod, with a dry bean weight of 1.1 kg $tree^{-1}$.

Table 5: Yield performance of cocoa clones under coconut palms

Clones/varieties	No. of pods/ tree/year	Weight of pod (g)	Weight of single dry bean (g)	No. of beans/pod	Dry bean yield (kg/tree)
VTLC – 1	7.21	368.10	56.88	1.01	0.510
VTLCP – 3	6.25	226.12	23.24	0.98	0.390
VTLC – 13	7.24	210.14	31.22	1.11	0.570
VTLC – 15	21.25	346.50	52.24	1.16	0.940
VTLC – 17	26.14	386.20	58.24	1.22	1.010
VTLC – 18	14.25	374.12	55.16	1.04	0.714
VTLC – 25	11.20	378.10	52.17	1.08	0.708
VTLCP –8	14.25	372.00	52.47	1.22	0.614
VTLC – 37	8.26	356.10	50.22	1.14	0.622
VTLCP – 6	11.25	382.16	52.20	1.04	0.824
VTLCP – 10	12.70	375.22	56.70	1.08	0.828
VTLC – 128	16.20	394.12	62.26	1.07	0.838
VTLCP – 9	15.25	372.18	57.26	0.99	0.756
VTLCP- 1	11.20	209.14	31.20	1.05	0.744
VTLCP – 5	12.40	395.20	53.22	0.76	0.812
VTLCP – 16	22.26	391.20	54.00	0.96	0.890
VTLCP –14	11.25	361.27	52.20	1.03	0.792
VTLCP –11	17.28	362.24	53.25	1.14	0.814
VTLCP –12	6.25	210.18	34.28	0.95	0.477
VTLCP – 15	12.20	381.29	55.89	1.16	0.864
VTLCP – 13	14.10	367.81	50.76	0.98	0.625
Mean					
S Em±	4.95	48.22	8.31	0.04	0.228
CD at 5%	14.86	144.67	24.86	NS	0.681

Vijayarai

The evaluation was initiated in adult oil palm garden during 2012-13. Among the 12 varieties and 2 hybrids evaluated, there were no significant differences for all growth and yield characters during 2020-21 (Table 6).

Expt. 3: Establishment and maintenance of polyclonal garden for the production of quality planting material

Thrissur

Establishment of clonal garden

Clonal gardens are established by planting better combiners in a specified manner for the mass production of genetically improved seeds. Ninety percent of India's cocoa plantations are established with seed material produced from Cocoa Research Centre, Kerala Agricultural University, Vellanikkara. KAU maintains one biclonal garden and nine poly clonal gardens. Details are given in Table 7.

Vegetative multiplication of genotypes for establishing polyclonal garden

Varieties were budded and kept in nursery to establish a new polyclonal garden and distribution to other institute for establishing polyclonal gardens. Out of 1000 plants budded, 818 were successful.

Maintenance of existing clonal gardens

Clonal gardens are maintained by regular irrigation (Once in 5-7 days during dry period), fertilizer application (Irrigated: 4 times (April- May, Sept- Oct, Dec & Feb), measures for managing pest and diseases on need basis, weed management at

Table 6: Growth and yield parameters of clonal varieties and hybrids of cocoa intercropped in oil palm

Clones/ varieties	Stem girth (cm)	Canopy area (m^2)	Number of pods per plant	Average pod weight (g)	Pod yield/ plant (kg)	Number of beans per pod	Average bean weight (g)	Dry bean yield(kg/ plant)
VTLC-1	33.82	17.14	9.51	286.66	2.70	43.50	0.97	0.41
VTLC-9	36.69	16.14	20.60	483.33	10.75	36.25	1.37	1.06
VTLC-13	40.02	16.91	24.45	443.33	10.17	41.75	1.17	1.29
VTLC-17	32.41	14.85	18.08	512.50	9.22	38.50	1.35	1.05
VTLC-18	33.41	14.21	27.33	332.50	9.34	37.25	1.24	1.25
VTLC-20	33.42	15.59	15.16	473.33	7.12	47.25	1.27	0.91
VTLC-25	33.57	16.14	18.87	470.83	8.15	48.50	1.43	1.34
VTLC-36	34.69	15.53	7.80	420.00	3.31	45.50	1.35	0.49
VTLC-37	33.88	14.92	14.41	292.50	4.19	40.75	1.02	0.61
VTLC-57	40.29	17.76	42.67	360.83	15.31	37.50	0.95	1.51
VTLC-65	35.27	16.51	25.37	315.00	8.22	39.00	1.03	1.17
VTLC-128	35.90	14.98	17.66	372.50	6.79	40.75	1.32	1.07
VTLCH-3	30.52	13.34	10.62	439.16	4.62	41.50	0.91	0.40
VTLCH-4	31.65	15.80	11.96	505.00	5.69	39.00	1.26	0.6
CD (5%)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
S.Em(±)	0.89	0.37	2.87	25.20	1.07	1.19	0.05	0.11
CV (%)	9.75	15.18	67.93	18.85	59.81	10.14	15.4	81.68

Table 7: Cocoa clonal gardens of KAU, Thrissur

Garden	No. of parents	No. of plants	Year of planting
Polyclonal garden I	12	120	1989
Polyclonal seed garden II	38	228	1993
Biclonal Seed garden	6	1243	1996
Polyclonal Seed garden III	5	100	2000
Polyclonal Seed Garden IV	8	1100	2005
Polyclonal Seed Garden V	7	946	2006
Polyclonal Seed Garden VI	10	400	2010
Polyclonal Seed Garden VII	6	286	2010
Polyclonal Seed Garden VIII	8	299	2014
Polyclonal Seed Garden IX	5	178	2016
Polyclonal Seed Garden X	**6**	**139**	**2020**
Total	**105**	**5039**	

Table 8:Budding details of varieties

Sl. No.	Variety	No. of plants budded	Successful bud take
1.	CCRP 4	100	80
2.	CCRP 5	200	170
3.	CCRP 6	50	40
4.	CCRP 7	100	85
5.	CCRP 8	100	89
6.	CCRP 9	100	78
7.	CCRP 11	100	86
8.	CCRP 12	100	77
9.	CCRP 13	50	39
10.	CCRP 15	100	74
	Total	**1000**	**818**

required intervals, harvesting at pod maturity. Management of pests and diseases for budded plants in nursery is by regular spraying with insecticides and fungicides.

Expt. 4: Establishment, maintenance and evaluation of polyclonal cocoa clones in oil palm gardens

Vijayarai

Fourteen Cocoa clones namely VTLC-5, VTLC-7, VTLC-8, VTLC-9, VTLC-10, VTLC-11, VTLC-15, VTLC-19A, VTLC-30A, VTLC-61, VTLC-63, VTLC-65, VTLC-66, VTLC-68 obtained from CPCRI, RS, Vittal were planted in RBD with three replication in 27 years old oil palm garden, in August 2017. Trial was well maintained with recommended fertilizer application under drip irrigation. Pruning was done twice a year in the month of June and September-October months.

IX. MONITORING REVIEWS AND MEETINGS

Monitoring Reviews Monitoring Reviews

Due to rampant COVID-19 pandemic situation in all around the country, the project coordinator has made review meetings to monitor the technical programmes, budget utilization and progress of the projects of all the centres as per the need through virtual 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 the scientists of ICAR-AICRP on Palms for the smooth functioning of the research programmes. During review meeting, PC has given guidelines to proper utilization of budget, publications and improving the technical programmes.

Meetings

30th Annual Group Meeting of All India Co-ordinated Research Project on Palms

The 30th Annual Group Meeting of All India Co-ordinated Research Project on Palms organized by Central Plantation Crops Research Institute, Kasaragod through virtual mode was inaugurated on November 22, 2021. Dr.B.K.Pandey, Assistant Director General (Horticultural Sciences II), ICAR, New Delhi was the Chief Guest of the event. Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi and Dr. Eaknath B. Chakurkar, Director, ICAR- CIARI, Port Blair participated in the Inaugural Session. Dr. Anitha Karun, Director and Project Co-ordinator (Acting), CPCRI, Kasaragod welcomed the dignitaries and delegates in which she applauded the unstinted support rendered by the Deputy Director General (Horticultural Sciences) and the Assistant Director General (Hort. Sci. II) for the progress of the AICRP (Palms) scheme by providing first hand information on diverse arena. She presented the report of the AICRP (Palms) for the year 2020-2021. The action taken report of the recommendations of the AGM held on 10th – 11th August 2020 was presented by Dr Ravi Bhat, Acting Head (Crop Production) and Scientist In Charge, PC Cell. The Assistant Director General (Horticultural Sciences) in his inaugural address suggested bringing out a publication on "Fifty Years of AICRP (Palms)" on the eve of Golden Jubilee Celebrations of the AICRP (Palms). He envisaged the need for the collection, conservation and evaluation of trait specific germplasms devoid of duplicates, enhancing input use efficiency with special reference to micronutrients, identification of alternatives for red labelled chemicals towards hassle free plant protection and demonstration of cutting edge research technologies to the farm front through KVKs of the states and digitization of data for easy reference by the scientists. He appreciated AICRP (Palms) centres for the exemplary work and wished the Palm Scientists to reach the pinnacle of success on technological platform. Development of T x T coconut hybrids, coconut based multispecies cropping system, location specific Integrated Farming System models, management of stem bleeding disease in coconut through *Trichoderma harzianum* and *T.reesei*, technology capsule for the management of Rugose Spiraling Whitefly in coconut, integration of coriander in arecanut system, bioagents for the control of crown choke disease in arecanut and identification of best performing cocoa clones *viz.*, VTCH -2, 16, 20, 17 and 4 for intercropping in coconut gardens are the noteworthy contributions made during 2020. Effective Transfer of Technology from lab to land through diverse tools and modes and need based diagnostic field visits despite COVID curfew remain the major strength of this programme. Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi invited researchers to explore alternative pesticides, to develop cropping systems approach and to enhance resource use efficiency in cropping systems. Dr E. B. Chakurkar, Director, ICAR-CIARI, Port Blair appreciated the work of Palm Scientists and requested them to come out with location specific farming system models which can double the income of small and marginal farmers. About 72 participants from different AICRP centres and ICAR-CPCRI were connected through virtual mode. The crops experts also provided their valuable suggestions / recommendations for further improving the efficacy

of the AICRP on Palms. The detailed progress made during 2020-21 was presented and the technical programmes for coming year (2021-2022) were finalized during the meeting. The inaugural session was followed by technical sessions on genetic resources and crop improvement, crop production, crop protection, post harvest technology and transfer of technology.

30th Annual Group Meeting of All India Co-ordinated Research Project on Palms

Following technologies have been recommended to farming community

- Site Specific Nutrient Management with secondary ($CaSO_4$. $2H_2O$ – 1 kg and $MgSO_4$ – 500 g per palm per year) + Micronutrient mixture ($FeSO_4$, $MnSO_4$, $CuSO_4$, $ZnSO_4$, Borax and ammonoium molybdate) @ 1 kg per palm per year + Coconut frond mulching + *Azospirillum* – 100 g + *Phosphobacteria* - 100 g + VAM -100 g per palm per year enhanced productivity by 32 % over farmers' practice in Tender nut variety Chowghat Orange Dwarf. Net Returns and Benefit cost ratio were Rs. 4.38 lakhs per ha and 2.99 in INM package as against Rs. 3.10 lakhs per ha and 2.66 in farmer's practice respectively.
- 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.
- Burmese coriander is a popular herb grown in the Andaman and Nicobar Islands. The herb was grown as an intercrop in bearing arecanut palms of variety Samrudhi to study the profitability of this herb as an intercrops in the warm humid tropical conditions of South Andaman Island. Results suggested that introduction of Burmese coriander in the interspaces could give higher net returns of Rs. 13,03,065/- as against Rs. 9,59,600/- in the arecanut sole crop. The B:C ratio of this treatment was found to be 3.19 and hence, it could be recommended for the island farmers.
- Due to Covid 19 pandemic, reviewed the progress made in the implementation of the research projects allotted to the respective centres through limited visit and virtual mode.

S.No	Date	Details of the review meeting
1	23.4.2021	Review meeting of All AICRP coconut centres through zoom at 11.00 AM to 01.00 PM
2	20.7.2021	Review meeting of All AICRP oil palm, palmyrah, arecanut and cocoa centres through zoom at 11.00 AM to 01.00 PM
3	4.8.2021	AICRP on Palms and HRS, Ambajipeta conducted a web based training program on the mass production of *Apertochrysa astur* for other AICRP (Palms) centres on 04.08.2021
4	22.10.2021-23.10.2021	Preliminary review meeting for 30th AGM (All AICRP centres) through zoom meeting
5	17.12.2021	Technical programme review meeting for Pest and Disease
6	29.12.2021	Review meeting of All AICRP centres through zoom

X. EXTENSION, POPULARIZATION OF TECHNOLOGIES

Aliyarnagar

Training programme for farmers

Training programmes were organized for farmers on various aspects of coconut cultivation and production in different districts of Tamil Nadu. A total of 10 trainings were organized benefitting 500 farmers.

Farmer's training on RSW in coconut

System Demonstrations on Exposure Visits

Training programme organized for extension personnel

Date	Topic of training	Number of extension personnel trained
05.01.2021	Integrated Nutrient Management in Coconut	40
02.02.2021	Integrated Nutrient Management in Cocoa	50

Research - Extension - Farmer interface programme

28 Research - Extension - Farmer interface programmes were conducted on different aspects of coconut cultivation in coordination with Farm produce organization, ATMA SEEPERS, Department of agriculture benefitting 1060 farmers.

Training programme organized for SCSP farmers

S.No,	Date	Place	Name of the training programme	Beneficiary
1.	09.01.2021 13.01.2021 27.2.2021 13.3.2021 17.3.2020 18.9.2021	Nagaruthu I Angalakuruchi Thampampathy Saralapathy Gopalpathy	Coconut cultivation and production	150 Nos

Distribution of Inputs under SCSP

Nearly 500 farmers from the major coconut growing districts of Tamil Nadu *viz.*, Coimbatore, Tiruppur, Erode, Dindigul, Salem, Namakkal, Tirunelveli, Thiruvannamalai and Kanyakumari were enlightened on the following aspects on their exposure visits under Agricultural Technology Management Agency (ATMA) scheme of the State Department of Agriculture to Aliyarnagar centre

1. Field performance of coconut varieties and hybrids
2. Management of coconut nursery to obtain elite seedlings
3. High Density Multi Species Cropping with cocoa, banana and pepper
4. Goat based Integrated Farming System (Fodder grass trial, Slated Goat Shed)
5. Residue recycling through trenches and composting techniques
6. Fertilizer application to palms
7. Rugose Spiraling Whitefly - Symptoms and their management
8. Traps for insect and non-insect pests of coconut
9. Application of biocontrol agents *viz.*, *Bacillus* and *Trichoderma*

Radio / TV programme/ press media

A total of 10 press coverages were made on RSW and root (wilt). Coconut Scientist and farmers interaction on RSW was broadcasted.

Publication of extension literature

Technology highlighted and title of publication	Type of extension publication
Integrated disease management in Coconut	Booklet - 24 pages
Rugose spiraling whitefly in coconut	Folders - 6 pages
Drip fertigation in coconut	Folders - 6 pages

Ambajipeta

Training programmes

- Scientist from the centre has participated in Rythu Sadassu conducted at KVK, VR Gudem, P. Gannavaram (V) of East Godavari district jointly organized by Assistant Director of Agriculture, P. Gannavaram, Horticulture department, Amalapuram and ADH, Veterinary, P. Gannavaram. Lectures on Seasonal crop condition of coastal zone – I and Management of Rugose Spiraling white fly in plantation crops were delivered.

Technology Demonstration

Field demonstrations were conducted for effective transfer of developed technologies on various aspects of coconut to create awareness among farmers. Demonstrated entomo pathogenic fungus (*Isaria fumasorosea*) spray against Rugose spiralling whitefly on coconut, Rugose spiralling whitefly infestation, symptoms and parasitoid release technique of *Encarsia guadelopae* and paste application of *Trichoderma reesei* against stem bleeding disease. A total of 350 farmers were benefited.

Sl.No	TOT	No. of Programmes	No of Participants
01	Training programme for farmers & Extension functionaries	35	890
02	Demonstrations conducted	26	542
03	Facilitating farmer producer organisations (FPOs)	18	353
04	Linkage with the District KVK and ATMA/RBK	05	83
05	Conducting exhibitions	03	760
06	Popular article published	06	—
07	Press coverage	43	—
08	Television programme presented	01	-

Field demonstrations

Scientist from the centre has participated in five training programmes organized by various bodies like KVK, NABARD and NIPHM as resource person. The farmers interacted on various aspects viz., recent advances in coconut, IPM on coconut, integrated crop management in coconut, pest and disease management in coconut.

Arsikere

Training programmes organized

Sl. No	Training on	Date & Place	Number of participants
1	Integrated nutrient management in coconut	11-1-2021	60
2	Vermicompost production	18-1-2021	36
3	Value addition in coconut	25-1-2021	23
4	Integrated pest management for Rugose spiralling whitefly in coconut	28-1-2021	50
5	Integrated disease and pest management in coconut	19-2-2021	60
6	Use of coconut climbing machine	9-3-2021	50
7	Importance of honey bee in plantation crops	22-5-2021	30
8	Pre monsoon cultivation practices in coconut	24-6-2021	40
9	Integrated management of Rugose spiraling whitefly in coconut	20-9-2021	36
10	Honey bee rearing and value addition in honey	26-10-2021	50

Diagnostic field visits/ consultancy

Diagnostic field visits/ consultancy by Scientists

Field visit/ consultancy		Problems identified and solution given on
Field visits:	22	· Moisture conservation in coconut · Intercropping in coconut · Drip irrigation in coconut · Nutrient management in coconut · Pest management in coconut · Disease management in coconut · Varieties of coconut · Planting method in coconut
Through Phone:	321	
Farmers visit to HRES:	112	

h) Presentation in radio and TV programme

Sl.No.	Date	Technology highlighted	Place
1	9-2-2021	Advance production technology in coconut	AIR, Hassan
2	17-6-2021	Cultivation practices coconut	AIR, Hassan

Demonstration of technologies

Field demonstrations on root feeding with Hexaconazole for control of basal stem rot disease in coconut, release of Goniozus parasites, root feeding with Azadirachtin and Vermicompost production were conducted.

Bhubaneswar

Training programmes

Organized training programmes on "Livelihood improvement through integrated coconut farming" and "Coconut farming for more profit" at the centre benefiting 104 farmers. Organized exposure visit of 50 farmers at the centre to enlighten about the technologies developed.

Training progaramme organized at Bhubaneshwar

Women empowerment activity

Conducted demonstration on Coconut Production Technology to empower women in horticulture sector and to create awareness about coconut cultivation and 120 members of women self help groups were benefited.

Distribution of inputs to farmers under SCSP

Goa

Centre has involved in four farmers field visit to diagnose problems in Arecanut as well as Coconut. Demonstrated coconut climbing device at Priol village under SCSP programme. World coconut day was celebrated.

Kahikuchi

Training programmes

Training programmes on Production technology & management practices in coconut and arecanut, improved production technology in coconut, nursery management and production technology of coconut, and Nutrient management and recycling of coconut waste were organized benefitting 300 farmers.

Linkage with the District KVK and ATMA

Name of KVK/ATMA	Nature of linkage established	Technology highlighted
1.KVK, Puri , Sakhigopal 2.KVK,CIFFA, Bhubaneswar 3.ATM ,Ganjam	Training programme and FLD	Production technology of coconut, Coconut based cropping system and value addition in coconut

Date	Topic of training	Number of farmers trained
20.01.2021	Production technology & management practices in coconut & arecanut	50
26.02.2021	Nursery management & production technology of coconut	50
08.04.2021	Improved production technology in coconut	50
17.06.2021	Nutrient management & recycling of coconut waste	50
24.09.2021	Raising of coconut and arecanut nursery	50
02.10.2021	Production technology & management practices in coconut	50

Training programme organized for extension personnel

Training on 'Urban Agriculture (by-product, value addition & management of Fruits & Spices') was conducted in which around 50 numbers of agriprenuers from different districts of Assam were beneficiaries.

Women empowerment activities

Topic of training/demonstration	Total no. of members of women self help group benefited
Skill development in Horticulture for women of SC category i) Nursery raising & management	50

Training programme at Kahikuchi

Research-Extension-Farmers interface programme

Date	Theme of interface programme	Agencies involved	No. of participants
15.09.2021	Zonal Research and Extension Advisory Committee Meeting	HRS, Kahikuchi,KVKs of LBVZ of Assam, RARS, Gossaigoan, State Dept. of Agriculture	150

Linkage with District KVK and ATMA

Name of the KVK/ATMA	Nature of linkage established	Technology highlighted
KVK Kamrup& ATMA Kamrup	i) Conducting FLDs in the farmers field & World Coconut Day in collaboration with the KVK(Kamrup)ii) Acted as a resource person in training conducted by ATMA	i) Coconut based cropping systemii) INM & IPM in coconutiii) Cultivation technique & management in coconut

Killikulam

Organising training programme for farmers

Name of the FPO	Major activity of FPO supported by AICRP	No of farmers benefited
Tirunelveli district palm produce co operative federation	AICRP and EDII	25

Research - Extension - Farmer interface programme conducted

Date	Theme of interface programme	Agencies involved	No. of participants
21.09.2021	Nursery techniques for palmyrah	Kurunkulam Department of Horticulture	22

Conducting exhibitions

Title of exhibition	Venue	Organized by	No. of farmers / Stakeholders benefited
Palmyrah production and value addition	Thalai vassal, Salem District, Tamil Nadu	TNAU, Coimbatore	250

Navasari

Training programmes

Date	Topic of training	Number of farmers trained
09-08-2021	One day virtual National level webinar on "Recent Advances in Production Technology and Value Addition of Coconut"	174 participants from 23 different states
02-09-2021	Celebration of World Coconut Day by organizing training on 'Value addition and making of articles from coconut fibre'	60 farm women's

Training programme at Navasari

Pandirimamidi

- Dr. K.Rajendra Prasad, Scientist (Horti.) Delivered lecture on "Palmyrah Importance and its utility in tribal areas" and "Fibers from Palmyrah and its uses in tribal areas" in the adopted village Tamarapalli, Rampachodavaram East Godavari dt, Andhra Pradesh on 21.10.2021 and 27.11.2021.

Linkage with the district KVK and ATMA

Name of KVK/ATMA	Nature of Linkage established	Technology highlighted
KVK, Navsari	OFT	Package of practices of Coconut
KVK, Surat	OFT	Package of practices of Coconut
KVK, Vyara	OFT	Intercropping
KVK, Waghai	OFT	Intercropping
KVK, Ambheti (Valsad)	OFT, FLD etc.	Package of practices of Coconut
ATMA, Valsad	OFT, FLD etc.	Package of practices of Coconut
KVK, Kodinar	OFT	Package of practices of Coconut

Distribution of Inputs under TSP

Organising training programme for farmers

Date	Topic of training	Number of farmers trained
17.03.2021	Palmyrah Utility and utilisation.	25
29.02.2021	Palmyrah climbing with advanced climbers.	25
01.03.2021	Palmyrah Jaggery making.	15

Exhibition	Venue	Organized by	No. offarmers/ Stakeholder benefited
Products and bi products of Palmyrah	KVK,Pandirimamidi	KVK, Pandirimamidi	100
Products and bi products of Palmyrah	DR.YSRHUVR.gudem	DR.YSRHUVR.gudem	200

- Er. P. C Vengaiah, Scientist (Food Sci.& Tech.) delivered lecture on "Utilization of palms in rural areas for sustainable development" through online webinar conducted by Dr BR Ambedkar university, Srikakulam on 12.08.2021.
- Distributed coconut seedlings and climbing gadget to farmers under SCSP programme on 09.12.2021.

Pasighat

The scientist in charge of the center has under taken the following extension activities for popularizing the oil palm crop in North Eastern Region of the country during the year 2021.

1. Organized field visit to oil palm plantation for farmers – 05 nos.
2. Exhibition stalls in Agri Fair and Agri Expo - 02 no's.
3. Lecture delivered on oil palm cultivation in different training programmes related to horticulture organized by CHF, CAU - 01 no's.
4. Acted as Resource person in different training programmes: 04 times
5. Organized Exposure visits for farmers, school students, and officials of state department - 02 no's.
6. Imparted consultancy to farmer's regarding cultivation of oil palm: 8 no's

Pattukkottai

Training programmes/field days

Scientists from the centre participated in 5 training programmes on oil palm cultivation technology as resource person. Over 170 ATMA farmers of 3 different districts were benefited.

Radio/Television Programme:

Sl. No.	Date	Department/ Centre	Topic
1.	10.02.2021	ARS, Pattukkottai	Radio talk on "Oil Palm Cultivation in Tamil Nadu" at All India Radio-Trichy

Ratnagiri

Training programmes

Ten training programmes and five training classes were arranged on different aspects of coconut plantation management benefitting 750 farmers.

Demonstration of technology

Organized about 15 method demonstrations on coconut production technology, preparation of vermicompost, pest management and biocontrol agent mass production and 450 farmers were benefited.

Radio/TV programme/ press coverage

- Two TV programmes on 'Intercrops in coconut', and 'World coconut day' were telecasted in Doordarshan and Krishidarshan sahyadri.
- A total of 20 press coverages were made in the daily news papers on the technologies of the centre.

Diagnostic field consultancy

Field visit/ consultancy		Problems identified and solution given on
Field visits:	20	· Coconut production technology
Telephone guidance:	128	· Nursery management
Farmers visit to HRES:	3000	· Drip irrigation in coconut
		· Nutrient management in coconut
		· Pest management in coconut
		· Disease management in coconut
		· Varieties of coconut

Farmers- Scientist Interaction Programme

The ICAR-AICRP on Palms center, Ratnagiri organized a day long Farmers- Scientist Interaction Programme on 23rd December 2021 with special emphasis on promotion of coconut intercropping with spices in the Konkan region of Maharashtra. The main objective of the interaction programme was to exchange views and experiences directly with the tribal farmers under TSP programme on different problems in Horticulture and allied sectors with special emphasis on coconut based cropping system. About 100 tribal men and women farmers from Karol, Sayade, Pachgar, Jogalwadi village were the beneficiaries. The farmers

discussed with the scientists on cultivation of coconut, nutmeg, Lakibaug system, integrated nutrient management in coconut, integrated farming system (coconut + poultry), disease and pests management, vermicompost production, soil testing, etc. About 800 Coconut, 300 Black pepper, 200 Nutmeg and 100 Cinnamon seedlings were also distributed to the beneficiaries. Necessary training and method demonstration was imparted for higher productivity and income of the farming community with the increase of cropping intensity.

Distribution of seedling

Veppankulam

Farmers – Scientist Interaction meeting

Organising training programme for farmers\

SC- SP Training programme Beneficiaries		
Men	**Women**	**Total**
27	23	50


Inputs and Agri tools distribution

Off-Campus Training on Coconut cultivation technology

Method demonstration-Root feeding of fungicides against Basal stem rot disease


Exposure visit – Copra processing and oil extraction unit

XI PUBLICATIONS

Reports

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XII. WEATHER DATA OF COORDINATING CENTRES

Coconut centres

Aliyarnagar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	33.0	19.0	90.8	65.4	65.4
February	36.5	17.5	90.0	55.0	0.0
March	36.5	20.0	91.2	47.0	34.0
April	37.5	25.0	89.4	42.0	84.6
May	37.5	26.0	84.4	40.0	0.0
June	36.5	25.0	85.0	52.0	19.3
July	36.0	24.5	83.0	61.0	98.6
August	33.5	25.5	85.9	61.0	49.9
September	35.5	20.0	86.7	59.0	29.7
October	33.5	24.5	91.6	73.0	258.6
November	33.5	24.0	92.0	60.0	316.1
December	33.0	21.0	93.8	70.1	9.3

Ambajipeta

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	18.6	31.3	86.1	68.4	0.0
February	18.1	32.1	86.0	64.0	0.0
March	21.5	35.1	85.3	63.8	0.0
April	24.0	37.3	78.6	53.9	12.7
May	25.0	38.0	81.0	69.4	16.6
June	26.1	36.7	88.1	70.7	67.8
July	24.4	32.1	89.0	76.3	353.8
August	25.0	33.2	87.3	72.5	195.0
September	23.9	32.7	88.5	75.8	414.8
October	25.2	34.1	71.7	96.3	198.5
November	30.7	23.6	94.6	74.8	246.9
December	18.5	29.6	60.5	96.6	1.3

Arsikere

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	27.7	21.0	70.7	53.6	-
February	31.9	22.4	59.4	41.6	89.1
March	35.0	27.1	49.9	36.1	-
April	37.4	27.2	63.4	42.2	26.0
May	37.9	26.2	77.6	56.0	173.4
June	37.4	25.4	81.0	64.9	73.7
July	39.1	25.2	91.0	79.0	58.8
August	38.8	26.9	85.8	79.5	63.0
September	36.5	24.6	86.2	81.1	51.5
October	38.7	23.9	84.6	83.8	283.1
November	36.6	23.1	85.3	83.6	221.9
December	35.6	22.5	73.0	62.5	31.0

Bhubaneswar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.5	16.3	93.1	39.8	0
February	32.8	15.3	92.5	28.6	0
March	37.7	23.0	94.1	33.1	7.5
April	38.5	25.8	90.0	44.7	7.2
May	36.5	26.1	89.8	58.8	200.3
June	34.0	26.3	93.1	69.5	352
July	33.5	26.1	93.3	75.0	265.5
August	33.3	26.1	93.0	75.4	285.1
September	32.4	25.5	95.0	80.4	579.4
October	33	24.7	93.5	67.8	77.2
November	30.2	21.8	87.3	69.0	82.6
December	26.8	15.2	91.7	73.4	72.6

Jagdalpur

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	29.1	11.8	92.1	33.5	0.0
February	30.4	10.5	89.5	24.8	17.2
March	35.4	17.1	78.7	23.9	0.0
April	36.1	19.6	75.5	34.1	62.4
May	34.9	22.5	74.1	45.0	90.0

June	31.0	22.7	87.7	69.1	170.7
July	29.8	22.4	90.8	74.2	317.6
August	29.8	22.3	93.1	75.4	354.9
September	29.7	22.2	92.1	72.7	188.9
October	30.9	20.4	94.3	59.8	57.7
November	29.2	17.8	94.6	55.0	150.5
December	26.8	11.8	93.8	50.1	0.3

Kahikuchi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	23.8	10.2	82.6	73.4	6.8
February	26.5	11.5	74.7	69.0	1.8
March	28.7	15.2	71.9	66.0	6.7
April	30.8	20.1	77.7	70.4	175
May	32.5	23.2	81.2	75.6	215.0
June	32.7	25.4	87.4	81.7	305.0
July	32.9	25.6	88.8	83.0	366.0
August	33.0	26.6	89.2	84.5	228.0
September	31.0	24.8	85.2	82.4	136.0
October	30.1	23.0	82.7	80.1	82.0
November	27.9	17.3	80.2	79.0	12.0
December	23.5	11.4	79.1	74.5	Trace

Mondouri

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	24.8	11.8	91.3	52.0	0.0
February	29.3	13.8	89.1	39.2	0.1
March	35.9	20.7	86.5	33.1	0.0
April	37.0	24.6	84.2	41.1	0.9
May	34.2	24.7	89.5	66.0	11.4
June	32.6	25.8	93.5	77.6	11.9
July	32.6	26.2	94.4	79.4	8.2
August	32.8	26.3	94.9	77.3	7.4
September	31.7	25.6	93.9	77.6	8.5
October	31.2	23.3	93.2	69.4	5.6
November	28.4	17.6	90.0	57.0	0.7
December	24.4	14.1	91.7	62.6	4.9

Navsari

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.4	13.9	87.1	55.5	0.0
February	33.5	14.3	84.0	38.7	0.0
March	37.3	17.0	82.6	36.4	0.0
April	36.1	21.5	90.6	57.0	0.0
May	35.2	24.7	86.9	63.9	144.0
June	32.6	24.5	89.2	80.7	384.0
July	31.3	24.7	89.7	84.4	423.0
August	30.6	23.4	92.2	81.3	170.0
September	30.6	22.9	97.1	89.2	493.0
October	33.9	20.1	89.7	69.9	18.0
November	33.7	18.3	75.2	43.3	11.0
December	29.3	14.7	90.6	54.8	66.0

Pilicode

Month	Temperature (°C)		Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	32.5	22.1	74.0	80
February	33	21.2	74.8	11.8
March	34.3	24.3	75.0	1.8
April	34.3	25.2	76.0	64
May	32.2	24.4	78.0	649.5
June	31	24	88.0	553
July	29.6	22.9	87.7	806.6
August	29.8	23	91.4	579.1
September	30.3	23.4	84.6	422.6
October	30.9	23.9	80.4	555
November	31.1	23.7	81.2	221.8
December	32.8	22.2	78.0	93.3

Ratnagiri

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	33.3	23.1	91.6	71.0	0.0
February	32.5	21.9	91.9	73.9	0.0
March	32.7	21.1	93.2	73.7	0.0
April	33.7	23.4	94.0	79.9	0.0
May	33.3	24.3	92.4	64.8	502.2

June	31.5	22.8	95.5	91.9	999.8
July	29.9	22.3	95.2	94.8	1828.2
August	30.3	22.1	96.1	95.0	374.1
September	30.1	20.3	96.3	96.2	675.4
October	32.6	22.4	93.1	89.1	68.4
November	33.4	19.4	90.4	82.5	84.0
December	31.6	17.7	92.8	89.2	33.6

Sabour

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	21.5	11.0	94.2	78.8	0.0
February	25.5	12.6	89.3	65.0	0.0
March	32.6	19.2	84.6	55.1	0.4
April	36.4	24.4	77.9	59.3	0.0
May	33.5	24.3	85.8	62.6	251.3
June	33.8	26.0	89.1	63.4	298.6
July	33.0	26.3	88.6	68.4	331.2
August	32.4	27.3	91.5	77.1	104.7
September	32.6	27.3	91.6	75.4	119.4
October	31.8	24.3	94.1	73.1	210.0
November	28.0	16.2	94.0	73.4	0.0
December	24.9	12.3	94.3	68.6	15.6

Veppankulam

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.4	21.3	96.0	61.0	290.4
February	26.0	16.8	96.0	51.0	-
March	35.5	22.9	96.0	52.0	-
April	35.6	25.8	96.0	56.5	10.2
May	35.2	25.6	96.0	50.0	33.2
June	36.9	25.6	96.0	63.0	3.2
July	35.7	25.8	96.0	61.0	2.2
August	34.7	25.6	96.0	62.0	135.6
September	33.2	24.7	96.0	58.0	203.2
October	32.4	24.6	96.0	68.0	155.9
November	29.5	23.7	96.0	70.0	640.1
December	29.6	22.2	92.0	67.0	33.0

Oil palm centres

Mulde

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	34.4	19.4	92.8	50.2	11.6
February	35.4	17.1	90.6	41.4	0.0
March	37.5	20.2	91.4	40.5	0.0
April	37.4	22.5	85.8	48.6	13.2
May	35.2	24.2	87.0	62.9	500.4
June	30.8	23.1	92.7	78.7	1153.8
July	29.4	22.9	94.8	83.6	1497.2
August	30.0	23.6	94.0	78.0	603.2
September	30.1	23.4	96.0	84.7	889.2
October	34.5	23.8	90.0	58.4	103.2
November	34.7	22.6	94.0	58.8	186.8
December	33.6	18.0	93.0	49.0	79.4

Pasighat

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	21.0	NA	83.7	68.1	26.8
February	21.4	NA	77.3	67.5	0.0
March	26.1	NA	85.2	84.7	36.8
April	25.9	NA	83.2	85.8	133.7
May	24.8	NA	84.5	85.4	281.5
June	27.1	NA	91.5	88.8	668.5
July	30.7	27.5	89.4	89.2	269.2
August	30.7	24.9	91.5	90.7	1521.0
September	29.8	23.4	76.5	75.8	162.2
October	28.2	22.1	81.9	79.8	196.1
November	24.4	21.7	66.4	65.4	2.0
December	22.3	19.2	65.9	55.3	0.0

Note:- **NA**: Data for Minimum Temperature is not available at meteorological observatory of College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh due to some technical problems.

Pattukkottai

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.4	21.3	96.0	61.0	353.1
February	26.0	16.8	96.0	51.0	-
March	35.6	22.9	96.0	52.0	-

April	35.6	25.8	96.0	56.5	10.5
May	35.2	25.6	96.0	50.0	-
June	36.9	25.6	96.0	63.0	-
July	35.7	25.8	96.0	61.0	46.9
August	34.7	25.6	96.0	62.0	174.3
September	33.2	24.7	96.0	58.0	187.6
October	32.4	24.6	96.0	68.0	267.0
November	29.6	23.8	96.0	70.0	571.5
December	29.6	22.2	92.0	67.0	17.0

Pedavegi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	31.2	19.1	99.2	54.2	0.0
February	32.2	18.1	99.7	47.0	0.0
March	31.6	21.3	98.9	61.6	0.0
April	30.7	23.9	96.5	69.9	7.9
May	37.1	27.9	91.4	51.3	42.9
June	36.8	27.1	93.7	60.2	32.0
July	33.2	26.1	99.2	72.2	304.2
August	33.4	26.1	96.3	64.5	124.0
September	32.6	26.1	98.2	72.2	194.8
October	33.9	26.2	96.3	76.4	10.3
November	30.3	24.2	96.1	74.3	142.2
December	30.6	21.2	94.2	61.7	0.0

Vijayarai

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	31.2	19.1	99.2	54.2	0.0
February	32.2	18.1	99.7	47.0	0.0
March	31.6	21.3	98.9	61.6	0.0
April	30.7	23.9	96.5	69.9	7.9
May	37.1	27.9	91.4	51.3	42.9
June	36.8	27.1	93.7	60.2	32.0
July	33.2	26.1	99.2	72.2	304.2
August	33.4	26.1	96.3	64.5	124.0
September	32.6	26.1	98.2	72.2	194.8
October	33.9	26.2	96.3	76.4	10.3
November	30.3	24.2	96.1	74.3	142.2
December	30.6	21.2	94.2	61.7	0.0

Arecanut centres

Goa

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	34.4	21.5	82.5	41.7	9.1
February	34.8	20.5	80.1	35.1	2.0
March	35.7	24.1	88.6	52.2	0.0
April	35.4	24.4	84.5	52.0	27.0
May	34.1	25.2	86.6	63.1	422.6
June	30.9	23.4	91.2	79.4	903.9
July	29.2	23.2	92.7	84.3	1345.9
August	29.9	23.8	93.8	77.9	343.9
September	29.8	24.7	94.5	78.4	481.0
October	32.4	24.0	92.8	65.5	239.9
November	33.0	23.3	89.0	60.2	166.4
December	32.4	20.9	88.7	49.6	105.9

Port Blair

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.2	24.7	72.1	68.2	25.5
February	30.5	24.1	73.0	71.0	92.2
March	32.2	25.0	76.3	72.3	0.0
April	32.1	24.8	81.1	74.4	247.9
May	33.4	25.4	85.0	81.1	469.1
June	31.1	25.2	83.1	81.2	321.9
July	30.2	24.5	89.3	88.2	649.2
August	30.0	24.6	87.0	86.6	430.9
September	29.6	24.3	90.9	86.0	541.2
October	30.3	24.8	87.4	83.4	305.8
November	30.6	25.1	85.2	80.3	224.9
December	30.1	24.7	78.0	72.5	91.6

Wakawali

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.5	14.5	92.4	55.2	0.0
February	32.8	14.4	91.6	48.9	0.0
March	32.6	16.7	86.1	51.4	0.0
April	34.0	20.8	87.5	52.4	0.1
May	34.2	23.3	85.4	59.9	0.2

June	30.8	23.6	93.3	84.2	25.7
July	29.0	23.5	95.2	89.5	46.9
August	28.4	23.5	94.2	90.7	45.0
September	30.1	23.1	94.5	80.2	11.3
October	30.8	22.4	94.2	79.2	5.5
November	33.1	17.3	87.0	50.9	0.0
December	32.5	14.9	92.5	67.1	0.3

Palmyrah centres

Killikulam

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	29.2	20.6	70.0	60.0	172.6
February	30.6	20.6	66.0	44.0	0.0
March	34.2	20.8	70.0	45.0	23.6
April	35.1	21.8	72.0	52.0	34.8
May	35.4	23.0	69.0	52.0	26.0
June	36.6	26.6	69.0	52.0	28.8
July	36.0	24.1	68.0	53.0	5.0
August	35.9	23.9	65.0	48.0	1.2
September	36.4	23.5	61.0	41.0	21.2
October	33.7	21.5	69.0	52.0	231.6
November	30.0	20.5	76.0	64.0	366.2
December	30.8	19.6	75.0	63.0	26.0

Pandirimamidi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	15.56	31.54	99	38	9.0
February	14.58	31.76	96	33	0.0
March	17.29	35.49	91	30	55.2
April	18.15	39.3	88	38	62.2
May	20.51	42.35	84	43	40.4
June	23.52	39.27	61	52	106.5
July	23.16	35.08	97	79	272.1
August	26.47	35.27	98	74	230.8
September	22.96	35.52	97	80	409.5
October	18.1	35.62	98	72	151.7
November	14.66	34.62	99	73	134.1
December	10.97	31.23	99	59	0.0

Cocoa centres

Thrissur

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	32.3	21.3	78.1	50.0	45.7
February	34.6	21.6	70.2	38.8	0.0
March	36.8	23.0	84.1	34.2	31.8
April	34.9	23.6	89.4	38.6	72.4
May	32.7	22.9	94.3	73.8	550.5
June	31.2	23.7	94.4	74.1	473.0
July	29.8	23.5	96.6	77.1	626.9
August	30.2	23.4	96.0	76.3	409.1
September	30.7	23.9	96.3	71.5	291.7
October	31.3	23.6	96.1	77.4	593.2
November	31.0	23.4	91.7	71.7	364.2
December	32.5	23.3	80.5	55.0	19.2

Sirsi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.2	16.9	87.1	62.4	90.6
February	31.1	14.5	82.3	59.5	2.0
March	34.1	18.2	86.0	45.3	51.8
April	34.3	20.9	89.4	46.7	24.2
May	32.1	20.2	88.4	56.2	197.4
June	28.9	20.4	88.3	71.5	540.8
July	27.0	20.4	89.4	76.4	964.6
August	28.0	20.9	89.8	77.1	159.2
September	27.7	20.7	90.3	76.4	332.2
October	30.0	20.7	90.2	70.8	173.8
November	29.8	19.7	87.9	69.4	160.2
December	NA	NA	NA	NA	NA

Note:- **NA**: Data is not available at meteorological observatory

वार्षिक प्रतिवेदन

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