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2019



भा.कृ.अनु.प. - अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना
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ICAR- All India Co-ordinated Research Project on Palms
ICAR-Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
Kasaragod, Kerala, India – 671 124



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ICAR-AICRP on Palms

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Dr. Maheswarappa H. P.
Project Coordinator (Palms)
ICAR - All India Co-ordinated Research Project on Palms
ICAR - Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
Kasaragod, Kerala, India – 671 124
Phone: 04994 – 232733; Fax: 04994 – 232614
E mail: pcpalms.cpcri@icar.gov.in
Website: <http://www.cpcri.gov.in>



Compiled and edited by

Dr. Maheswarappa H. P.
Dr. Jilu V. Sajan
Mr. Balanagouda Patil

Cover Page

Background - Kalparatna



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Hindi Translation

Dr. Alka Gupta
Smt. K. Sreelatha

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In memory of



Dr. K. V. A. Bavappa (1930-2019)

**Founder Director and first Project Coordinator of AICRP on Palms, CPCRI, Kasaragod
and a Father of Plantation Crops Research and Development**

**ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS
ICAR-CPCRI, KASARAGOD**



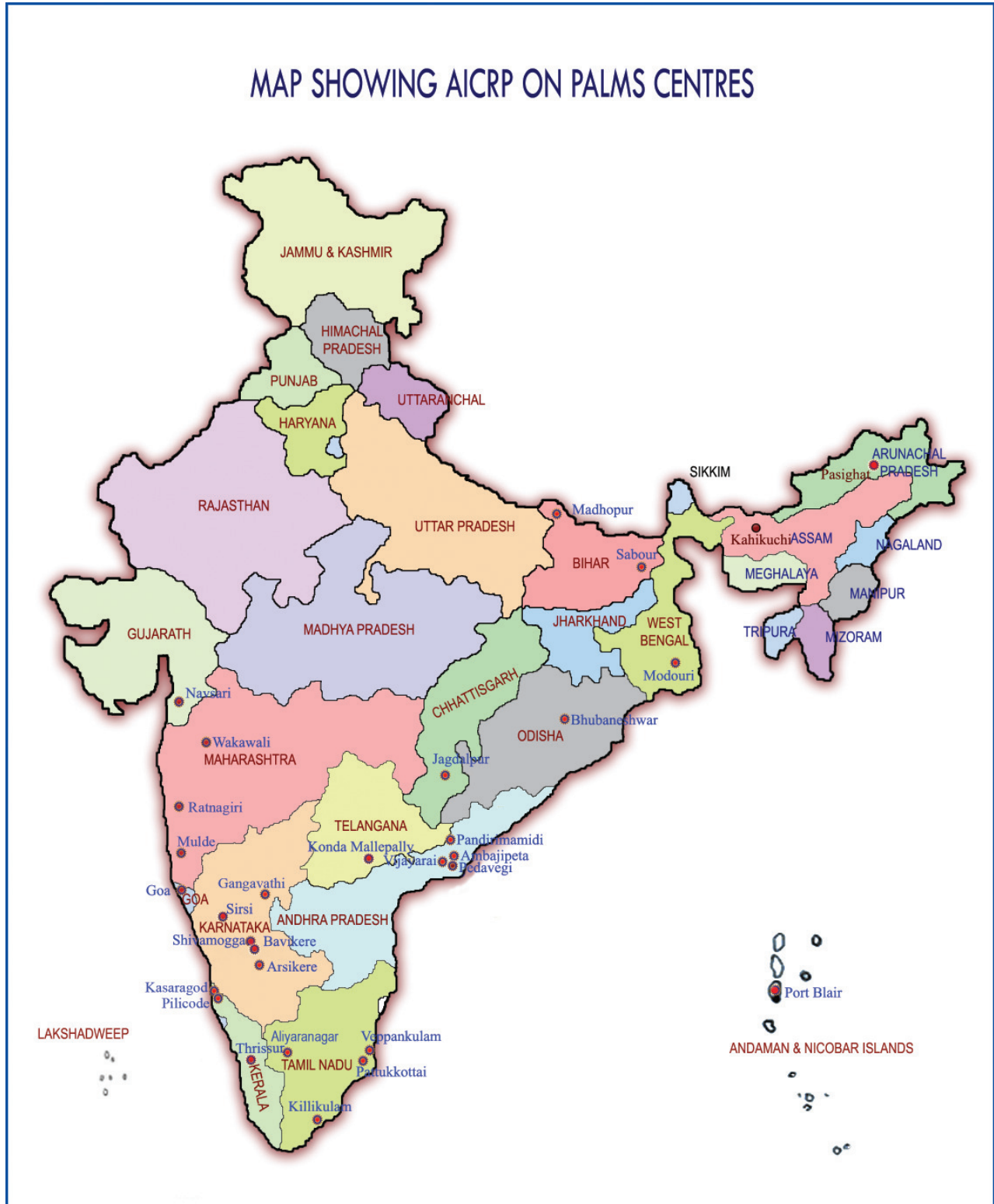
**MANDATE
CROPS**



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MAP SHOWING AICRP ON PALMS CENTRES



I. प्रस्तावना



अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना मुख्य फसलों पर स्थानीय विशेष अनुसंधान आयोजित करने के लक्ष्य के साथ शुरू की गई। वर्तमान में इस परियोजना में मुख्य फसलों के रूप में नारियल, तेल ताड़, सुपारी, पॉमैरा और कोको हैं जो समन्वयन केंद्र के रूप में 13 राज्य कृषि विश्वविद्यालय/राज्य बागवानी विश्वविद्यालय और एक केंद्रीय विश्वविद्यालय और 14 राज्यों को प्रतिनिधित्व 4 भाकृअनुप संस्थान और एक संघ राज्य क्षेत्र सम्मिलित 28 केंद्रों के साथ स्थित है। परियोजना के अधीन वर्ष 2019 की अवधि पर प्राप्त की गई मुख्य उपलब्धियाँ इस वार्षिक रिपोर्ट में प्रस्तुत की गई हैं।

कल्प रत्ना एक लंबी नारियल प्रजाति जो फेडरेटड मलय स्टेट्स (आईएनडी 010 एस) सेलेक्शन है जो मलेशिया से प्रारंभ में भारत में लगाया गया और भारत के दक्षिणी राज्य जैसे कर्नाटक, केरल और तमिलनाडु के नारियल वृद्धि क्षेत्रों में खेती के लिए सिफारिश किया गया। लंबी अवधि के संकर मूल्यांकन से तेल ताड़ संकर क्रमानुगत क्षेत्रों में विमोचन के लिए सिफारिश किया गया जैसे आन्ध्रप्रदेश के लिए गोदावरी स्वर्णा के रूप में एनआरसीओपी-4, तमिलनाडु के लिए गोदावरी गोल्ड जैसे एनआरसीओपी-17 और महाराष्ट्र के लिए गोदावरी रत्ना के जैसे एनआरसीओपी-2 विमोचन के लिए सिफारिश किया गया। उचित फसल के साथ नारियल आधारित सघन फसलन पद्धति के अधीन आरडीएफ (नाइट्रोजन, फोस्फोरस, पोटैश) का 50% + वर्मीकंपोस्ट के साथ जैविक पुनःचक्रण से 50% नाइट्रोजन + वर्मीवाश + जैव उर्वरक और स्वस्थाने हरी खाद प्रयोग (टी 2) से उच्चतम उत्पादन क्षमता और उसके बाद शुपांशित नाइट्रोजन, फोस्फोरस, पोटैश का 75% + वर्मीकंपोस्ट या पूर्ण जैविक के साथ जैविक पुनःचक्रण से 25% प्रयोग से उत्पादन क्षमता देखा गया। आरडीएफ का 50% पुनःचक्रण उपचार के माध्यम से 50% नाइट्रोजन के अधीन उच्चतम सकल आय 1.66 लाख रुपए/हेक्टर से 6.08 लाख रुपए/हेक्टर की दर में प्राप्त किया गया। जबकि नारियल इकफसल से केवल 0.36 लाख/हेक्टर से 1.37 लाख/हेक्टर की दर से प्राप्त किया गया। तरुण ताड़ों में राईनोसेरस भृंग के विरुद्ध कैंटोफासस वनस्पतिक केक + प्रति ताड़ 15 ग्रा दर से लेप सिफारिश किया जा सकता है। यह नारियल ताड़ में तर्कु क्षति और पत्ता क्षति कम करने में प्रभावी पाया गया है। नारियल बाग में कोको प्रजातियों/संकरों का निष्पादन के मूल्यांकन पर वीटीएलसीच-2 से उच्चतम बीन/पौध (2.1 कि. ग्रा) रिकार्ड किया गया। और वीटीएलसीसी-1 और वीटीएलसीएच-4 से (1.8 कि ग्रा/पेड़) समान पाया गया। प्रौद्योगिकियों के स्थानांतरण के अनुसरण में विभिन्न केंद्रों में खेतों में, खेतों के बाहर प्रशिक्षण, किसान मेला आयोजित करने में, प्रदर्शनियों में भागीदारी, नैदानिक प्रक्षेत्र संदर्शन और प्रेस और मीडिया द्वारा अवलोकन करने में शामिल थे। अनुसूचित जन जाति उप योजना उनके आजीविका सुरक्षा सुधारने और उनके हित के लिए विभिन्न राज्यों में कार्यान्वित किया गया।

डॉ. त्रिलोचन महापात्र, सचिव (डेयर) और महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली द्वारा परियोजना के लिए दिए गए निरंतर प्रोत्साहन और मार्गदर्शन को मैं अपना सौभाग्य मानकर आभार प्रकट करता हूँ। डॉ. आनन्द कुमार सिंह, उप महानिदेशक (बागवानी विज्ञान), डॉ. वसाका सिंह दिल्लीन, पूर्व सहायक महानिदेशक (बागवानी विज्ञान) और भाकृअनुप के बागवानी विज्ञान अनुभाग के स्टाफ सदस्यों द्वारा दिए गए समर्थ सहारे और आवश्यक मार्गदर्शन के लिए आभार प्रकट करता हूँ। तकनीकी कार्यक्रमों के रूपांकन और कार्यान्वयन के लिए डॉ. अनिता करुण, कार्यकारी निदेशक और भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान के स्टाफ सदस्यों द्वारा दी गई सहायता और मार्गदर्शन के लिए मैं कृतज्ञता ज्ञापन करता हूँ। डॉ. आर.के. माथुर, निदेशक, भाकृअनुप- भारतीय तेल ताड़ अनुसंधान संस्थान, पेड़वेगी और अन्य स्टाफ सदस्यों द्वारा दिए गए मार्गदर्शन के लिए आभार प्रकट करता हूँ। विभिन्न कार्यक्रमों के आयोजन के लिए विभिन्न केंद्रों के सभी स्टाफ सदस्यों द्वारा किए गए प्रयास और उत्साह के लिए धन्यवाद। हिंदी अनुवाद के लिए डॉ. अल्का गुप्ता और श्रीमती के. श्रीलता को भी धन्यवाद प्रस्तुत करता हूँ। डॉ. जिलु वी साजन (वैज्ञानिक), श्रीमती के. नारायणी (निजी सचिव), श्री बालन गौडा पाटिल (कनिष्ठ अनुसंधान फेलो), श्री करुणाकरा. एस और श्री ए. मोहना को भी साधुवाद देता हूँ जिन्होंने इस रिपोर्ट के निष्पादन में मदद और समन्वयन कार्य किया है।

जून, 2020

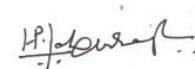
डा. ए. पी. महेश्वरप्पा
(डॉ. एच.पी. महेश्वरप्पा)

I. PREFACE

The All India Coordinated Research Project on Palms functioning with the objective to conduct 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 CAU and four ICAR institutes. The achievements made during 2019 under the project are briefed in this annual report.

Kalpa Ratna, a tall coconut variety which is a selection from Federated Malay States (IND 010 S) initially introduced to India from Malaysia was recommended for release for cultivation in the coconut growing regions of the Southern states of India viz., Karnataka, Kerala and Tamil Nadu. Based on long term hybrid evaluation, the oil palm hybrids were recommended for release in respective regions viz., NRCOP-4 as Godavari Swarna for Andhra Pradesh; NRCOP-17 as Godavari Gold for Tamil Nadu; and NRCOP-2 as Godavari Ratna for Maharashtra. Under coconut based high density cropping system with compatible crops, application of 50% of RDF (NPK) + 50% N through organic recycling with vermicompost + vermiwash + biofertilizer and in situ green manuring recorded higher system productivity followed by 75% of recommended NPK + 25% through organic recycling with vermicompost or fully organic. The net returns obtained was higher under 50% of RDF + 50% N through organic recycling treatment which ranged from Rs. 1.66 lakhs/ha to Rs. 6.08 lakhs/ha compared to monocrop of coconut (Rs. 0.36 lakhs/ha to Rs. 1.37 lakhs/ha). CPCRI Botanical cake + paste@ 15g each/palm was recommended against rhinoceros beetle in juvenile palms as it was found effective in reducing spindle damage and leaf damage in coconut. Under evaluation of cocoa varieties/hybrids as intercrop in coconut garden, VTLCH-2 recorded higher dry beans/ plant (2.1 kg) and found to be at par with VTLCC-1 and VTLCH-4 (1.8 kg/tree). With respect to transfer of technology, different centres were involved in conducting on-farm, off-farm trainings, kisan melas, participation in exhibition, diagnostic field visits and coverage through press and media. The Scheduled Caste Sub Plan (SCSP) was implemented to improve their livelihood security in different states.

I take this opportunity and privilege to express my sincere gratitude to Dr. Trilochan Mohapatra, 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. Wasakha Singh Dhillon, Former ADG, Dr. B.K.Pandey, Actg. ADG (HS) and staff of Horticulture Science Division, ICAR for their support and necessary guidance. The technical guidance and help in implementation of programmes by Dr. Anita 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 effort made by all the staff of the centres during execution of various programmes is well appreciated. The help rendered by Dr. Alka Gupta and Mrs. K. Sreelatha in Hindi translation is acknowledged with gratitude. The support and coordination of Dr. Jilu V. Sajan (Scientist), Smt. K. Narayani (Private Secretary), Mr. Balanagouda Patil and Ms. Dhatri. N. R. (SRFs), Mr. Karunakara and Mr. A. Mohana of AICRP Cell for bringing out this report is appreciated.



(Dr. Maheswarappa H. P.)

June, 2020

II. कार्य सारांश

भा कृ अनु प - अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना वर्ष 1972 में मुख्या फसलों पर स्थानीय विशेष अनुसंधान आयोजित करने के लक्ष्य के साथ कार्य शुरू किया गया। वर्तमान में मुख्य फसल के रूप में नारियल, तेल ताड़, सुपारी, पॉमैरा और कोको फसलों पर परियोजनाएँ 28 केंद्रों में कार्यान्वित की जाती हैं। जिसका मुख्यालय भाकृअनुप-कें रो फ अ सं, कासरगोड़ में स्थित है और नारियल पर 15 केंद्र, तेल ताड़ पर 6, सुपारी पर 4, पॉमैरा पर 4 और कोको पर 7 केंद्रों में अनुसंधान पर समन्वयन कार्य किया जाता है। इसका समन्वयन केंद्र 14 राज्यों में स्थित है और संघ शासित क्षेत्र में 13 राज्य कृषि विश्वविद्यालय और राज्य बागवानी विश्वविद्यालय, एक केंद्रीय कृषि विश्वविद्यालय और चार भाकृअनुप के संस्थान हैं।

इस वर्ष 2019 का बजट (अप्रैल-दिसंबर) 453.17 लाख रुपए था और 75% अंश भाकृअनुप और 25% अंश राज्य कृषि विश्वविद्यालय और 100% केंद्रीय कृषि विश्वविद्यालय और भाकृअनुप संस्थानों के मामलों में निधि प्रदान करने के साथ क्रमानुगत राज्य कृषि/बागवानी विश्वविद्यालय पर 75:25 आधार पर कार्यान्वित किया जाता है।

अनुसंधान उपलब्धियाँ

नारियल फसल सुधार

एक लंबी नारियल प्रजाति जो फेडरेटड मलय स्टेट्स (आईएनडी 010 एस) का सलेक्शन है जो 1940 की अवधि में प्रारंभ में मलेशिया से भारत में लाया गया। भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़, केरल और अलियार नगर, तमिलनाडु के अखिल भारतीय समन्वित ताड़ अनुसंधान केंद्र में प्रजाति का श्रेष्ठ निष्पादन के आधार पर कल्परत्ना के रूप में विमोचन के लिए भारत के एक दक्षिणी राज्य जैसे कर्नाटक, केरल और तमिलनाडु के नारियल वृद्धित प्रदेशों में कृषि के लिए सिफारिश किया गया। इस प्रजाति का फलन 5 वें वर्ष से शुरू होता है और रोपाई के आठवाँ वर्ष से स्थिर उपज प्राप्त होने लगा। पीला- हरा लंगीन अण्डाकार फल से अधिक मात्रा में डाब पानी (575 मि. ली), 99.9 गुठली/ताड़/वर्ष औसत गुठली उपज और 162 ग्रा/गुठली खोपड़ा मात्रा और 12.7 कि. ग्रा/ताड़/वर्ष खोपड़ा उपज प्राप्त की गयी।

मूल्यांकन परीक्षण के अधीन अलियार नगर में वर्ष 2011 में रोपित पाँच लंबी नारियल संकर संयुक्त में बी जी आर X ए डी ओ टी से उच्चतम गुठली उपज 81.4 गुठली /ताड़/वर्ष और डब्ल्यू सी टी X टी पी टी से समतुल्य उपज 70.9 गुठली /ताड़/ वर्ष प्राप्त की गयी।

रत्नलगिरी केंद्र में वर्ष 2011 में रोपित पाँच नारियल बौनी X बौनी संकर संयुक्त का मूल्यांकन परीक्षण में संकर संयुक्त के बीच जी बी जी डी X एम ओ डी संकर में रोपाई के 27 महीने के बाद पहला पुष्प निकलते देखा गया और सी ओ डी X एम जी डी में 28 महीने के बाद जबकि एम वाई डी X सी जी डी में उच्चतम मात्रा में डाब पानी पाया गया (463.8 मि.ली)।

फसल उत्पादन

उचित फसल के साथ नारियल आधारित सघन फसलन पद्धति के अधीन आर डी एफ (नाइट्रोजन, फोस्फोरस, पोटाश) का 50% + वर्मीकंपोस्ट के साथ जैविक पुनःचक्रमण से 50% नाइट्रोजन + वर्मीवाश + जैव उर्वरक और स्वस्थाने हरा खाद प्रयोग (टी 2) से उच्चतम उत्पादन क्षमता और उसके बाद शुपाशित नाइट्रोजन, फोस्फोरस, पोटाश का 75% + वर्मीकंपोस्ट या पूर्ण जैविक के साथ जैविक पुनःचक्रमण से 25% प्रयोग से अधिक उत्पादन क्षमता देखी गयी। आर डी एफ का 50% पुनःचक्रमण उपचार के माध्यम से 50% नाइट्रोजन के अधीन उच्चतम सकल आय 0.94 लाख रुपए/हेक्टर से 6.08 लाख रुपए/हेक्टर की दर में प्राप्त किया गया। जबकि नारियल इकफसल से केवल 0.36 लाख/हेक्टर से 1.37 लाख/हेक्टर की दर में प्राप्त किया गया।

अलियार नगर केंद्र में नारियल + कोको + केला + अनानास फसलन पद्धति में वर्मीकंपोस्ट के साथ जैविक पुनःचक्रमण से 25% नाइट्रोजन, फोस्फोरस, पोटाश के साथ शुपाशित नाइट्रोजन, फोस्फोरस, पोटाश का 75% के साथ समीकृत पोषण प्रबंधन से उच्च गुठली उपज और अंतर फसल और 3.28 लाख प्रति हेक्टर सकल आय प्राप्त किया गया और शुपाशित नाइट्रोजन, फोस्फोरस, पोटाश का 50% + 50% जैविक प्रयोग से 3.07 लाख रुपए प्रति हेक्टर और पूर्ण जैविक प्रयोग से 2.96 लाख रुपए प्रति हेक्टर प्राप्त किया गया।

इकफसल की तुलना में नारियल, चारा घास और गाय के साथ समीकृत सस्यन से अधिक गुठली संख्या 7154/एकड़ और उच्च खोपड़ा मात्रा 150.2 ग्रा/गुठली प्राप्त की गयी। नारियल आधारित समीकृत सस्यन पद्धति नारियल इकफसल से अधिक लाभप्रद है। इकफसलन से प्राप्त आय की तुलना में (74900/- रुपए) आईएफएस मोडल से उच्चतम सकल आय 2,87510/-रुपए रिकार्ड किया गया।

फसल संरक्षण रोग प्रबंधन

समीकृत प्रबंधन पद्धति पर बहुस्थानीय पर परीक्षण 25 कि. ग्रा /ताड़ दर से जैविक खाद + 50 ग्रा. प्रति ताड़ की दर में ट्राईकोडेरेमा विरिडे + 100 ग्राम प्रति ताड़ अलवाल की दर में घाइनचा बीज की बुआई और पुष्पित होने के साथ मिला लेना + उर्वरकों की शुपाशित मात्रा + 50 ग्राम प्रति ताड़ की दर में ज़िंक सल्फेट कीटनाशी (1 मि.ली/लीटर पानी की दर में इमिडाक्लोप्रिड) प्रयोग से नियंत्रण प्लोट की तुलना में औसत जड़ मुर्झा रोग में कमी और नारियल की गुठली उपज में वृद्धि पायी गयी।

अलियार नगर में जनवरी, जुलाई की अवधि में 100 मि. ली पानी की दर में कारबेन्डाज़िम के साथ मूल वेधन के रूप में फफूंद नाशी का अनुक्रमिक प्रयोग और अप्रैल तथा अक्टूबर में 100 मि. ली पानी में 5 मि. ली की दर में प्रोपिकोनज़ोल का प्रयोग पत्ता चित्ती रोग लक्षण नियंत्रण में प्रभावी पायी गयी।

तिमाही के अंतराल में 3 मि. ली की दर में हेक्सोकोनज़ोल + 100 मि. ली पानी का मूल वेधन का समीकरण और तीन

महीने के अंतराल में 50 कि. ग्रा एफवाईएम के साथ ईपीसी 5 का 100 ग्राम टाल्क आधारित संरूपण के मृदा प्रयोग से आधार तना सड़न रोग लक्षण विशेष रूप से कम पाया गया और प्रभावी रूप से प्रति ताड़ गुठली उपज में वृद्धि पायी गयी ।

कीट प्रबंधन राईनोसेरस भृंग

तमिलनाडु (अलियार नगर), आन्ध्रप्रदेश (अम्बाजिपेटा), कर्नाटक (अरसिकरे) और महाराष्ट्र (रत्नगिरी) में किए गए प्रक्षेत्र अध्ययन से नारियल की उपज बढ़ाने के साथ तर्कु क्षति और पत्ता क्षति कम करने में प्रभावी पायी गयी । इसलिए राईनोसेरस भृंग क्षति समाघात के लिए रोगनिरोधी प्रबंधन रणनीति के रूप में वनस्पतिक केक और लेपन का उपयोग किया जा सकता है ।

एरियोफिड कीट

एकीकृत पोषण प्रबंधन और एकीकृत कीट प्रबंधन पद्धति एरियोफिड कीट के विरुद्ध प्रभावी और नारियल उपज बढ़ाने में प्रभावी पायी गयी । नियंत्रण की तुलना में कीट संख्या में महत्वपूर्ण कमी पायी गयी। एकीकृत सूत्रकृमि नियंत्रण और एकीकृत कीट नियंत्रण में गुठली उपज में उच्च वृद्धि 48.9 गुठली/ताड़ पायी गयी । लेकिन बिना उचार के नियंत्रणाधीन प्लोर में 31.3 गुठली/ताड़ पायी गयी ।

सर्पिल आकार सफेद मच्छर

रुगोस सर्पिल आकार सफेद मच्छर की तीक्ष्णता और लक्षण कम करने में समीकृत कीट प्रबंधन रणनीति प्रभावी पायी गयी। समीकृत कीट प्रबंधन में प्लोट लक्षण स्वीकार किया गया और रुगोस सर्पिल आकार सफेद मच्छर की तीक्ष्णता में 56.6% से 28.3% और 64.3 से 32.2% तक कमी पायी गयी। लेकिन प्राकृतिक नियंत्रण में लक्षण प्रतिशत और कीट तीक्ष्णता क्रमशः 48.2% से 6.2% और 60.4% से 71.6% वृद्धि पायी गयी ।

कीटनाशी अवकाश पहल सफलतापूर्वक सिद्ध किया गया कि सभी स्थानों में प्राकृतिक शत्रु जैसे एनकार्शिया का संरक्षण जो रुगोस सर्पिल सफेद मच्छर संक्रमण प्रबंधन में प्रभावी है ।

तेल ताड़

लंबी अवधि संकर मूल्यांकन पर आधारित , तेल ताड़ संकर जैसे गोदावरी स्वर्णा, गोदावरी गोल्ड और गोदावरी रत्ना क्रमानुगत क्षेत्रों जैसे आन्ध्रप्रदेश के लिए गोदावरी स्वर्णा के रूप में 30.11 टन/हेक्टर ताजा फल गुच्छ उपज का एनआरसीओपी-4, तमिलनाडु के लिए गोदावरी गोल्ड जैसे 28.37 टन/हेक्टर के उपज ताजा फल गुच्छ का एन आर सी ओ पी -17 और महाराष्ट्र राज्य में गोदावरी रत्ना के जैसे 22.69 टन/हेक्टर का ताजा फल गुच्छ के साथ एनआरसीओपी -2 विमोचन के लिए सिफारिश किया गया ।

वर्ष 2007 में बेतस्तीब ब्लोक डिजाइन में नए संकर संयुक्त के मूल्यांकन के अधीन तेल ताड़ के 10 नए संकर संयुक्त का रोपण किया गया और अध्ययन से यह देखा गया कि जीनोटोइप एनआरसीओपी-2 में 9.87 गुच्छ संख्या, 221.78 कि.ग्रा/ताड़ ताजा फल गुच्छ का उपज प्रति पौध और 31.71 टन/हेक्टर उपज अधिकतम पायी गयी ।

प्रतिविलित संकरों के बीच एन आर सी ओ पी 32 में उच्चतम ताड़ ऊँचाई 4.89 मीटर और पत्ता लंबाई 3.99 मीटर और संकर एन आर सी ओ पी 38 में उच्चतम ताड़ परिधि (3.40 मीटर), उच्चतम पत्ता चौड़ा (1.72 मीटर) और पर्णकों/पत्तों की संख्या 161.98 रिकार्ड किया गया । उच्चतम ताजा फल गुच्छ उपज 120.4 कि ग्रा/ताड़ एन आर सी ओ पी 38 संकर में और एन आर सी ओ पी 38 में 17.21 टन उपज प्रति हेक्टर और एनआरसीओपी 33 में 15.84 टन/हेक्टर उपज रिकार्ड की गयी।

सुपारी

शिवमोगा में छत्र रुद्ध प्रबंधन पर प्रौद्योगिकी प्रदर्शनी द्वारा यह सूचित किया गया कि प्रबंधन पद्धति से पौध में उत्तम मूल विकास तथा उत्तम पोषण अवशोषण होता है जिसके परिणाम से प्रभावित ताड़ों में संक्रमित पत्तों की संख्या में कमी होगी । उपचार पूर्व की तुलना में स्वास्थ्य पौध और संक्रमित पौध का उत्पादन (क्रमशः : 5.1 और 2.6 गुच्छ /पौध) उपचार के हस्तारोपण के एक वर्ष के बाद स्वास्थ्य पौध द्वारा 5.8 गुच्छ /पौध का उत्पादन किया गया और संक्रमित पौध द्वारा 2.9 गुच्छ / पौध का उत्पादन किया गया

वकावालि केंद्र में 7 सुपारी प्रजातियों की वृद्धि निष्पादन का मूल्यांकन किया गया । अन्य परीक्षित प्रजातियों की तुलना में मोहितनगर प्रजाति पौध गुण एवं वृद्धि गुण में श्रेष्ठ पायी गयी।

पोर्टब्लेयर केंद्र में धनिया और पुदीना के साथ सुपारी का अंतर फसलन किया गया और अन्डमान क्षेत्र में लाभदायक पाया गया । प्रति ताड़ों के अधीन कोको क्लोन्स का बहुस्थानीय परीक्षण विभिन्न अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्रों जैसे अलियार नगर, अरसिकरे, काहिकुची, रत्नागिरी और विजयगिरी में प्रगति पर है । अम्बाजिपेटा के नारियल बाग में कोको प्रजातियों/संकरों का निष्पादन के मूल्यांकन पर वी टी एल सी एच -2 से उच्चतम 2.1 कि. ग्रा बीन/पौध रिकार्ड किया गया और वीटीएलसीसी-1 और वीटीसीएलसीएच-4 से 1.8 कि ग्रा/पेड़ समान पाया गया । वीटीएलसीएच-2 और वी टीएलसीएच- 4 में प्रति फली बीन की संख्या उच्च पायी गयी । नवसारी में वीटीएलसीएच-4 अधिकतम फली भार, एकल सूखा बीन भार, बीन की संख्या/फली और सूखा बीन उपज/पेड़/वर्ष सहित पंजीकृत किया गया ।

पॉमैरा

नीरा संग्रहण की केंरोफअसं विधि से संग्रहित ताजा नीरा निर्जिवाणुकरण और पीइटी बोटल जीवाणुनाशन से प्रशीतित परिस्थिति के अधीन अधिकतम 30 दिनों का शेल्फ जीवन प्राप्त किया गया ।

कूलिंग बॉक्स से संग्रहित और कांच बोटल में भण्डारण किए गए रस से बनाया गया 65 डिग्री ब्रिक्स का पॉमैरा मिस्टोद/मधु का शेल्फ जीवन परिवेशी स्थिति के अधीन 6 महीने तक पाया गया । प्रशीतित परिस्थिति के अधीन यह एक वर्ष से अधिक तक लंबित किया जा सकता है । निर्जलीकृत कंद और कंद चूर्ण वाणिज्यिकीकरण के लिए तैयार है और आदिवासी रोजगार के लिए गैर सरकारी संगठन 'आशा' द्वारा इसका उपयोग किया जा रहा है।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की 28 वीं वार्षिक समूह बैठक

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की 28 वीं वार्षिक समूह बैठक तमिलनाडु कृषि विश्वविद्यालय, कोयम्बतूर में 6-7 जून 2019 को आयोजित की गई। डॉ. एन. कुमार, कुलपति, तमिलनाडु कृषि विश्वविद्यालय ने उद्घाटन समारोह की अध्यक्षता की। डॉ. वसाका सिंह द्विल्लन, सहायक महानिदेशक (बागवानी विज्ञान), भाकृअनुप, नई दिल्ली मुख्या अतिथि थे। डॉ. पी. रेतिनम, पूर्व कार्यपालक निदेशक, एशियन पैसेफिक नारियल समुदाय, जकार्ता, डॉ. के. मुरलिधरन, निदेशक प्रभारी, भाकृअनुप-केंरोफअसं, कासरगोड और डॉ. आर. के. माथुर, निदेशक, भाकृअनुप - भारतीय तेल ताड़ अनुसंधान संस्थान, पेडवेगी मान्य अतिथि थे। कार्यक्रम का शुभारंभ प्रार्थनागीत और भाकृअनुप के प्रसंग गान जो किसानों की वैभव विशिष्टता है, से किया गया।

डॉ. के. एस. सुब्रह्मणियन, अनुसंधान निदेशक, तमिलनाडु कृषि विश्वविद्यालय, कोयम्बतूर ने सभा का स्वागत किया और ताड़ अनुसंधान के अगले स्तर पर तमिलनाडु कृषि विश्वविद्यालय की अनुसंधान उपलब्धियों पर विवरण दिया। डॉ. एच. पी. महेश्वरप्पा, परियोजना समन्वयक में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के पाँच फसल नारियल, तेल ताड़, पॉमैरा, सुपारी और कोको पर 13 राज्य कृषि विश्वविद्यालय/राज्य बागवानी विश्वविद्यालय, 1 केंद्रीय विश्वविद्यालय और चार भाकृअनुप संस्थान और एक संघ राज्य क्षेत्र के साथ 14 राज्यों में 28 केंद्रों पर स्थित अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की उपलब्धियों पर विवरण दिया।

डॉ. वसाका सिंह द्विल्लन, सहायक महानिदेशक (बागवानी विज्ञान-1) ने बागवानी क्षेत्र की समस्त वृद्धि और जीडीपी में उसका महत्वपूर्ण अंशदान और देश की पोषण सुरक्षा पर विहंगम दृष्टि डाली। डॉ. एन. कुमार, कुलपति, तमिलनाडु कृषि विश्वविद्यालय ने अपने अध्यक्षीय भाषण में गुणी पौधों के उत्पादन के लिए एकीकृत मातृबाग के विकास की आवश्यकता पर बल दिया और मौसम परमसंकट का विचार करते हुए सूखापन शमन रणनीतियाँ विकास करने के लिए वैज्ञानिकों का ध्यान दिलवाया। बागवानी अनुसंधान वर्ष 2018-19 का उत्तम अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्र के रूप में बागवानी अनुसंधान स्टेशन, विजयराय को चुन लिया गया।

उच्च पदाधिकारियों द्वारा प्रकाशनों में नारियल और तेल ताड़ पर तीन पुस्तक, दो तकनीकी बुलेटिन और सात फॉल्डर्स और पुस्तिकाओं का विमोचन किया गया। डॉ. एल. पुगलेन्दी, डीन (बागवानी), तमिलनाडु कृषि विश्वविद्यालय ने धन्यवाद ज्ञापन किया।

बैठक में निम्नलिखित प्रौद्योगिकियों के विमोचन के लिए सिफारिश की गई :

- भाकृअनुप - केंरोफअसं जाति आईएनडी 010 फेडरेटड मलय स्टेट्स से निकाले गए आई एन डी 010 एस कल्प रत्ना के नाम से केरल और तमिलनाडु में विमोचन के लिए सिफारिश किया गया।
- तेल ताड़ संकर जैसे एन आर सी ओ पी 4, एन आर सी ओ पी 17 और एन आर सी ओ पी 2 महाराष्ट्र, तमिलनाडु और आन्ध्रप्रदेश में विमोचन के लिए प्रस्ताव सिफारिश किया गया।
- संगत फसलों के साथ नारियल आधारित सघन फसलन पद्धति के अधीन आर डी एफ (नाईट्रोजन, फोस्फोरस, पोटाश) का 50% प्रयोग + वर्मीकंपोस्ट के साथ जैविक पुनःचक्रमण से 50% नाईट्रोजन वर्मीवाश प्रयोग + जैवउर्वरक प्रयोग और स्वस्थाने हरी खाद प्रयोग से उच्च उत्पादन क्षमता रिकार्ड की गयी और सिफारिश किया गया नाईट्रोजन, फोस्फोरस, पोटाश का 75% + वर्मीकम्पोस्ट के साथ जैविक पुनःचक्रमण से 25% या पूर्ण जैविक प्रयोग अलियार नगर, अम्बाजिपेट, अरसिकरे, भुबनेश्वर, जगदलपुर, काहिकुची, मन्डौरी, नवसारी, रत्नागिरी, साबोर और वेपंकुलम केंद्र में सिफारिश किया गया।
- राईनोसेरस भृंग का प्रबंधन : तरुण ताड़ों में राईनोसेरस भृंग के विरुद्ध केंरोफअसं वनस्पतिक केक +15 ग्रा दर से लेप प्रति ताड़ सिफारिश किया जा सकता है। यह नारियल ताड़ में तर्कु क्षति और पत्ता क्षति कम करने में प्रभावी पाया गया है।



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. Its headquarters is at ICAR-CPCRI, Kasaragod and 15 centres are conducting research on coconut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa. The coordinating centres are located at 14 states and one union territory covering 13 SAUs/SHUs, one CAU and four ICAR institutes.

The budget for the year 2019 (April-December) was Rs. 453.17 lakhs and the scheme is implemented through the respective state Agricultural/Horticultural Universities on 75:25 basis, with 75% ICAR share, 25% share from State Agricultural Universities and with 100% ICAR funding in the case of Central Agricultural Universities and ICAR Institutes.

RESEARCH ACHIEVEMENTS

COCONUT

CROP IMPROVEMENT

- A tall coconut variety which is a selection from Federated Malay States (IND 010 S) initially introduced to India from Malaysia during 1940. Based on the superior performance of the variety at ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala and AICRP (Palms) centre at Aliyarnagar, Tamil Nadu, it was recommended for release as Kalpa Ratna for cultivation in the coconut growing regions of the southern states of India viz., Karnataka, Kerala and Tamil Nadu. This variety starts bearing from 5th year onwards and gave stabilized yield from 8 years after planting. The fruit is oval in shape, yellow to green in color with good amount of tender nut water (575 ml). It gives an average nut yield of 99.9 nuts/palm/year with a copra content of 162 g/ nut and copra yield of 12.7 kg/ palm/ year.
- Under evaluation trial, among five coconut Tall x Tall cross combinations planted during 2011 at Aliyarnagar centre, the cross combination BGR x ADOT recorded the highest nut yield

(81.4 nuts/palm/year), which was on par with WCT x TPT (70.9 nuts/palm/year).

- In the evaluation trial of five coconut Dwarf x Dwarf cross combinations planted during 2011 at Ratnagiri centre, among the hybrid combinations, the first inflorescence emergence was noticed in GBGD x MOD hybrid at 27 months after planting followed by COD x MGD (28 months) whereas, the highest quantity of tender nut water was found in MYD x CGD (463.8 ml).

CROP PRODUCTION

- Under coconut based high density cropping system with compatible crops, application of 50% of RDF (NPK) + 50% N through organic recycling with vermicompost + vermiwash + biofertilizer and *in situ* green manuring (T₂) recorded higher system productivity followed by 75% of recommended NPK + 25% through organic recycling with vermicompost or fully organic. The net returns obtained was higher under 50% of RDF + 50% N through organic recycling treatment which ranged from Rs. 1.66 lakhs/ha to Rs. 6.08 lakhs/ ha compared to monocrop of coconut (Rs. 0.36 lakhs/ha to Rs. 1.37 lakhs/ha).
- In coconut+cocoa+banana+pineapple cropping system, integrated nutrient management (INM) with 75% of recommended NPK through fertilizer coupled with 25% NPK through organic recycling with vermicompost recorded higher nut yield and intercrops yield, along with higher net income (Rs. 3.28 lakhs per ha) followed by 50% of recommended NPK+50% through organic (Rs. 3.07 lakhs per ha) and fully organic treatment (Rs. 2.96 lakhs per ha) at Aliyarnagar centre.
- The integrated farming system with coconut, fodder and cows has recorded more number of nuts 7154/ acre and higher copra content 150.2 g/ nut as compared to monocrop. The coconut based integrated farming system has found remunerative over other monocrop of coconut. The IFS model has recorded a highest net return Rs. 2, 87510/ acre compared to monocrop (Rs.74900).

CROP PROTECTION

Disease Management

- Multilocation trial on integrated management practices involving addition of organic manure @ 25 kg/palm + *Trichoderma viride* @ 50 g/palm + sowing of dhaincha seeds @ 100 g/palm basin and incorporation with the initiation of flowering + recommended dose of fertilizers + zinc sulphate @ 50 g/palm + insecticide (Imidacloprid @ 1 ml/l of water) resulted in increase in nut yield of coconut compared to control plot in root (wilt) affected garden.
- Sequential application of fungicides as root feeding with carbendazim @ 5g in 100 ml of water during Jan, July followed by propiconazole @ 5ml in 100 ml of water during April and October was found effective in controlling the leaf blight incidence in coconut in Aliyarnagar.
- Integration of root feeding of Hexaconazole @ 3 ml + 100 ml water at quarterly interval and soil application of 100g talc based formulation of EPC5 along with 50kg FYM at 3 months interval was found significantly reduced basal stem rot disease incidence and effectively increased the nut yield when compared to untreated control.

Pest Management Rhinoceros beetle

A field study was carried out in Tamil Nadu (Aliyarnagar), Andhra Pradesh (Ambajipeta), Karnataka (Arsikere) and Maharashtra (Ratnagiri) to find out efficacy of botanical cake and paste and it was found effective in reducing spindle damage and leaf damage in coconut.

Eriophyid mite

Integrated nutrient management with organic & RDF and integrated pest management package was found effective against eriophyid mite with increased coconut yield. The mite population was showed a significant reduction when compared to control. There was increasing nut yield of coconut in INM and IPM plot, compared to untreated control plot in all the centres.

Spiralling whitefly

The Integrated Pest Management strategies effectively reduced the incidence and intensity of

rugose spiralling whitefly (RSW). In the IPM strategies adapted plot, the incidence and intensity of RSW was significantly reduced from 56.6% to 28.3% and 64.3 % to 32.2% respectively when compared to the natural control where the percent incidence and pest intensity was increased from 48.2% to 60.2% and 60.4% to 71.6%, respectively.

Pesticide holiday approach successfully proved for conservation of natural enemies like *Encarsia* in all localities which was effective in managing rugose spiraling whitefly infestation.

OIL PALM

- Based on long term hybrid evaluation, the oil palm hybrids viz., Godavari Swarna, Godavari Gold and Godavari Ratna were recommended for release in respective regions viz., NRCOP-4 with FFB yield of 30.11t/ha as Godavari Swarna for Andhra Pradesh; NRCOP-17 with FFB yield of 28.37 t/ha as Godavari Gold for Tamil Nadu; and NRCOP-2 with FFB yield of 22.69 t/ha as Godavari Ratna for Maharashtra states.
- Among the hybrids, the highest palm height of 4.89 m and leaf length of 3.99 m were recorded in NRCOP 32 and the hybrid NRCOP 38 registered the highest palm girth (3.40 m), the highest leaf breadth (1.72 m) and number of leaflets / leaf (161.98). NRCOP 38 registered the highest FFB yield (120.40 kg/palm) and yield per ha (17.21 t) was registered in hybrid NRCOP 38 followed by NRCOP 33 (15.84 t/ha) at pattukkottai (TN).

ARECANUT

- Technology demonstration on crown choke management at Shivamogga indicated that, management practices influenced better root development as well as better uptake of nutrients by the plant resulting in reduction of the infected leaves in the affected palms. After the imposition of treatments, healthy plants produced 5.8 bunches/ plant and infected plants produced 2.9 bunches/ plant compared to pre-treatment yield (5.1 and 2.6 bunches/ plant, respectively).
- At Wakawali centre, growth performance of 7 arecanut varieties were evaluated, Mohitnagar variety found statistically superior in plant characters and growth attributes over other varieties tested.



- Intercropping of arecanut with coriander and mint were carried out at Port Blair centre and identified that intercrops in arecanut plantations are found profitable, remunerative at Andaman regions.

COCOA

Multilocation trials (MLT) of cocoa clones under palms are 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). Number of beans per pod was also the highest in VTLCH-2 (38.42) followed by VTLCH-4 (38.32). At Navsari, VTLCH-4 registered the maximum pod weight, single dry bean weight, numbers of beans/pod and dry bean yield/tree/year.

PALMYRAH

Fresh Neera collected through CPCRI method was further processed by pasteurization followed by PET bottle sterilization gave maximum shelf life of 30 days for neera under refrigerated conditions. Palmyrah Syrup/honey of 65° Brix made from sap collected through cooling box method stored in glass bottle recorded shelf life of up to 6 months under ambient condition and it can be extended more than one year under refrigerated conditions.

MEETINGS HELD:

28th Annual Group meeting of AICRP on Palms

The 28th Annual Group Meeting of All India Co-ordinated Research Project on Palms was organized at Tamil Nadu Agricultural University, Coimbatore during 6th & 7th, June 2019. The inaugural function was presided by Dr. N. Kumar, VC, TNAU and Dr. W. S. Dhillon, Assistant Director General (Horticultural Sciences), ICAR, New Delhi was the Chief Guest. Dr. P. Rethinam, Former Executive Director, Asian and Pacific Coconut Community, Jakarta, Dr. K. Muralidharan, Director (i/c), ICAR-CPCRI, Kasaragod and Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi were the guests of honour. The Project Co-ordinator of AICRP (Palms), Dr. H. P. Maheswarappa in his report briefed the mission and achievement of AICRP on five crops - coconut, oil palm, palmyrah, arecanut and cocoa

distributed across 30 centres of 14 states and one union territory covering 13 State Agricultural Universities, four ICAR Institutes and two central universities.

Dr. W. S. Dhillon, Assistant Director General (HS -I), gave a bird's eye view of the overall growth of horticultural sector and its significant contribution to GDP and nutritional security of the nation. Dr. N. Kumar, Vice Chancellor, TNAU, in his Presidential address underlined the need for the development of composite mother gardens for the production of quality seedlings and called on palm scientists to develop drought mitigation strategies considering the weather extremities. Horticultural Research Station, Vijayarai was adjudged as the best AICRP (Palms) centre for the year 2018-19. Handful of publications which include three books on coconut and oil palm, two technical bulletins and seven folders and pamphlets were released by the dignitaries.

Following technologies have been recommended for release during the meeting

- IND 010 S derived from the ICAR CPCRI accession IND 010 Federated Malay States has been recommended for release in Kerala and Tamil Nadu in the name of Kalpa Ratna.
- Proposals for release of oil palm hybrids viz., NRCOP 4, NRCOP 17 and NRCOP 2 were recommended for release in the states of Maharashtra, TN and AP.
- Under Coconut based high density cropping system with compatible crops, application of 50% of RDF (NPK) + 50% N through organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring recorded higher system productivity followed by 75% of recommended NPK + 25% through organic recycling with vermicompost or fully organic is recommended for Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour and Veppankulam centres.
- **Management of rhinoceros beetle:** CPCRI Botanical cake + paste @ 15g each/palm can be recommended against rhinoceros beetle in juvenile palms as it was found effective in reducing spindle damage and leaf damage in coconut.

III. PROFILE OF AICRP ON PALMS

Objectives

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 livelihoods of millions of small and marginal farmers in the country. The All India Co-ordinated research Project on palms came to existence in the year 1972 to carry out the location specific research on mandate crops and the mandates of the project are as follows:

- 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 operating research 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, Production & Protection	Dr. Y.S.R Horticultural University, West Godavari Dt., Andhra Pradesh - 534 101
	Pandirimamidi: Horticultural Research Station, Pandirimamidi, Ramapachodaram, East Godavari Dt. - 533 288, Phone : 08864-246577	Palmyrah: Crop Improvement, Production & Post Harvest Technology	
	Vijayarai: Horticulture Research Station, Vijayarai, West Godavari Dt. - 534 475, Phone : 08812-225431	Oil palm: Crop Improvement & Production Cocoa: Crop Improvement	
	Pedavegi: Indian Institute of Oil Palm Research, Near Jawahar Navodaya Vidyalaya, Pedavegi, West Godavari Dt. -534 450, Phone :08812-259409/259532	Oil palm: Crop Improvement & Production	Indian Council of Agricultural Research
Andaman and Nicobar	Port Blair: Central Island Agricultural Research Institute, Port Blair -744101 Phone : 03192-250436	Coconut and Arecanut: Crop Improvement & Production	Indian Council of Agricultural Research
Arunachal Pradesh	Pasighat: College of Horticulture & Forestry, Pasighat - 791 102 Phone : 0368-2224887	Oil palm: Crop Improvement & Production	Central Agricultural University, P.O. Box 23, Imphal, Manipur - 795004
Assam	Kahikuchi: Horticultural Research Station, Kahikuchi, Guwahati Kamrup Dt. - 781 017, Phone : 0361-2840232	Coconut: Crop Improvement & Production	Assam Agricultural University, Jorhat, Assam - 785 013



Bihar	Sabour: Bihar Agricultural College, Sabour, Bhagalpur Dt. - 813210 Phone : 0641-2451001	Coconut: Crop Improvement & Production Palmyrah: Crop Improvement & Post Harvest Technology	Bihar Agricultural University, Sabour, Bhagalpur, Bihar - 813 210
Chattisgarh	Jagdalpur: Shaheed Gunda dhur College of Agriculture & Research Station, Kumhara wand Farm, Jagdalpur - 494 005 Phone : 07782-229360	Coconut: Crop Improvement & Production	Indira Gandhi Kri shi Vishwavidya laya, Raipur, Chhattisgarh - 492 012
Goa	Goa: Central Coastal Agricultural Research Institute, Ela, Old Goa Dt. - 403 402, Phone : 0832-2285448	Coconut and Arecanut: Crop Improvement & Production	Indian Council of Agricultural Research
Gujarat	Navsari: ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari - 396 450, Phone : 02637-282144	Coconut: Crop Improvement & Production Cocoa: Crop Improvement	Navsari Agricultural University, Navsari, Gujarat - 396 450
Karnataka	Arsikere: Horticultural Research and Extension Station, Arsikere, Hassan Dt. -573 103, Phone: 08174-291565 /291711	Coconut: Crop Improvement, Production & Protection	University of Horticultural Sciences, Navanagar, Bagalkot, Karnataka - 587 102
	Sirsi: Horticulture Research and Extension Centre, Sirsi, Uttara Kannada Dt.- 581401, Phone: 08384-226797/247787	Cocoa: Crop Improvement	
	Bavikere: Agricultural and Horticultural Research Station, Bavikere, Chikkamagaluru- 577144, Phone :08261 255122	Oil palm: Crop Production	University of Agricultural & Horticultural Sciences, Navile, Shivamogga, Karnataka - 577 225
	Shivamogga: Arecanut Research Centre, College of Agriculture, Navile, Shivamogga Dt. - 577 225, Phone : 08181-267011	Arecanut: Crop Improvement, Production & Protection	
Kerala	Kasaragod: Central Plantation Crops Research Institute, Kasaragod - 671 124, Phone : 04994-232733	Coconut: Crop Production	Indian Council of Agricultural Research
	Pilicode: Regional Agricultural Research Station, Pilicode P.O., Kasaragod - 670353, Phone:0467-2260450	Coconut: Crop Improvement	Kerala Agricultural University, Vellanikkara, Thrissur, Kerala - 680 656
	Thrissur: Cocoa Research Centre, Kerala Agricultural University, Vellanikkara, Thrissur Dt.- 680 656, Phone: 0487-2438457	Cocoa: Crop Improvement	
Maharashtra	Mulde: College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. - 416520, Phone: 02362-244231/244232	Oil palm: Crop Improvement & Production	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri Dt., Maharashtra - 415 712
	Ratnagiri: Regional Coconut Research Station, Bhatye, Ratnagiri Dt. - 421612 Phone : 02352-255077	Coconut: Crop Improvement, Production & Protection Cocoa: Crop Improvement	

	Wakawali: Central Experimental Station, Asond block, Wakawali, Dapoli Taluk. Phone : 02358-282417	Arecanut: Crop Improvement & Production	
Odisha	Bhubaneswar: Department of Horticulture, (OUAT), Bhubaneswar - 751 003 Phone : 0674-2397463	Coconut: Crop Improvement & 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 Ph: 04253-288722/288662	Coconut: Crop Improvement, Production & Protection Cocoa: Crop Improvement	Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu - 641 003
	Killikulam: Agricultural College & Research Institute, Killikulam, Vallanad, Tuticorin Dt. - 628 252 Phone : 04630-261226	Palmyrah: Crop Improvement & Production	
	Pattukkottai: Agricultural Research Station, Pattukkottai, Thanjavur Dt. - 614 602 Phone : 04373-235832	Oil palm: Crop Improvement & Production	
	Veppankulam: Coconut Research Station, Veppankulam, Thanjavur Dt. - 614 906 Phone: 04373-260205/202534	Coconut: Crop Improvement, Production & 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 – 500030
West Bengal	Mondouri: Directorate of Research, P. O. Kalyani, Nadia Dt. - 741 235, Phone :033-25827574	Coconut: Crop Improvement & Production	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal - 741252

Budget

The budget for the year 2019 (April to Dec) was Rs. 453.17 lakhs (ICAR Share)
(Rs. in lakhs)

Sl. No.	Head	Expenditure
1.	Pay and allowances	330.17
2.	T.A.	8.40
3.	RC	96.40
4.	HRD	3.20
5.	Equipments	15.00
	Total	453.17

Centre wise budget for 2019 (ICAR share Rs. in Lakhs)

Centre	Pay	TA	RC	HRD	Eqpt.	Total
Aliyarnagar	34.42	0.70	6.15	0.40	1.00	42.67
Ambajipeta	37.65	0.43	4.30	0.40	1.88	44.66
Arsikere	21.80	0.00	5.30	0.30	3.27	30.67
Jagdapur	15.40	0.64	3.20	0.20	0.00	19.44
Kahikuchi (NEH)	32.75	0.40	3.20	0.20	0.00	36.55
Bhubaneswar	6.08	0.00	3.50	0.20	0.00	9.78
Mondouri	10.00	0.20	1.50	0.10	0.00	11.80
Ratnagiri	42.43	0.40	4.85	0.30	0.63	48.61
Veppankulam	34.62	0.26	3.00	0.10	0.00	37.98
Killikulam	14.65	0.50	2.10	0.10	0.00	17.35
Pandirimamidi	26.59	0.20	2.80	0.10	2.50	32.19
Pattukkottai	12.62	0.20	3.00	0.10	0.72	16.64
Mulde	16.55	0.30	3.10	0.10	0.00	20.05
Vijayarai	7.88	0.00	3.00	0.00	0.00	10.88
Navsari	3.95	0.00	3.10	0.10	0.00	7.15
Sabour	10.45	0.16	3.40	0.00	0.00	14.01
Pasighat (NEH)	0.00	0.20	2.00	0.10	0.00	2.30
Pilicode	0.00	0.05	2.35	0.00	0.00	2.40
Kasaragod (ICAR)	0.00	0.00	0.00	0.00	0.00	0.00
PC cell	0.00	3.50	7.10	0.00	0.00	10.60
Port Blair (ICAR)	0.00	0.00	4.50	0.10	0.00	4.60
Goa (ICAR)	0.00	0.00	3.00	0.10	0.00	3.10
Shivamogga	2.33	0.16	3.50	0.10	0.00	6.09
Wakawali	0.00	0.00	2.50	0.00	0.00	2.50
IIOPR, Pedavegi (ICAR)	0.00	0.00	3.50	0.00	0.00	3.50
Bavikere	0.00	0.00	3.25	0.10	0.00	3.35
K Mallepally	0.00	0.05	1.40	0.00	0.00	1.45
Sirsi	0.00	0.05	1.40	0.00	0.00	1.45
Thrissur	0.00	0.00	1.40	0.00	0.00	1.40
Aliyarnagar (SCSP)	0.00	0.00	0.75	0.00	0.75	1.50
Ambajipeta (SCSP)	0.00	0.00	0.50	0.00	0.50	1.00
Arsikere (SCSP)	0.00	0.00	0.50	0.00	0.50	1.00
Jagdapur (SCSP)	0.00	0.00	0.50	0.00	0.50	1.00
Kahikuchi (SCSP)	0.00	0.00	0.50	0.00	0.50	1.00
Ratnagiri (SCSP)	0.00	0.00	0.50	0.00	0.50	1.00
Veppankulam (SCSP)	0.00	0.00	0.50	0.00	0.50	1.00
Bhubaneswar (SCSP)	0.00	0.00	0.25	0.00	0.25	0.50
Sabour (SCSP)	0.00	0.00	0.25	0.00	0.25	0.50
K Mallepally (SCSP)	0.00	0.00	0.25	0.00	0.25	0.50
Pandirimamidi (SCSP)	0.00	0.00	0.25	0.00	0.25	0.50
Killikulam (SCSP)	0.00	0.00	0.25	0.00	0.25	0.50
Total	330.17	8.40	96.40	3.20	15.00	453.17

SCSP: Scheduled caste sub plan

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	34
Technical	19
Supporting	16
Total	69

Staff Position**HEAD QUARTERS****Project Coordinator's Cell, ICAR-CPCRI, Kasaragod, Kerala - 671 124**

Project Coordinator	:	Dr. Maheswarappa, H. P
Scientist (SPMA)	:	Dr. Sumitha S.
Scientist (Entomology)	:	Dr. Jilu V. Sajan
Private Secretary	:	Mrs. K. Narayani
Skilled supporting staff	:	Mr. A. Mohana
Senior Research Fellow	:	Ms. Dhathri N R
Clerical Assistant	:	Mr. S. Karunakara

ANDHRA PRADESH**Horticultural Research Station, Ambajipeta, East Godavari Dt. - 533 214 (Phone: 08856 – 243847)**

Senior Scientist (Hort.)	:	Dr. G. Ramanandam (Up to August, 2019) Dr. B.V.K. Bhagavan (From August, 2019)
Scientist (Agron.)	:	Dr. A.Kireeti (From 22.08.2019)
Scientist (Pathology)	:	Dr. B. Neeraja
Technical Asst.	:	Shri. B. Koteshwara Rao, Smt. N. Maheshwari

Horticultural Research Station, Pandirimamidi, Ramapachodavaram, East Godavari Dt. - 533 288 (Phone: 08864 – 243577)

Scientist (Food Sci. & Tech.)	:	Dr. P. C. Vengaiah
Scientist (Horticulture)	:	Dr. Rajendra Prasad

Horticultural Research Station, Vijayarai, West Godavari Dt. – 534 475 (Phone: 08812-225431; Fax: 08812- 225826)

Scientist (Horticulture)	:	Dr. M. Kalpana
Scientist (Horticulture)	:	Dr. M. Thirupathi Reddy

ICAR- Indian Institute of Oil Palm Research, Near Jawahar Navodaya Vidyalaya, Pedavegi, West Godavari Dt. – 534 450 (Phone :08812-259409/259532)

Principal Scientist (Horticulture)	:	Dr. B. Narsimha Rao
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ANDAMAN & NICOBAR ISLANDS**ICAR- Central Island Agricultural Research Institute, Port Blair - 744 101 (Phone: 03192 250436; Fax: 03192-251068)**

Scientist (Horticulture)	:	Dr. Ajit Arun Waman
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ARUNACHAL PRADESH**College of Horticulture and Forestry, Central Agricultural University, Pasighat, East Siang Dt. - 791 102 (Phone: 0368- 2224887; Fax - 0368- 2225066)**

Scientist (Horticulture)	:	Dr. Barun Singh
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**ASSAM****Horticultural Research Station, Kahikuchi, Guwahati, Kamrup Dt. -781 017 (Phone: 0361- 2840232)**

Principal Scientist (Horticulture) : Dr. J. C. Nath
Senior Scientist (Horticulture) : Mrs. Rinku Moni Phukon
Technical Assistant : Shri. Rajaram Patowari

CHHATTISGARH**Shaheed Gunadadthur College of Agriculture & Research Institute, Kumharawand Farm, Jagdalpur, Bastar Dt. - 494 005 (Phone: 07782- 229150; Fax: 07782- 229360)**

Scientist (Horticulture) : Dr. Beena Singh
Scientist (Agronomy) : Shri. P. K. Salam (on study leave)

GOA**ICAR- Central Coastal Agricultural Research Institute, Ela, Old Goa - 403 402 (Phone: 0832-2284678 / 79; Fax: 0832-2285649)**

Principal Scientist (Horticulture) : Dr. V. Arunachalam

GUJARAT**Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari - 396450 (Phone: 02637-282144)**

Scientist (Horticulture) : Dr. Pankaj Pandurang Bhalerao

KARNATAKA**Horticultural Research and Extension Station, Arsikere, Hassan Dt. – 573 103 (Phone: 08174 - 291565)**

Senior Scientist (Horticulture) : Mr. R. Siddappa
Scientist (Pathology) : Dr. Manjunath Hubballi (Up to 12.06.2019)
Dr. Kiran Kumar K C (From 13.06.2019)
Scientist (Entomology) : Dr. G. S. Chandrashekar
Technical Assistant : Ms. Swetha
Mr. K. E. Dayananda

College of Agriculture, Navile, Shivamogga Dt. – 577 216 (Phone: 08182267011)

Principal Scientist (Plant Pathology) : Dr. B. Gangadhara Naik

Agricultural and Horticultural Research Station, Bavikere, Chikkamagaluru Dt. 577 144 (Phone: 08261 255122)

Scientist (Horticulture) : Dr. Nagarajappa Adiyavappar (From 10.07.2018)

Horticulture Research and Extension Centre, Sirsi, Uttara Kannada Dt.- 581 401(Phone: 08384-226797/247787)

Professor (Horticulture) : Dr. Laxminarayan Hegde (Upto 20.08.2019)
Shri. Sudheesh Kulkarni (From 21.08.2019)

KERALA**ICAR- Central Plantation Crops Research Institute, Kasaragod- 671 124 (Phone: 04994-232893)**

Principal Scientist (Agronomy) : Dr. P. Subramanian

Regional Agricultural Research Station, Pilicode, Kasaragod Dt. – 670 533(Ph: 0467-2260450/2282737)

Principal Scientist (Plant Breeding) : Dr. Vanaja T.

Cocoa Research Centre, Kerala Agriculture University, KAU P.O. Vellanikkara, Thrissur, Kerala-680656 (Phone: 0487-2438457)

Senior Scientist (Plant Breeding) : Dr. J. S. Minimol

MAHARASHTRA

College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. – 416 520 (Phone: 02362 244231 – 244232; Fax: 02362 – 244231)

Scientist (Horticulture) : Dr. M. S. Gawankar
Senior Technical Assistant : Shri N. M. Naik

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

Senior Scientist (Plant breeding / Horti.) : Dr. 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

Central Experimental Station, Asond block, Wakawali, Ratnagiri Dt. (Phone : 02358-282417)

Scientist (Horticulture) : Dr. C. M. Praful

ODISHA

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

Scientist (Horticulture) : Dr. S. C. Sahoo
Technical Assistant : Mr. P. C. Behera (From 01.04.2018)

TAMIL NADU

Coconut Research Station, Aliyarnagar, Coimbatore Dt. – 642 101 (Phone: 04253- 288722)

Scientist (Horticulture) : Dr. V. Sivakumar
Scientist (Entomology) : Dr. M. Alagar
Scientist (Agronomy) : Dr. S. Rani
Scientist (Plant Pathology) : Dr. E. Rajeswari
Technical Assistant : Mr. M. Panjalingam

Agricultural Research Station, Pattukkottai, Thanjavur Dt. – 614 602 (Phone: 04373 – 235832)

Scientist (Horticulture) : Dr. M. Tamil Selvan
Senior Technical Assistant : Th. S. Vivekananthan

Coconut Research Station, Veppankulam, Thanjavur Dt. - 614 906 (Phone: 04373- 260205)

Scientist (Horticulture) : Dr. K. S. Vijaya Selvaraj
Scientist (Agronomy) : Dr. A. Selvarani
Scientist (Plant Pathology) : Dr. Surali Rajan
Technical Assistant : Mrs. B. Sundari: Mr. P. Nallathambi

Agricultural College & Research Institute, Killikulam, Vallanad, Tuticorin Dt. – 628 252 (Phone: 04630 – 261226; Fax: 04630 – 261268)

Scientist (Horticulture) : Dr. Ravindran
Technical Assistant : Smt. P. Anantha Bai

TELANGANA

Horticulture Research Station, Konda Mallepally Mandal, Nalgonda Dt. – 508 243

Scientist (Horticulture) : Dr. T. Suresh Kumar

WEST BENGAL

Department of Plantation Crops, Faculty of Horticulture, BCKVV, Mondouri (Kalyani), Nadia Dt. -741 235 (Phone: 033- 25827574)

Senior Scientist (Horticulture) : Dr. Dipak Kumar Ghosh (LKN)

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

Centers: Bhubaneswar, Navsari and Sabour

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

List of germplasms under evaluation

Center	Genotypes evaluated
Bhubaneswar	COD, Kalparaksha, MYD, Gangabondam, SSG, Guam- I, Kerakeralam, Kalpatharu, St. Vincent, Kalpamitra, BSI, Andaman Ordinary, Zanzibar Tall, Benaulim (Pratap), San Ramon and Sakhigopal
Navsari	COD, MYD, Gangabondam, CGD, Pratap, PHOT, Kappadam, Seychelles, Borneo, FMS, LCOT, ADOT, San Ramon, Guam, WCT, BRR, BGL, BYL and Spicata,
Sabour	LCOT, PHOT, ADOT, Benaulim, Tiptur Tall, Arasampatti Tall, ECT, Gonthebili Tall, Zanzibar Tall, Hazari Tall, Assam Green Tall, Malayan Yellow Dwarf, Malayan Orange Dwarf, Kamrupa Green Dwarf, COD, GBGD and Sakhigopal

Bhubaneswar

This experiment was initiated with sixteen germplasm accessions comprising of 4 Dwarf and 12 Talls during 2004 as an un-replicated observation trial. Among the dwarfs under evaluation, the minimum plant height (2.6m) was recorded in MYD. However, GBGD performed better by exhibiting maximum plant girth (137 cm), number of functional leaves (33.3 nos.), annual leaf production (13 nos.), number of inflorescences (12.8 nos.) and number of female flowers (300.3 nos.). Highest nut yield (66.8 nuts) was recorded in COD followed by GBGD (66 nuts). Among the talls, minimum plant height (3.3 m) was recorded in Java Tall. Maximum plant girth at base (195.5 cm) as well as leaf length (6.2 m) was recorded in WCT. Similarly, maximum number of functional leaves (33 nos.) and annual leaf production (12.8 nos.) were recorded in Guam-I. The cultivar St. Vincent registered the maximum number of inflorescences (12.8 nos.) and female flowers (258.8 nos.). However, the maximum nut yield (78 nuts/palm/year) was recorded in Andaman Ordinary



Field view of Gen.1.Expt.1 at Bhubaneswar

which consistently producing maximum nuts in last few years.

Navsari

This experiment includes four dwarf and fifteen tall genotypes which were planted during August, 2014. Results revealed that, the growth characters like plant height (396.7 cm) recorded maximum in Guam whereas, collar girth (194.7 cm) recorded

maximum in Borneo. Generally, all the genotypes are produced average 10-12 numbers of annual leaf/year whereas; functional leaves on the crown (26.7 nos.) were recorded maximum in ADOT. Moreover, highest leaf length (586.7 cm) was recorded in Kappadam and petiole length (185.3 cm) was recorded in PHOT. The maximum inflorescence production (10.7 nos.) was in FMS whereas; nut yield/palm/year (28.3 nuts) was highest in LCOT .

Sabour

A total of fourteen germplasms were planted during 2013 at Sabour centre and seedlings are under establishment phase. As per growth parameter is concerned maximum plant height was noted in variety Shakhi Gopal followed by MYD and IND 007(COD) with plant height of 650 cm ,605 cm and 490cm, respectively. The minimum plant height of 271 cm was noted in Arasampatti Tall followed by Tiptur Tall (291.0 cm). The maximum number of functional leaves was noted in Shakhi Gopal Tall (18.5leaves per plant) followed by IND007 (COD) with 18.2 leaves and minimum in Arasampatti Tall (8.7). Variety Malayan Yellow Dwarf (MYD) and Chowghat Orange Dwarf (COD) were earliest to come in flowering with 63 and 65 months from date of planting. Assam Green Tall (AGT), CRP 509(ECT), Chandra Kalpa and VPM 3 (ADOT) took 71 to 73 months for flowering.

Expt. 2: Collection, conservation and evaluation of location specific germplasms

Centers: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Pilicode, Ratnagiri, Sabour and Veppankulam.

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.

Aliyarnagar

Eleven germplasms were collected during 2008 in which five germplasms (IC No. 610370, 610375, 610376, 610377 and 610378) are maintained as a replicated trial and the remaining six (IC No. 610371, 610372, 610373, 610374, 610375 and 610379) have been planted as observational trial.

Replicated trial

Among the ecotypes being maintained under replicated experiment, analysis of observations revealed that, the ecotype IC No. 610375 recorded lowest palm height (284.6 cm) and expressed as a dwarf nature among the ecotypes. The ecotype IC No. 610378 exhibited vigorous nature by recording maximum trunk girth (165.8 cm) and leaf length (536.9 cm). Regarding the nut yield, the ecotype IC No. 610370 recorded the higher nut yield (88.9 nuts/palm/year) which is followed by IC No. 610376 (71.5 nuts/palm/year). The ecotype IC No. 610378 expressed favourable nut characters by recording higher whole nut weight (2182.8 g/nut), de-husked nut weight (1140.3 g) and copra weight (303.8 g) (Table 1).

Table 1: Growth and yield characters of location specific germplasms of coconut at Aliyarnagar (Year of planting 2008 & 2012)

IC number	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves (nos.)	Leaf length (cm)	Nut yield (nuts/palm/year)
610370	296.5	163.2	11.6	32.3	455.2	88.9
610375	284.6	152.6	10.5	28.6	430.1	62.2
610376	358.4	158.4	11.2	32.1	481.6	71.5
610377	306.9	143.2	10.8	30.4	510.6	58.9
610378	330.5	165.8	11.5	29.5	536.9	68.5
Mean	315.4	156.6	11.1	30.6	482.9	70.0
SE d±	14.2	NS	NS	NS	8.7	1.3
CD (P=0.05)	32.8	NS	NS	NS	20.1	2.9

Ambajipeta

Thirteen local germplasms were collected from traditional coconut growing districts viz., Srikakulam, East and West Godavari districts of Andhra Pradesh. The experiment was laid out during February 2013. Out of thirteen accessions, five accessions viz., ECT green (IC No. 610311), Jonnalarasi brown (IC No. 610309), Pillalakodi green (IC No. 610306), Pillalakodi brown (IC No. 610307) and Gangabondam green dwarf (IC No. 610310) were planted in RBD with four replications and 4 palms per replication and remaining eight accessions viz., Jonnalarasi green (CRP 747), ECT Brown (CRP 751), Itikulagunta ECT Big (CRP 754), Itikulagunta ECT Small, Saradapuram ECT (CRP 753), Srikakulam ECT (CRP 752), Vemulapalli ECT Big, Vemulapalli ECT Small were planted as an observational trial at 6 palms per accession and they are in vegetative to bearing stage.

Observations on growth attributing characters were recorded and significant difference was noticed among different accessions for girth, total leaf length and petiole length. Significantly the highest girth (113.1 cm) was observed in ECT green (IC No. 610311), whereas Pillalakodi brown (IC No. 610307) recorded the highest petiole length (167.8 cm) and ECT green (IC No. 610311) recorded maximum leaf length (577.8 cm). With regards to flowering, Gangabondam (IC No. 610310) was the earliest to flower in 37 months followed by Pillalakodi brown (50 months) and Pillalakodi green (51 months). Significantly higher number of nuts (91.7 nuts/palm/year) was recorded in Jonnalarasi brown (IC No. 610309) followed by Pillalakodi brown (IC No. 610307) (85.6 nuts) and Pillalakodi green (IC No. 610306) (84.4 nuts) which were on par (Table 2).

Table 2: Growth characters and yield performance of location specific germplasms of coconut at Ambajipeta (Year of planting 2013)

IC number	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves	Petiole length (cm)	Inflorescences /palm/year	No. of spikelet	Nut yield (nuts/ palm/ year)
610311	316.8	113.1	12.7	29.2	159.8	7.4	37.3	63.8
610309	291.8	107.5	12.8	27.8	167.8	7.5	38.5	91.7
610306	324.7	107.9	13.1	28.1	159.8	7.7	40.4	84.4
610307	328.8	98.2	12.6	27.6	157.1	7.7	40	85.6
610310	313.2	73.3	14.3	30.3	129.3	7.9	37	48.8
Mean	315	100	13.1	28.6	154.7	7.6	38.6	74.9
SEd±	14.4	4.3	0.7	1.1	4.3	0.6	2.3	8.3
CD (P=0.05)	NS	13.3	NS	NS	13.2	NS	NS	25.6

Arsikere

Among the germplasms in the replicated trial, the maximum plant height (483.3 cm), plant girth (108.8 cm), leaf length (232.4 cm), petiole length (131.5 cm), annual leaf production (12.1 nos.) and number of functional leaves (29.4 nos.) were observed in IC No. 610339. With regards to flowering IC No. 610339 was earliest compared to others germplasms.

Bhubaneswar

A field experiment, comprising of eleven local germplasms were initiated during December, 2003 as an un-replicated observational trial with 10 palms per germplasm. Among the different growth parameters studied, minimum plant height (4.3 m) was recorded



Yield of Pillalakodi brown (IC No. 610306)

in IC No.612467. The maximum plant girth (195.4 cm) and annual leaf production (12.9 nos.) were recorded in IC. No. 612457, locally known as Local Giant. The same germplasm also showed its superiority over others by producing maximum number of inflorescences (12.6 nos.), female flowers (230.4 nos.) and nut yield (85 nuts/palm/year). The germplasm IC. No. 612458 also performed better by registering maximum number of leaves (32.1 nos.) and nuts (79.2 nuts/palm/year) next to IC. No. 612457. There was hardly any variation among all local germplasm with respect to length of leaf and petiole.

Jagdalpur

The accessions of six collected germplasms were planted in July 2011 in RBD with four replications at 4 palms per replication and observations on growth parameters were recorded. The maximum plant height (615.8 cm) was in IC 610325 which was at par with IC 610327 (515.1 cm) whereas the leaf length was the highest in CRP724 that was at par with IC 610325, IC 610323 and IC 610328 (336.2, 314.9, 298.4 and 282.1 cm respectively). The plant girth was the highest in accession IC 610325 (144.9 cm) which was at par with IC 610327 (122.4 cm).

Kahikuchi

The experiment was initiated with 10 local accessions CRP 701 (IC No 61035) to CRP 710 (IC No 610362) along with two check varieties viz., Kamrupa and WCT under replicated trial during 2005. The experiment was laid out in RBD with three replications.

Replicated trial

The data showed that highest plant height (5.2 m), plant girth (162.2 cm), number of functional leaves (32.5 nos.) and annual leaf production (11.8nos.) were recorded in Kamrupa. The highest petiole length (165.1 cm) and leaf length (428.6 cm) were observed in IC No. 610358, and IC No. 610360 respectively. The highest number of inflorescence (11.5nos.) and number of buttons (25.6nos.) were recorded in Kamrupa followed by the germplasm IC No 610357 and the lowest values were obtained in IC No 610358. With regard to nut characteristics and nut yield, the genotype (IC No. 610354) recorded the highest nut length of 28.7 cm, girth (49.7 cm) with nut weight (1476.5 g/nut) and tender coconut water content (375.6 ml/nut). Significantly the highest nut yield of 82.4 nuts/palm/year was observed in Kamrupa followed by IC No 610357 (76.5 nuts/palm/year) compared to other germplasms (Table 3).

Table 3: Nut yield and nut parameters of location specific germplasms of coconut in at Kahikuchi (Year of planting 2005)

IC No.	Inflorescences/ palm/year (nos.)	No. of buttons (nos.)	Nut yield (nuts/palm/year)	Weight of whole nut (g)	Water content (ml)	Length of nut (cm)	Breadth of nut (cm)
610353	10.4	22.8	63.5	1269.0	320.5	26.9	45.5
610353	10.4	22.8	63.5	1269.0	320.5	26.9	45.5
610354	10.6	22.9	65.1	1476.5	375.6	28.7	49.7
610355	10.0	21.8	58.6	1265.5	275.4	28.0	44.8
610356	10.3	23.0	64.2	1350.6	330.5	27.9	46.9
610357	11.1	25.0	76.5	1240.5	299.0	25.4	47.5
610358	9.8	21.7	60.6	1320.7	280.6	27.9	45.3
610359	10.1	22.0	61.8	1380.8	325.2	25.6	45.0
610360	10.4	22.7	59.2	1300.7	290.8	25.8	42.9
610361	10.0	23.0	61.0	1385.6	295.0	27.0	45.7
610362	10.7	22.1	65.0	1375.4	282.4	28.2	44.6
WCT	10.2	22.9	63.0	1360.8	295.7	26.7	46.4
Kamrupa	11.5	25.6	82.4	1375.7	345.5	26.9	48.9
Mean	10.4	23.0	65.1	1236.4	309.7	27.1	46.1
CD (P=0.05)	0.5	0.8	3.8	43.5	18.4	1.8	1.1

Mondouri

A total of ten local germplasms were collected from different districts of West Bengal. Out of these local germplasms, five (IC No. 612447, 612448, 612449, 612450 and 612451) were planted in replicated trial during 2007 and remaining five local germplasms (IC No. 612452, 612453, 612454, 612455 and 612456) were planted in observational trial during 2009.

Replicated trial

Among the germplasms evaluated under replicated trial, significant variations were recorded in different vegetative characters. Annual leaf production (22.8 nos.) was maximum in CRP779 (IC No. 612447) but plant height (3.84 m) was maximum in CRP783 (IC No. 612451). The maximum plant girth (1.38 m) was recorded in CRP782 (IC No. 612450) and the maximum nut yield (48 nuts) were recorded in the collection CRP783 (IC No. 612451).

Navsari

Four local germplasms (IC No. 610319, 610320, 610321 and 610322) were planted in RBD with five replications during 2013 and the seedlings are in establishment phase. The data on growth and flowering characters revealed that, the maximum plant height (244.8 cm), annual leaf production (9.8 nos.), leaf length (497.6 cm) with minimum age at first flowering (45.3 months) was observed in CRP730 (IC No. 610320). However, plant girth (187.4 cm), number of functional leaves (24.2 nos.), inflorescence production (10.6 nos.) and nuts yield (28.6 nuts) recorded maximum in CRP 729 (IC No. 610319), whereas, maximum petiole length (164.4 cm) was recorded in CRP 731 (IC No. 610321). Regarding to reaction of biotic stresses, 2-3 % palms of all germplasm are infected by Rhinoceros beetle and no other infestation of pests and diseases are observed in the experimental plot.

Pilicode

At Pilicode center, six dwarf local ecotypes collected from different parts of Kerala have been raised in replicated experiment during February 2017 along with local check CGD. Three juvenile growth parameters viz., plant height, no. of leaves, girth, and Rhinoceros beetle infestation were observed. Out of

seven dwarf genotypes, 'Chulliyode' exhibited significantly shortest height (1.54 m) which is on par with 'Chakkitapara Local' and 'Mannukusumbil-2'. With respect to number of leaves, the check variety CGD exhibited significantly highest number (11.8 nos.). Among new collections, 'Nirvaram' showed highest number of leaves (9.6 nos.) which is on par with that of 'Azheethala', 'Mannukusumbil-2' and 'Chakkitapara Local'. The check variety CGD showed the highest plant girth. Among new dwarf collections highest girth recorded for 'Mannukusumbil-2' (55.03 cm) followed by 'Nirvaram'. The check variety CGD started flowering and fruiting during the third year. Among seven genotypes, RARS-DC-3 (Azheethala) and RARS-DC-1 (Chulliyode) showed lowest infestation of rhinoceros beetle.

Ratnagiri

At Ratnagiri centre, a total of six local germplasms collected from Konkan region were planted in replicated trial (IC No. 599111 to 599116) and remaining six were planted in observational trial (IC No. 599994 to 599999) during 2007 and 2010, respectively. One more germplasm (sweet coconut-*Mohacha naral*) having the IC No. 599123 and one embryo cultured plantlets) which was collected from Guhagar Tahsil of Ratnagiri district, the fourteen seedling types and one set of embryo culture plantlets were planted in the field during 2007 for evaluation.

Replicated trial

Among the germplasms evaluated under replicated trial, significant variations were recorded in different vegetative characters. The data on growth and flowering characters revealed that, the maximum plant height (479.7 cm) were maximum plant girth (110.3 cm), recorded in genotype IC 599115. Genotype IC599113 recorded maximum annual leaf production (12.3 nos.), IC 599115 recorded maximum number functional leaves (28.1 nos.), IC 599113 recorded highest leaf length (425 cm) and genotype IC599112 recorded maximum petiole length (160.6 cm) among all genotypes under evaluation. Flowering was observed in all the genotypes. Genotype IC 599113 recorded maximum no. of inflorescence (11.3 nos.) and IC 599116 recorded maximum no. of buttons (164.7 nos.). The genotype IC 599112 recorded maximum nuts yield (64.9 nuts), maximum whole nut

weight (1412.5 g), maximum de-husked nut weight (954.8 g) and maximum copra weight (188.1g). The Rhinoceros beetle incidence was highest in IC 599111 (4.73 %) whereas lowest in IC 599116 (0.68 %), the

highest eriophyid mite incidence was in IC 599112 (33.33 %) and highest Rugose spiralling whitefly incidence was in genotype IC 599113 (4.0%) among all genotypes under evaluation (Table 4).

Table 4: Growth characters of location specific germplasm of coconut at Ratnagiri (Year of planting 2007)

IC Number	Plant height (cm)	Plant girth(cm)	Annual leaf production (nos.)	No. of functional leaves/palm(nos.)	No. of buttons(nos.)	Nut yield (nuts/palm/year)
599111	422.7	104.3	11.8	27.1	128.8	31.4
599112	460.6	98.1	11.9	27.4	151.9	64.9
599113	455.6	105.5	12.3	27.3	157.5	42.2
599114	435.0	101.8	12.2	26.2	159.4	55.5
599115	479.7	110.3	11.4	28.1	156.9	55.6
599116	436.0	100.2	11.8	23.1	164.7	46.5
Mean	448.3	103.4	11.9	26.5	411.2	153.2
SEd±	13.3	2.8	0.17	0.89	6.41	7.8
CD (P=0.05)	40.1	8.4	0.51	2.69	19.33	23.4

Sabour

Six germplasm have been collected and four have been planted in the field during 2014 and two collections are in nursery stage, which were planted in the field during July, 2019. All the seedlings are in vegetative growth stage. Six germplasm has been collected at Sabour Centre. Five genotypes have been planted in field and one collection is in nursery stage that will be planted in the field during July, 2020. All the seedlings are still in vegetative growth stage. The maximum plant growth was noted in collection SBRC-1 and SBRC- 2 having plant height of 243 cm and 205 cm, plant girth of 90 cm and 82cm and no of leaves 7.7 and 6.5, respectively. Collection SBRC -3 and SBRC -4 registered plant height of 152.0cm and 150 cm, respectively. One more genotype will be planted during July, 2020.

Veppankulam

Five germplasm (IC No. 599263 to 599267) have been collected and planted during 2005 as under planting along with 2 check varieties (Kerakeralam and ALRCN1). The old plants in this experiment were removed during 2012 and the palms are now in bearing phase with real expressivity. Due to the occurrence of 'Gaja' cyclone during November 2018, 12 palms were

lost and bunch in all the genotypes with different maturity were fallen down. The trees are recovering slowly after adequate irrigation and application of recommended dose of fertilizers with incorporation of vermin compost, neem cake and bio-fertilizers. Among the germplasm, IC No. 599266 was found to be dwarf stature (736 cm) and IC No. 599265 recorded higher annual nut yield (June.2018 to Nov.2018) of 51 nuts/palm with superior nut quality characters, viz., maximum whole nut weight and copra content (940 g/nut, and 172 g/nut respectively).

Expt. 3: Evaluation of elite germplasm

Centers: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Ratnagiri and Veppankulam With a view to assess few elite exotic coconut genotypes, this trial was initiated in multiple locations as replicated field experiments for their yield performance and to reaction to biotic and abiotic stresses. Inter-se mated seed nuts of different sets of materials were supplied from ICAR-CPCRI to centres as furnished hereunder and the experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication (Table 5).

Table 5 : Participating centres and genotypes under evaluation

Elite genotypes	Aliyarnagar	Ambajipeta	Arsikere	Bhubaneswar	Ratnagiri	Veppankulam
Verrickobari Tall	*	*	*	*	*	*
St. Vincent Tall	-	*	*	-	*	-
Guam-II Tall	-	*	*	-	-	*
Guam-III Tall	*	-	-	*	*	-
Zanzibar Tall	-	*	-	-	*	-
Straits Settlement Green Tall	*	*	*	-	*	-
Markham Tall	*	-	*	-	-	*
Laguna Tall	-	-	-	*	-	*
Nigerian Green	*	-	*	*	*	*
Palawan Tall	*	-	-	*	-	*
Kenya Tall	-	*	-	*	-	-
Local check	*	*	*	*	*	*

Note: in all the centres, seedlings were planted during 2015-2016 and the trial is in establishment stage

Aliyarnagar

With a view to assess few elite exotic coconut genotypes, this trial was invented in at Aliyarnagar as replicated field experiment for their yield performance and to observe for reaction to biotic and abiotic stresses. *Inter-se* mated seed nuts of six exotic genotypes were supplied by the ICAR-CPCRI, Kasaragod, Kerala and the experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Experiment was initiated during the year 2015 and the trial is in flowering stage. The data on growth parameters

revealed that there was no significant variation among different exotic collections except annual leaf production. Nigerian Green Tall proved its dwarf stature by registering lower palm height (477.4 cm) among the germplasm evaluated, whereas Gauam-III Tall expressed vigorous nature by producing higher stem girth (182.5 cm), number of functional leaves (25.5 nos.) and leaf length (524.1 cm). Among the six elite germplasms, flowering was observed in all genotypes in few palms in every replication. Average incidence of Rhinoceros beetle leaf damage was found 5.7 % and spindle damage was found 5.8 per cent (Table 6).

Table 6: Growth characters and pest and diseases incidence of elite coconut germplasms at Aliyarnagar (Year of planting: 2015)

Genotypes	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm (nos.)	Leaf length (cm)	Petiole length (cm)	Rhinoceros beetle incidence(%)		Bud rot incidence (%)
							% Leaf damage	% Spindle damage	
Verrickobari Tall	509.2	177.7	7.5	18.6	509.2	157.3	6.0	4.5	-
Guam-III Tall	524.1	182.5	9.7	25.5	524.1	175.6	3.5	7.5	-
Markham Tall	485.2	121.1	8.2	15.9	485.2	211.8	6.5	4.0	3.5
Straits Settlement Green Tall	498.3	124.1	9.8	21.5	498.3	138.5	4.0	3.5	-
Nigerian Green	477.4	148.7	10.0	19.8	477.4	150.2	2.0	2.5	-
Palawan Tall	523.6	158.1	9.9	17.6	523.6	167.6	6.0	5.5	-
West Coast Tall	472.2	140.7	7.5	15.9	472.2	139.8	12.0	13.0	-
Mean	498.6	150.4	9.0	19.3	498.6	163.0	5.7	5.8	3.5
SE d±	NS	NS	0.8	NS	NS	NS			
CD (P=0.05)	NS	NS	1.8	NS	NS	NS			

Ambajipeta

With a view to assess few elite exotic coconut genotypes, this trial was initiated as replicated field experiment. *Inter-se* mated seed nuts of six exotic genotypes were supplied by the ICAR-CPCRI, Kasaragod, Kerala during May 2014 and seedlings were raised in polybag. The experiment was planted in March 2016 and it is in vegetative stage. The experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Data on growth parameters revealed that there was no significant variation among different exotic collections. Regarding growth parameters, a lowest plant height of 625.7 cm was recorded in West Coast Tall while the highest plant height of 783.6 cm was recorded in Verikkobari Tall.

Arsikere

Inter-se mated seed nuts of six exotic genotypes were supplied by the ICAR-CPCRI, Kasaragod, Kerala and the experimental layout consisted of six test entries and one local check, planted in randomized block design with three replications and five palms per genotype per replication. Experiment was initiated during the year 2015 and it is in vegetative stage. Data recorded on growth parameters revealed that there was significant variation among different exotic collections. Among the elite exotic germplasms, Straits Settlement Green Tall was observed more vigour and has recorded significantly maximum plant height (300 cm), plant girth (75.3 cm), annual leaves production (9.5 nos.), number of functional leaves (12.4 nos.), leaf length (153 cm) and petiole length (99.6 cm) as compared to other genotypes under evaluation followed by St. Vincent Tall.

Bhubaneswar

At Bhubaneswar, the data recorded on different growth parameters revealed significant variation among different germplasms. Maximum plant height (5.6 m), number of leaves per palm (18 nos.) and annual leaf production (9.2 nos.) were recorded in Laguna Tall, whereas, maximum plant girth (99.7 cm) was recorded in Kenya Tall followed by Laguna Tall (99.2 cm). Verikkobari Tall showed the dwarf stature (4.9 m) among the germplasm under evaluation in same condition. Among the six exotic cultivars, the early flowering was observed in Verikkobari Tall, Nigerian Tall and Palwan Tall cultivars.

Ratnagiri

With a view to assess few elite exotic coconut genotypes, this trial was initiated at Ratnagiri *Inter-se* mated seed nuts of six exotic genotypes were supplied by the ICAR-CPCRI, Kasaragod, Kerala during May 2014 and seedlings were raised in polybags and planted in July 2015. Experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Data on growth parameters revealed that there was significant variation among different exotic collections. Regarding growth parameters, the local check - Pratap recorded maximum plant height (349.4 cm), Guam-III Tall recorded maximum plant girth (127.8 cm), Straits Settlement Green Tall recorded maximum annual leaf production (11.8 nos.), Verikkobari Tall recorded maximum number of functional leaves (19.7 nos.), Straits Settlement Green Tall recorded highest leaf length (295cm) and Verikkobari Tall recorded maximum petiole length (138.3 cm). Rhinoceros beetle incidence was highest in Guam-III Tall (10.9%) whereas lowest incidence was observed in local check - Pratap (2.3%). Rugose Spiralling Whitefly incidence was highest in Guam-III Tall (17.4%) among all elite germplasms under evaluation.

Veppankulam

Inter-se mated seed nuts of six exotic genotypes were supplied by the ICAR-CPCRI, Kasaragod, Kerala in the year 2014. The experiment was planted in August, 2015. Experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Data on growth parameters revealed that there was found significant variation among different exotic collections. Among the six ecotypes, Makham Tall showed dwarf stature (510 cm), Laguna Tall (530 cm) with slender nature (105 cm). Earliness in flowering was observed in Markham Tall (3.4 years) followed by Nigerian Green (3.8 years) among all elite germplasms under evaluation.

Expt. 4: Evaluation of INGR 13065

Centers: Aliyarnagar and Ratnagiri

With a view to assess the performance of dwarf genotype INGR 13065 (*Niu Lekha dwarf*). The seedlings supplied by the ICAR-CPCRI, Kasaragod, Kerala were used for planting as un-replicated trials along with local checks during July, 2015.

Experiment was started at Aliyarnagar for performance evaluation of the dwarf genotype INGR 13065 (*Niu Lekha*). The seedlings supplied by the ICAR-CPCRI, Kasaragod, Kerala were used for planting as un-replicated trials along with local checks (COD and KTD) during July, 2015 and they are started spathe emergence. INGR 13065 was found to be highly vigorous than check varieties. INGR 13065 proved its earliness by producing spathe emergence at the age of 33 months after planting at Aliyarnagar. Data on growth attributes revealed that, the maximum plant height (462.5 cm), girth at base (174.5 cm), number of functional leaves (22.9 nos.), leaf length (460.5 cm) and petiole length (140 cm) were registered in INGR 13065. The least values for all the above character were registered by KTD. The average rhinoceros beetle leaf damage was found 9.1 per cent.

Ratnagiri

The data on growth parameters revealed that the average initial plant height of INGR 13065 was 521.1

cm. The average initial plant girth of INGR 13065 was 130.5 cm. The least values for all the above character were registered by COD. In respect of pest incidence, generally 5-8 % palms are infected by Rhinoceros beetle and Rugose Spiralling Whitefly among the INGR 13065 while maximum observed in genotype COD (Table 7).



Evaluation of INGR 13065 at Aliyarnagar

Table 7: Growth characters of coconut germplasm INGR 13065 at Ratnagiri (Year of planting: 2015)

Genotypes	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/ palm	Leaf length (cm)	Petiole length (cm)	Rhinoceros beetle leaf damage (%)	RSW (%)
INGR 13065	521.1	130.5	11.1	18.5	283.9	117.9	8.5	8.2
COD	203.4	64.2	11.7	19.8	303.8	97.5	11.3	12.17
Mean	362.3	97.4	11.4	19.2	293.9	107.7	9.9	10.2
SD	224.6	46.9	0.4	0.9	14.1	14.4	2.0	2.8
C.V.%	62.0	48.2	3.7	4.8	4.8	13.4	20.0	27.6

Coc./Gen. 2: Evaluation of coconut hybrids in different agro-climatic regions

Expt.1: Production and evaluation of new cross combinations in coconut

Centers: Bhubaneswar

A field experiment, comprising of eight different hybrids cross combinations along with one tall cultivar (CRP 509) as a check was initiated during November, 2005 at Bhubaneswar in RBD with four replications for evaluation of yield, quality and tolerance to biotic and abiotic stresses. Data with respect to plant girth, number of functional leaves, number of buttons and nut yield revealed significant variation among different cross combinations.

Maximum plant girth (183.0 cm) was recorded in GBGD x PHOT hybrid which was on par with hybrids ECT x MYD (174.7 cm), ECT x GBGD (167.0 cm) and check ECT (167.8 cm). However, the minimum plant girth (145.4 cm) was recorded in LO x COD cross. Maximum number of buttons (286.5 nos.) was recorded in WCT x MYD cross. Among the different cross combinations, ECT x GBGD performed better by exhibiting maximum leaves (33.6 nos.) and was significantly superior to other crosses by producing maximum nuts (108.5 nuts) (Table 8).

Table 8: Growth, floral and yield attributes of new cross combinations at Bhubaneswar (Year of planting: 2005)

Germplasms	Plant height (m)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm (nos.)	Leaf length (m)	No. of inflorescences/palm/year	No. of buttons (no's/ Infl.)	Nut yield (nuts/palm/year)
Chandra Laksha (LO x COD)	4.3	145.4	12.8	31.5	5.7	12.5	271.6	91.3
VHC 1 (ECT x MGD)	4.4	157.4	12.7	33.0	5.8	12.6	271.9	88.1
Konkan Bhatye coconut hybrid 1 (GBGD x ECT)	4.7	160.0	12.8	31.9	5.8	12.7	285.7	90.1
Gautami Ganga x Kera Chandra (GBGD x PHOT)	4.5	183.0	12.7	32.6	5.9	12.6	271.9	90.9
ECT (CRP 509)	4.6	167.8	12.7	31.1	5.7	12.5	231.2	80.1
VHC2 (ECT x MYD)	4.9	174.7	12.7	32.0	5.7	12.7	283.6	93.2
Laksha Ganga (LCOT x GBGD)	4.3	159.2	12.5	31.9	5.7	12.5	281.0	90.3
Kera Sree (WCT x MYD)	4.3	154.9	12.8	32.4	5.7	12.7	286.5	87.9
Godavari Ganga (ECT x GBGD)	4.1	167.0	12.7	33.6	5.6	12.6	279.9	108.5
Mean	4.5	163.3	12.7	32.2	5.7	12.6	273.7	91.2
CD (P=0.05)	NS	13.6	NS	1.2	NS	NS	24.8	6.7

Expt. 2: Evaluation of new coconut hybrids of location specific cross combinations

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

To assess the performance of newly developed hybrids involving location specific combinations in respect of yield and reaction to biotic stresses. This experiment was laid out at eight centers as listed below in RBD with four replications.

ICAR-AICRP (Palms) centres with location specific cross combinations

Centres	Location specific cross combinations being evaluated
Aliyarnagar	Set I: COD x Arasampatti Tall, Arasampatti Tall x MGD, MGD x Arasampatti Tall, COD x WCT, Kenthali x Arasampatti Tall, WCT (C) and Kalpatharu (C) Set II: COD x Etamozhi Tall, Kenthali x Etamozhi Tall, WCT x Kenthali, WCT(C)
Ambajipeta	ECT x Cochin China, GBGD x Cochin China, ECT x PHOT, GBGD x PHOT, PHOT x GBGD and ECT x GBGD
Arsikere	Tiptur Tall x PHOT, Tiptur Tall x LCOT, LCOT x MYD, LCOT x MOD, Tiptur Tall x MYD, Tiptur Tall x MOD, TPT
Bhubaneswar	Sakhigopal x COD, MGD x Sakhigopal, Sakhigopal x GBGD, COD x CRP794 BANA (IC-0612461), GBGD x IND025 (GUAM)
Kahikuchi	Assam Green Tall (AGT) x Cochin China, AGT x PHOT, AGT x MYD (CRP 058), Bengal Hazari (CRP 502) x AGT, Assam Yellow Tall (CRP 1) x PHOT, AGT (C)
Mondouri	LCOT x PHOT, ECT x Bengal Hazari, PHOT x LCOT, ECT x Jamaica, ECT x Java Tall and ECT (c)
Ratnagiri	COD x Banawali Yellow Round, COD x Pratap, COD x Banawali Green Long, Banawali Yellow Round x COD, Pratap x COD, Banawali Green Long x COD
Veppankulam	WCT x Kenthali, WCT x MOD, MOD x WCT, ADOT x COD, WCT x MGD and VHC -2 (C)

Aliyarnagar

This trial consists of five locations specific cross combinations, which were planted during 2012 in RBD with four replications as set I. Besides this five location specific hybrid combinations in set I, three new combinations viz., COD x Etamozhi Tall, Kenthali x Etamozhi Tall and WCT x Kenthali were also planted with four replications and six palms per replication along with local check WCT as set II. Data recorded in set I revealed that, COD x WCT recorded minimum palm height (240 cm) and maximum was recorded in the ALR x MGD (334.9 cm). Among the five combinations, MGD x ALR

was observed to be the earliest to start flowering (34 months). Maximum nut yield was recorded in the hybrid COD x ALR (89.0 nuts). Regarding the nut characters, the cross COD x WCT recorded higher whole nut weight (2421 g), de-husked nut weight (1086 g), kernel thickness (1.4 cm) and copra weight (247.5 g). Among the hybrid combinations in Set II, KTD X ET expressed dwarfness by registering lowest palm height of 200.1 cm than other cross combinations. The maximum nut yield was recorded in the hybrid KTD x ET (64.7 nuts) followed by COD x ET (57.5 nuts) (Table 9).

Table 9: Growth and yield characters of new location specific hybrids of coconut at Aliyarnagar (Year of planting 2014)

Hybrids (Set II)	Plant height (cm)	Plant girth (cm)	No. of functional leaves/palm	Leaf length (cm)	Petiole length (cm)	Annual leaf production (nos.)	No. of spikelet	No. of buttons	Nut yield/ palm/ year
COD x ET	216.7	139.2	21.7	486.0	143.3	11.0	31.1	17.3	57.5
KTD x ET	200.1	130.1	22.6	484.1	146.4	11.2	25.1	22.9	64.7
WCT x KTD	267.6	159.8	20.9	509.1	156.0	10.6	27.1	17.6	61.1
WCT (c)	177.7	106.0	21.5	315.8	129.9	9.9	—	—	—
Mean	215.5	133.8	21.7	448.8	143.9	10.7	—	—	—
SE d±	NS	9.52	NS	27.3	6.0	—	—	—	—
CD (P=0.05)	NS	21.5	NS	61.7	13.4	—	—	—	—



Yield of COD X ET



Yield of KTD X ET

Ambajipeta

In Ambajipeta centre, six hybrid cross combinations were planted during June, 2011 in RBD with four replications. However due to Helen and Philin cyclones during October and November, 2013, some of the hybrids were adversely affected. Gap filling was done during the month of February, 2014 and the experiment is in bearing stage. The data on growth and yield characters revealed that, the cross ECT x PHOT recorded significantly highest plant height (295.7 cm) and plant girth

(115.6 cm). Minimum plant height was recorded in GBGD x Cochin China (190.9 cm) and plant girth was noted in PHOT x GBGD (93.8 cm). ECT x GBGD recorded more number of leaf scars in 1m (18.4). ECT x Cochin China recorded maximum petiole length with 182.1cm. With regards to nut yield, ECT x PHOT has recorded the highest nut yield (61.6 nuts) and it was on par with ECT x GBGD (58.8 nuts), PHOT x GBGD (54.58 nuts), ECT x Cochin China (53.3 nuts) and GBGD x PHOT (50.9 nuts) (Table 10).

Table 10: Growth and yield performance of new location specific hybrids of coconut at Ambajipeta (Year of planting 2012)

Hybrids	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm	Leaf length (cm)	Petiole length (cm)	No. of bunches /palm	Nut yield /palm /year
ECT x Cochin China	272.9	112.2	12.2	31.1	580.3	182.1	9.9	53.3
GBGD x Cochin China	190.9	101.6	12.9	28.7	523.0	159.5	8.9	34.7
ECT x PHOT	295.7	115.6	12.7	29.9	589.9	171.1	10.3	61.6
GBGD x PHOT	245.1	108.6	11.7	31.2	571.6	158.1	9.6	50.9
PHOT x GBGD	250.9	93.8	12.2	30.9	565.2	163.5	7.7	54.6
ECT x GBGD	249.6	96.0	12.5	30.7	583.1	157.8	9.2	58.8
Mean	250.9	104.6	12.4	30.4	568.8	165.4	9.2	52.3
SE d±	20.4	4.4	0.78	0.9	20.5	5.0	0.6	5.4
CD (P=0.05)	61.6	13.4	NS	NS	NS	15.0	NS	16.3

Arsikere

In Arsikere centre, six hybrid cross combinations along with one check variety were planted during September, 2012 in RBD with four replications. The data on growth and yield characters revealed that, the cross combinations, TPT x MOD has showed significantly maximum plant height (612.6 cm), plant girth (148.5 cm), leaf length (262.6 cm), petiole length (148.1 cm), annual leaves produced (11.6 nos.) and no. of functional leaves (45.5 nos.) compared to other cross combinations. The hybrid TPT x MOD and LCOT x MOD were observed to be earliest to start flowering 60 months. The maximum number of nut per palm (48 nuts) was recorded in hybrid TPT x MYD.

Bhubaneswar

In Bhubaneswar centre, a field experiment was conducted by taking five locations specific cross combinations in RBD with four replications in February, 2008. Among the cross combinations tested, the minimum plant height (2.4 m) was recorded in GBGD x GUAM. The maximum plant girth (130.3 cm) and leaves (34.6 nos.) were registered in SKL x GBGD. The crosses, SKL x COD and GBGD x GUAM produced maximum numbers of leave per palm (12.9 nos.). Among the different reproductive characters, significantly maximum number of inflorescences (12.5 nos.), no. of buttons (291.9 nos.) and nut yield (88.6 nuts/palm/year) were recorded in SKL x COD (Table 11).

Table 11: Growth and yield characters of new location specific hybrids of coconut at Bhubaneswar (Year of planting 2008)

Hybrids	Plant height(m)	Plant girth(cm)	Annual leaf production(nos.)	Leaf length(m)	No. of inflorescences/palm/yr	No. of buttons	Nut yield /palm /year
SKL x COD	2.8	127.5	12.9	5.4	12.5	291.9	88.6
MGD x SKL	3.0	121.2	12.6	5.4	12.2	285.0	86.2
SKL x GBGD	2.8	130.3	12.8	5.4	12.2	244.8	85.2
COD x BANA	2.5	130.1	12.7	5.3	12.0	277.5	79.0
GBGD x GUAM	2.4	99.5	12.9	5.3	12.4	284.3	83.4
Mean	2.7	121.7	12.8	5.4	12.3	276.7	84.5
CD (P=0.05)	0.3	11.7	0.2	NS	0.2	7.3	5.7

Kahikuchi

This field trial was initiated with five location specific cross combinations of coconut along with a check (AGT) during April, 2009 in RBD with six palms per replication. Analysis of the data indicated that, the highest plant height (2.7 m), girth (153 cm) were recorded in AYT x PHOT whereas, maximum leaf production per year (12 nos.), no. of functional

leaves/palm (32 nos.) were observed AGT x PHOT. On the other hand, cross combination AGT x CCNT recorded the highest total leaf length (479.2 cm) and petiole length (125.8 cm). Significantly the highest fruit yield (61.8 nuts) was recorded in AGT x PHOT followed by AGT x MYD (58.7 nuts). AGT x PHOT recorded highest number of inflorescences and female flowers compared to other crosses (Table 12).

Table 12: Growth and yield characters of new location specific hybrids of coconut at Kahikuchi (Year of planting 2009)

Hybrids	Plant height(cm)	Plant girth(cm)	No. of functional leaves/palm	Leaf length(cm)	Petiole length (cm)	Annual leaf production(nos.)	Nut yield /palm/year
AGT x Cochin China	2.1	144	27.0	479.2	125.8	10.8	51.0
AGT x PHOT	2.5	147	32.0	462.8	120.5	12.0	61.8
AGT x MYD	2.0	142	27.2	432.9	109.6	11.2	58.7
Bengal Hazari x AGT	2.3	148	25.8	459.8	118.5	11.7	50.7
AYT x PHOT	2.7	153	29.2	469.5	119.4	11.9	49.4
AGT (Local check)	2.5	146	25.7	450.6	121.5	11.8	35.2
Mean	2.4	146.7	27.8	459.1	119.2	11.6	51.1
CD (P=0.05)	0.21	2.23	0.93	10.12	3.56	NS	5.96

Mondouri

At Mandouri centre, five location specific hybrid cross combinations were planted along with ECT as local check under RBD in four replications with six palms per replication during 2009. The maximum trunk height (3.1 m) was recorded in ECT x Bengal Hazari. Maximum number of leaves/palm/year (19.6 nos.) was observed in ECT x Java Tall. Maximum girth (1.4 m) was recorded in LCOT x PHOT and maximum nut yield/palm/year (30 nuts) was recorded in ECT x Bengal Hazari.



AGT x PHOT under location specific combination at Kahikuchi

Ratnagiri

At Ratnagiri centre, six new location specific hybrid cross combinations were planted under RBD in four replications with six palms per replication during 2006. The growth characters of new location

specific cross combinations of coconut showed significant differences among the new coconut hybrids under evaluation. The data revealed that the hybrid CRP-513 x COD recorded maximum plant height (465.8cm) whereas the lowest plant height (335.5 cm) was in hybrid COD x Pratap. CRP-514 x COD recorded maximum plant girth (107.2cm) whereas the lowest plant girth (88.8 cm) was in hybrid COD x Pratap. Highest annual leaf production (12.2 nos.) was recorded in hybrid CRP-514 x COD. Maximum no. of functional leaves (33 nos.) were observed in hybrid CRP-513 x COD. The maximum leaf length was in hybrid COD x CRP-514 (425.6cm) and maximum petiole length was recorded in Pratap x COD (163.8cm). The hybrid COD x CRP-514 recorded maximum no. of inflorescence (11.3cm) whereas it was lowest in the hybrid COD x Pratap (8.5 nos.). The hybrid COD x CRP-513 recorded maximum no. of buttons (104.9 nos.) whereas the lowest was in Pratap x COD (58 nos.). The highest nut yield was recorded in hybrid COD x CRP-513 (83.7 nuts) whereas the lowest was in hybrid CRP-513 x COD (41.6). The Rhinoceros beetle incidence was maximum in hybrid Pratap x COD (5.93%) whereas lowest in the hybrid CRP-513 x COD (0.84 %). The generally 1-5% palms are infected by Rugose Spiralling Whitefly among all the new coconut hybrids under evaluation (Table 13).

Table 13: Growth and yield characters of new location specific hybrids of coconut at Ratnagiri (Year of planting 2006)

Coconut hybrids	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm	Nut yield (nuts/palm/ year)
COD x CRP-513	373.7	94.5	11.38	27.8	83.7
COD x Pratap	335.5	88.8	10.83	24.3	71.0
COD x CRP-514	404.5	95.6	11.88	29.5	75.8
CRP-513 x COD	465.8	98.1	12.00	33.0	41.6

Pratap x COD	404.7	102.0	11.79	30.0	48.1
CRP-514 x COD	397.9	107.2	12.21	32.8	53.3
Mean	397.0	97.7	11.7	29.6	62.3
SE d±	27.2	1.6	0.27	1.60	7.0
CD (P=0.05)	82	4.9	0.81	4.82	21.0

Veppankulam

Six location specific cross combinations were planted with four replications during 2008. Analysis of data recorded during the year revealed that the cross MOD x WCT had higher number of nuts (52 nuts/ palm/ year) which was followed by ADOT x COD (36 nuts/palm/year). Among the five cross combinations, ADOT x COD registered maximum whole nut weight and copra content (920 g/nut and 145 g/nut) respectively.

Varieties and hybrids under evaluation

Centre	Varieties / hybrids under evaluation	Year of planting
Ambajipeta	Hybrids: Chandra Sankara, Chandra Laksha, Kera Ganga, Laksha Ganga, VHC1, VHC 2 and Godavari Ganga Varieties: Chandra Kalpa and Double Century (C)	2002
Bhubaneswar	Hybrids: Kera Ganga, Chandra Sankara and Kera Sankara Varieties: Kera Chandra, Chandra Kalpa and Sakhigopal (C)	2004

Table 14: Growth characters of released varieties and hybrids in coconut at Ambajipeta (Year of planting 2002)

Varieties/Hybrids	Plant height(cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm	Leaf length(cm)	Petiole length(cm)	Length of 10 internodes (cm)
Chandra Sankara	869.8	98.8	13.6	31.6	542.1	131.1	99.3
Chandra Laksha	918.5	98.3	14.1	32.8	547.0	128.4	97.5
VHC-1	925.7	102.6	13.3	33.3	551.3	130.5	107.2
VHC-2	949.2	107.3	14.0	34.0	536.5	128.1	90.3
Kera Ganga	858.6	97.1	14.3	32.3	547.1	127.7	94.5
Laksha Ganga	898.3	105.0	14.8	33.8	542.4	130.2	99.7
Double Century (C)	928.0	114.8	13.6	31.6	536.5	125.9	92.7
Godavari Ganga	805.1	91.2	13.3	31.3	528.4	129.2	84.3
Chandra Kalpa	914.4	104.8	13.3	32.0	553.1	131.9	97.9
Mean	896.4	102.2	13.8	32.5	542.7	129.2	95.9
SE d±	25.1	4.1	0.8	1.0	19.3	2.9	4.0
CD (P=0.05)	75.2	12.1	NS	NS	NS	NS	11.9

Bhubaneswar

This experiment was initiated with three hybrids, two promising varieties and one local check (Sakhigopal-IND 041) in RBD with four replications in August, 2004. Among the different hybrids and varieties evaluated, Kera Sankar (WCT x COD) recorded significantly maximum plant height (4.6 m) and number of functional leaves (33.2 nos.). Maximum plant girth (152 cm) was

Expt. 3: Evaluation of released varieties in coconut

Centers: Ambajipeta and Bhubaneswar

This experiment was initiated to evaluate the promising varieties of coconut arising out of trials at CPCRI and SAUs. The genotypes involved in this trial are tabulated below. The experiment was laid out in RBD with three replications.

recorded in local check (IND 041), whereas, maximum annual leaf production (12.8 nos.) was observed in Kera Ganga. The hybrid, Kera Sankar (WCT x COD) registered maximum no. of inflorescences (12.4 nos.), no. of buttons (297.2 nos.) and nut yield (97.4 nuts). However, there was no significant variation among different germplasm with respect to leaf length and petiole length.



Field view of Gen.2.Expt.3 at Bhubaneswar

Expt. 4: Evaluation of Tall x Tall coconut hybrids

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

This experiment was started with the objective to assess five Tall x Tall hybrids, viz., LCOT x

ADOT, ADOT x ECT, BGR x ADOT, ECT x LCOT and WCT x TPT at various agro-climatic regions. The hybrids were produced at CPCRI, Kasaragod and supplied to eight AICRP (Palms) centres for evaluation in RBD with three replications and six palms per hybrid per replication.

Aliyarnagar

This experiment was initiated at Aliyarnagar during 2011. The data revealed that the cross, WCT x TPT was significantly smallest one having plant height (368.8 cm). The cross ADOT x ECT recorded maximum plant girth (120.3 cm), petiole length (152.8 cm), leaf length (547.2 cm) and nut yield (66.9 nuts/palm/year). Among the crosses, BRG x ADOT recorded highest copra weight (183.8 g) (Table 15).

Table 15: Growth characters of Tall x Tall coconut hybrids at Aliyarnagar (Year of planting 2011)

Hybrids(T x T)	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves (nos.)	Leaf length (cm)	Petiole length(cm)
LCOT x ADOT	389.6	110.7	11.2	24.2	510.9	143.9
ADOT x ECT	467.1	120.3	10.6	22.5	547.2	152.8
BGR x ADOT	386.4	114.9	11.4	24.9	521.0	149.9
ECT x LCOT	392.5	102.9	11.1	21.7	489.4	130.7
WCT x TPT	368.8	90.6	11.0	24.6	537.5	150.2
WCT (c)	356.8	102.3	9.5	30.0	440.0	164.3
Kalpatharu (c)	193.3	217.8	10.8	32.8	480.8	167.0
Mean	364.9	122.8	10.8	25.8	503.8	151.3
SE d±	37.1	10.7	NS	2.7	25.3	NS
CD (P=0.05)	78.0	22.4	NS	5.6	53.2	NS

Ambajipeta

The experiment was initiated during 2011 in RBD with four replications and six palms per hybrid per replication and due to Helen and Philin cyclones in 2013; some of the hybrids were severely damaged and gap filling has been carried out during February, 2014 and the palms are in bearing stage. Significant difference was recorded for palm height and palm girth. Lowest plant height was recorded in ECT

x LCOT cross combination (269.3 cm) while the highest plant height was recorded in LCOT x ADOT (341.1cm). However, the maximum plant girth was recorded in cross combinations ADOT x ECT (127.9 cm) followed by BGR x ADOT (121.3 cm). The cross combination BGR x ADOT recorded highest no. of inflorescences (9.99 nos.). The hybrid LCOT x ADOT were observed highest nut yield (57.4 nuts) followed by WCT x TPT (52.7 nuts) (Table 16).

Table 16: Growth and yield performance of Tall x Tall coconut hybrids at Ambajipeta (Year of planting 2011)

Hybrids (T x T)	Plant height(cm)	Plant girth(cm)	Annual leaf production (nos.)	No. of functional leaves/palm	Leaf length(cm)	Petiole length (cm)	Inflorescence/ palm/year	Nut yield /palm/year
LCOT x ADOT	341.1	107.3	12.7	30.4	582.9	156.2	8.8	57.4
ADOT x ECT	287.5	121.9	12.2	28.3	587.0	175.3	9.4	31.7
BGR x ADOT	293.3	121.3	12.5	29.0	607.3	179.4	10.0	40.3
ECT x LCOT	269.3	113.7	12.9	28.9	571.3	168.0	8.0	36.3
WCT x TPT	341.0	107.7	12.2	29.6	598.1	166.8	9.0	52.7
ECT (c)	304.4	111.7	11.7	27.3	600.5	171.2	8.7	29.1
Mean	306.1	113.9	12.4	28.9	591.2	169.5	9.0	41.2
SE d±	16.2	3.5	0.8	0.9	11.7	5.9	0.4	6.3
CD (P=0.05)	38.8	10.6	NS	NS	NS	NS	1.2	19.1

Arsikere

Five Tall x Tall hybrids were planted in RBD with four replication during 2012 along with one local check (TPT) to evaluate its yield potential and tolerance to biotic and abiotic stresses. Analysis of data on morphological parameters revealed significant variation among the hybrids and the hybrid LCOT x ADOT recorded significantly the highest plant height (591.8 cm), plant girth (131.8 cm), leaf length (252.3 cm), petiole length (182.5 cm), annual leaf production (9.8 nos.) and functional leaves (38.2 nos.) followed by ECT x LCOT. Also the hybrid LCOT x ADOT produced significantly higher no. of inflorescence (6 nos.), no. of female flowers/inflorescence (58 nos.) and nut yield (38 nuts) followed by BGR x ADOT.

Bhubaneswar

The experiment was initiated to evaluate five different Tall x Tall cross combinations along with one local check (Sakhigopal Tall-IND 041) in RBD with four replications in June, 2013. The result revealed that the minimum plant height (6.8 m) and plant girth (150.6 cm) were recorded in ECT X LCOT cross. The maximum number of leaves (30.6 nos.) as well as the annual leaf production (12.6 nos.) was recorded in BGRT x ADOT cross. But the crosses under evaluation did not differ



Experimental view of Gen.2 Expt: 4 (Arsikere)

significantly with respect to leaf length, petiole length, rate of production of inflorescence, no. of buttons and nut yield.

Kahikuchi

Field experiment on Tall x Tall cross combinations was initiated at Kahikuchi during June, 2013 and designed as RBD with four replications. Among the different crosses, The highest plant height (575 cm), plant girth (117.8 cm), no. functional of leaves (22.8 nos.), petiole length (114 cm) and leaf length (320 cm) were recorded in LCOT x ADOT whereas, the hybrid ADOT x ECT recorded lowest values for the above characters. With regards to age of first flowering, minimum months (70 months) required for flowering initiation was recorded in ECT x LCOT and maximum months (73 months) was taken by ADOT x ECT (Table 17).

Table 17: Growth characters of Tall x Tall coconut hybrids at Kahikuchi (Year of planting 2013)

Hybrids(T x T)	Plant height (cm)	Plant girth(cm)	No. of functional leaves/palm (nos.)	Leaf length(cm)	Petiole length (cm)	Age at first flowering (months)
LCOT x ADOT	575	117.8	22.8	320	114	72
ADOT x ECT	452	108	19	278	100.5	73
BGR x ADOT	458	112.5	20.2	311.5	106.8	71
ECT x LCOT	562	112	21.8	289.2	108.6	70
WCT x TPT	546	109.7	20.4	292	103.2	71
Kamrupa (c)	550	110.5	19.8	298.6	105.6	72
Mean	523.8	111.8	20.7	298.2	106.5	71.5
CD (P=0.05)	15.3	2.2	0.8	6.3	2.1	NS

Navsari

The field experiment on Tall x Tall cross combinations was laid out under RBD with four replications during July, 2013 at Navsari. The maximum collar girth (194 cm) was recorded in Gandevi selection. Highest leaf length (499.8 cm) was recorded in BGR x ADOT. The maximum petiole length (167.5 cm) recorded in ADOT x ECT. The cross combination ECT x LCOT were counted minimum age at first flowering (39 months) with

maximum numbers of inflorescence production per annum (8.8 nos.) and maximum nut yield (31.8 nuts). The non-significant results were found regarding annual leaf production and functional leaves on the crown during the experimental period. Regarding to reaction of biotic stresses, 5-7 % of palms of all hybrids are infected by Rhinoceros Beetle and no other infestation of pests and diseases are observed in the experimental plot.

Ratnagiri

The field experiment on five different Tall x Tall cross combinations along with one local check Pratap was laid out under RBD with four replications during August, 2011 at Ratnagiri. The observations growth parameters showed significant differences among the Tall x Tall coconut hybrids. Data showed that the local check - Pratap recorded maximum plant height (351.3cm) whereas among the hybrids LCOT x ADOT showed highest plant height (338.8 cm). ECT x LCOT recorded maximum plant girth (121.5 cm) whereas lowest plant girth (102.8 cm) was in local check-Pratap. Highest leaf production (13.1 nos.) was recorded in hybrid BGR x ADOT. Maximum no. of functional leaves (24.8 nos.) was observed in WCT x TPT. The maximum leaf length was in local check - Pratap (415.6cm) and maximum petiole length was recorded in hybrid WCT x TPT (171.3cm). The hybrid WCT x TPT recorded maximum no. of inflorescence (12.2cm), maximum no. of buttons (79.7 nos.), highest nut yield (59 nuts), maximum whole nut weight (1312.5g), maximum de-husked nut weight (662.5 g) and maximum copra weight (170 g). Rhinoceros beetle incidence was maximum in ECT x LCOT (5.55%)

whereas lowest in the hybrid BGR x ADOT (3.52 %). Eriophyid mite incidence was maximum in hybrid BGR x ADOT (65.42%) whereas lowest in the local check -Pratap (1.56 %). The generally 1-9 % palms are infected by Rugose Spiralling Whitefly among all the among the Tall x Tall coconut hybrids under evaluation.

Veppankulam

Five new Tall x Tall cross combinations were planted in RBD during 2011. Among the five new crosses and local check (VHC-3), LCOT x ADOT expressed the dwarf stature (505 cm) and BGR x ADOT recorded higher number of bunches (8 bunches/palm/year) and annual nut yield recorded for June, 2018 to November, 2018 (55 nuts/palm/year). The cross combination LCOT x ADOT recorded maximum whole nut weight (850 g) and copra weight (170 g).

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 at six palms per genotype per replication for evaluation of yield and reaction to biotic and abiotic stresses.

List of location specific Tall x Tall coconut hybrids under evaluation

Centres	Combinations evaluated
Ambajipeta	Java Tall x ECT, PHOT x ECT, Fiji Tall x ECT, ECT x PHOT, Laccadive Ordinary x ECT, Cochin China x ECT, ECT x Fiji Tall
Ratnagiri	PHOT x Benaulum Green Round Tall, Benaulum Green Round Tall x PHOT, PHOT x CRP 513, CRP 513 x PHOT, CRP 514 x PHOT, PHOT x CRP514, LCOT x Benaulum Green Round Tall
Veppankulam	WCT x PHOT, WCT x Cochin China, PHOT x WCT, San Ramon x ECT, ECT x Zanzibar, ECT x Java Giant, ECT x PHOT

Ambajipeta

Seven location specific Tall x Tall hybrids were planted during 2011. Due to Helen and Philin cyclones in the year 2013, there was mortality in some of the hybrids. Gap filling has been taken up during the month of February, 2014 and the experiment is in bearing stage. Maximum plant height was recorded in cross ECT x Fiji (298.5 cm) which was on par with Java Tall x ECT (287.9 cm), while, the lowest plant height of 214.8 cm was recorded in local check - ECT. With respect to plant girth,

maximum girth was recorded in ECT x Fiji Tall (119.6 cm) while, minimum plant girth was recorded in LCOT x ECT (94.16 cm). A significantly higher nut yield (56.8 nuts/palm/year) was recorded in ECT x PHOT followed by ECT x ECT (49.3 nuts) and LCOT x ECT (48.9 nuts).

Ratnagiri

In Ratnagiri centre, seven location specific Tall x Tall hybrids were planted during 2009 for evaluation. The observations growth parameters showed significant differences among the hybrids.

The data showed that the hybrid PHOT x BGR recorded maximum plant height (378.4cm), whereas minimum (260 g) was observed in local check - Pratap. Hybrid BYR x PHOT recorded maximum plant girth (115.7cm) whereas the lowest plant girth (101.7 cm) was in local check - Pratap. Average annual leaf production (11.5 nos.) was recorded in all the hybrids. The maximum no. of functional leaves (27.3 nos.) was observed in BGL x PHOT. Maximum leaf length was in BGR x PHOT (410cm) and maximum petiole length was recorded in

BGL x PHOT (173.3cm). Hybrid BGR x PHOT recorded maximum no. of inflorescence(12.3cm), maximum no. of buttons (120 nos.) and highest nut yield (71.7 nuts). The maximum whole nut weight (1377.8 g) was recorded in hybrid BGL x PHOT. The maximum de-husked nut weight (625 g) was recorded in hybrid LCOT x BGR and maximum copra weight (170 g) was recorded in hybrid BGR x PHOT. Rhinoceros beetle incidence was maximum in hybrid PHOT x BGR (7.57%) whereas lowest in PHOT x BGL (2.94%) (Table 18).

Table 18: Growth characters of location specific Tall x Tall coconut hybrids at Ratnagiri (Year of planting 2009)

Coconut	Plant Height (cm)	Plant Girth (cm)	Annual leaf Production (nos.)	No. of functional leaves/palm	Nut yield (nuts/palm/year)
PHOT x BGR	378.4	113.1	11.7	24.6	38.1
BGR x PHOT	327.3	110.3	11.5	22.2	71.7
PHOT x BYR	356.1	115.0	12.0	25.0	47.1
BYR x PHOT	353.8	115.7	11.7	25.3	59.5
BGL x PHOT	362.2	100.7	12.0	27.3	53.6
PHOT x BGL	346.9	114.1	12.0	25.1	32.7
LCOT x BGR	315.0	104.3	11.1	21.2	37.1
Pratap (Local check)	260.0	101.7	10.3	19.4	45.3
Mean	337.5	109.4	11.5	23.8	48.1
SE d±	23.4	2.3	0.3	1.2	3.4
CD (P=0.05)	71.1	7.1	0.9	3.5	10.3

Veppankulam

Seven location specific Tall x Tall cross combinations were planted during, 2009 for evaluation. Among the seven new crosses and local

check (VHC-3), the performance of ECT x PHOT was superior in terms of palm height (400 cm) i.e. dwarf stature with higher annual nut (56 nuts/palm/year) (Table 19).

Table 19 : Growth and yield performance of location specific Tall x Tall coconut hybrids at Veppankulam (Year of planting 2009)

Hybrids	Plant height(cm)	Plant girth (cm)	No. of functional leaves/palm	Nut yield(nuts/palm/year)*	Whole nut weight(g/nut)	Copra content(g/nut)
WCT x PHOT	440	200	28	41	780	135
ECT x Zanzibar	455	182	26	53	690	125
ECT x Java Giant	435	212	25	39	710	130
ECT x PHOT	400	200	29	56	890	155
San Ramon x Zanzibar	405	220	28	38	940	165
WCT x Cochin China	408	162	27	40	905	160
PHOT x WCT	585	207	29	42	920	162
VHC - 3 (c)	410	152	29	51	765	140
Mean	442.3	191.9	27.6	45.0	825.0	146.5
SE d±	2.7	4.3	1.3	2.7	27.9	12.5
CD (P=0.05)	7.0	11.6	3.1	5.1	48.3	25.9

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

Centres: Ambajipeta, Mondouri, Pilicode, Ratnagiri and Veppankulam

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 comprising 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, Kasargod and a local check. The palms were planted in RBD with four replications and six palms per hybrid per replication.

Ambajipeta

This experiment was initiated during 2011. Due to Helen and Philin cyclones in 2013, some of the hybrids were severely affected. Gap filling was done with planting material received from CPCRI, Kasargod in March, 2014. However, initiated production of COD x MYD seed nuts in 2015 and seed nuts were harvested in 2016. These seedlings were raised in polybags during 2017 and the selected seedlings were planted in experimental plot in 2018. These seedlings were established in the field and are in vegetative stage. Further, the other crosses combinations of the experiment are in bearing stage. Data pertaining to growth attributes and nut yields showed that the mean lowest plant height was recorded in GBGD x GBGD (163.8 cm) and maximum was recorded in MYD x CGD (245.7 cm) while the maximum plant girth was recorded in MYD x CGD (102.2 cm) followed by COD x MGD (86.4 cm). Maximum nut yield (57.5 nuts/palm/year) was recorded in COD x MGD followed by GBGD x MOD (54.9 nuts/palm/year) whereas, minimum nut yield was recorded in GBGD x GBGD (29.2 nuts/palm/year). The number of inflorescences per palm was recorded more in COD x MGD (12.3 nos.) and less was recorded in CGD x MGD (8.6 nos.).

Mondouri

The trial was established during 2012 and the palms are eight years old. Analysis of data on morphological parameters revealed that the minimum trunk height (80.4 cm) was recorded in CGD x MGD showing the more dwarfing trend among

different combinations. Maximum number of leaves/palm (14.8 nos.) and maximum girth (114.0 cm) was recorded in GBGD x MOD.

Pilicode

The trial was initiated during 2014 with a set of five D x D hybrids viz., COD x MYD, COD x MGD, MYD x CGD, GBGD x MOD, CGD x MGD and GBGD as a local check. It is establishment phase. Apart from these five crosses, one more hybrid combination of RARS, Pilicode namely GBGD x CGD was also included. The plot was intercropped with banana and turmeric and this year the plot is intercropped with turmeric and pulse. There is no significant difference between hybrids for traits, plant height, plant girth and length of third leaf. The hybrid GBGD x MOD showed maximum number of leaves (11.3 nos.) which was on par with all others except GBGD x CGD. With respect to length of 5th leaf, the hybrid GBGD x MOD recorded the highest (3.6m) length followed by COD x MGD and CGD x MGD. Hybrid MYD x CGD and check variety GBGB started flowering during the 5th year of planting. Regarding pest incidence, the Rhinoceros beetle incidence was highest (48.8 %).

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 difference among the D x D hybrids under study. The data revealed that the hybrid COD x MYD recorded maximum plant height (268.8cm) whereas minimum (190.4cm) was observed in CGD x MGD. Hybrid CGD x MGD recorded maximum plant girth (84.3 cm), maximum annual leaf production (12.3 nos.), Maximum no. of functional leaves (24.3 nos.), maximum leaf length (363.8cm) and maximum petiole length (131.3cm). The hybrid GBGD x MOD showed early flowering after planting (27.83 months) followed by COD x MGD (28.79 months). Also the hybrid GBGD x MOD recorded maximum no. of inflorescence (12.5 cm) and maximum no. of buttons (135 nos.). The hybrid GBGD x MOD is a promising cross for the earliness. The hybrid COD x MYD recorded highest tender nut yield (68 nuts) followed by the hybrid GBGD x MOD (62.5 nuts). Regarding to the quantity of tender nut water (ml/nut), the hybrid COD x MYD recorded maximum volume of tender

nut water (590.5 ml/nut). Regarding the Total Soluble Solids (TSS), the maximum score was recorded in the hybrid GBGD x MOD (5.6° Brix). Rhinoceros beetle incidence was maximum in local check COD

(11.30 %) whereas it was lowest in hybrid COD x MYD (4.16%). In general, 5-12 % palms were infected by Rugose Spiralling Whitefly among the entire D x D coconut hybrids under evaluation (Table 20).

Table 20 : Growth characters of Dwarf x Dwarf coconut hybrids at Ratnagiri (Year of planting 2011)

Hybrids(D x D)	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm	Leaf length (cm)	Tender nut yield (No./Palm/Year)
COD x MYD	268.8	84.3	12.3	24.3	363.8	68.0
COD x MGD	242.9	74.7	12.0	21.7	321.3	58.0
MYD x CGD	263.8	73.7	11.3	18.5	301.3	60.5
GBGD x MOD	218.0	74.4	11.5	22.8	282.5	62.5
CGD x MGD	190.4	69.6	10.2	20.1	321.9	51.3
COD (Local check)	203.4	64.2	11.7	19.8	303.8	42.8
Mean	231.2	73.5	11.5	21.2	315.7	57.2
SE d±	20.2	4.2	0.3	1.3	17.3	1.6
CD (P=0.05)	60.9	12.7	1.0	4.0	52.2	4.7



Yield of GBGD X MOD



Yield of COD X MYD

Veppankulam

This trial was started during 2011 at Veppankulam centre. Among five crosses being evaluated, the cross MYD x CGD started flowering on 22nd month after planting, which is a promising cross for the earliness. Based on morphological characters recorded, it is revealed that, GBGD x MOD expressed the dwarf stature (456 cm) with less girth (146 cm) and regarding the tender nut quality parameters, COD x MGD recorded maximum volume of tender nut water (510 ml/nut). Regarding the Total Soluble Solids, maximum score was observed in MYD x CGD (6.6 ° Brix) with higher number of tender nut yield (60 nuts). Regarding the pest incidence, CGD x MGD had less incidence of Rhinoceros beetle and Red palm weevil.

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

Expt. 1: Demonstration of released varieties of coconut in different agro-climatic regions

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

The demonstration block consisting of ten coconut varieties and hybrids namely Kalyani coconut hybrid 1, Gautami Ganga, KonkanBhatye coconut hybrid 1, Kerakeralam, Kera Bastar, Kahikuchi coconut hybrid, Kalpa Pratibha, Kalpamitra, Kalparaksha and Kalpadhenu released by different ICAR - AICRP (Palms) centres and ICAR - CPCRI, Kasaragod was established during 2011. The prime objective of this demonstration block was to showcase the performance of released cultivars in different agro-climatic situations. The demonstration block comprised of ten genotypes and one local check with ten palms per genotype. The palms in the centre are seven to eight years old and have started yielding.

Aliyarnagar

The demonstration block consisting of ten coconut varieties and hybrids namely Kalyani coconut hybrid 1, Gautami Ganga, Konkan Bhatye hybrid, Kerakeralam, Kera Bastar, Kahikuchi hybrid, Kalpa Prathiba, Kalpamitra, Kalparaksha and Kalpadhenu released by different AICRP centres and CPCRI, Kasaragod was established during 2011 at AICRP (Palms) centres Aliyarnagar. The primary aim of this demonstration block to showcase the performance of released cultivars in different agro-climatic situations. The demonstration block comprised of ten genotypes and one local

check with ten palms per genotype. The palms in the centre are eight years old and have started for the yield.

Ambajipeta

The observations on growth parameters revealed that the lowest plant height of 233.2 cm was recorded in Gautami Ganga and the maximum plant height of 375.6 cm was recorded on Kera Bastar. The highest nut yield of 97 nuts/palm/year followed by Kera Keralam (91.2 nuts/palm/year) and Kalyani coconut hybrid 1 (86.7 nuts/palm/year) (Table 21).

Table 21: Growth performance of released varieties of coconut at Ambajipeta (Year of planting 2011)

Varieties	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional Leaves (nos.)	Leaf length (cm)	Petiole length (cm)	Nut yield/ palm/ year
Kalyani coconut hybrid 1	301.7	108.2	12.4	29.2	581.1	173.2	86.7
Gautami Ganga	233.2	83	12.5	20.5	462.2	144.8	85.3
Konkan Bhatye coconut hybrid 1	322.3	95.2	12.6	28	592	157.6	84.3
Kerakeralam	316.7	113.4	10.8	27.9	607.6	224.5	91.2
Kera Bastar	375.6	118.4	12	28.2	619.1	173.4	76.8
Kalpa Samrudhi	262.8	106.4	13.1	28.4	597.1	171.2	81.5
Kalpa Prathiba	351.3	121.9	11	29.2	643.9	173.9	74.1
Kalpamitra	331.9	103.4	12.9	31.8	575.8	166.5	79.1
Kalparaksha	256.6	99.6	12.3	25	552.5	153	97
Kalpadhenu	326.8	110.1	13	23.4	595.7	170.7	74.8
Mean	307.9	106.0	12.3	27.2	582.7	170.9	83.1
SD	44.7	11.4	0.8	3.3	49.0	21.3	7.3
CV%	14.5	10.8	6.5	12.1	8.4	12.5	8.8

Arsikere

A field experiment comprising of 11 coconut released varieties was initiated during 2012 at Arsikere to demonstrate the released coconut variety. The highest growth parameters like plant height (777.0 cm), plant girth (142.4 cm), leaf length (360.2 cm) and petiole length (211.2 cm) were observed Kalpadhenu compared with other varieties and lowest growth parameter were observed in Kalparaksha. Among different released variety Gauthami Ganga has performed better under some ecological conditions which were reflected in term of production nut (60nuts/palm). Gauthami Ganga performed well in production of maximum number of buttons (70 no's), inflorescence (10 nos.).

Bhubaneswar

The trail was initiated with ten released varieties of coconut and one local check as un-replicated observational trail in June 2013. Among the different cultivars evaluated, Kalpa Prathiba noted maximum plant height (7.5 m), plant girth (159cm), leaf length (5.1 m) and petiole length (151.3 cm). The maximum number of leaves (31 nos.) and number of inflorescence (11.8 nos.) were noted in Gautami Ganga. Maximum annual leaf production (12.8 nos.) was recorded in Konkan Bhatye coconut hybrid 1. The genotype Kalpa Samrudhi registered maximum number of buttons (304.5 nos.) and nut yield (41nuts).

Jagdalpur

The perusal of data revealed the maximum plant height, plant girth, leaf length and petiole length recorded in Kalyani coconut hybrid 1 followed by number of leaves, leaf length and petiole length in the Konkan Bhatye coconut hybrid 1. Maximum number of leaves (14.6) was observed in Gautami Ganga. In contrast to the above results Kahikuchi coconut hybrid 1 recorded the minimum leaf length (188.2 cm) while Kalpa Pratibha recorded the lowest plant height (289.6 cm).

Kahikuchi

Planting of all the ten coconut varieties/hybrids at Kahikuchi was completed during July, 2013. Morphological characters of the varieties/hybrids were recorded. Highest values in respect of plant height (536cm), plant girth (118cm), no. of leaves (22 nos.) and leaf length (357.5 cm) were recorded in Kera Baster. While the lowest values for the above characters were observed in Kalparaksha. Among the varieties/hybrids, hybrid Kalpa Samrudhi recorded early flowering which was 68 months from date of planting.

Mondouri

The trail was initiated with ten released varieties of coconut and one local check as un-replicated observational trail in 2012. Out of 10 released varieties, the five varieties were planted in 2012 and rests of five were planted in 2014. From the data revealed that the highest plant height (203.2 cm) was recorded in Kalyani coconut hybrid 1. Maximum number of functional leaves (18.2 nos.) and maximum plant girth (146.8cm) were recorded in Kalpamitra.

Navsari

Experiment was laid out during July, 2013 as a demonstrational trial on different released varieties/hybrids at Navsari. Maximum plant height (275cm) was recorded in Kalpa Pratibha while, highest plant girth (205cm), functional leaves (31.3 nos.) with maximum inflorescence (11.7 nos.) and nut yield (35.67 nuts) were noted in Kalpadhenu. Generally all the genotypes are produced average 10-12 numbers of annual leaf/year whereas, leaf length (493.3cm) recorded was maximum in Kera Bastar.

Ratnagiri

The field trail was initiated with ten released varieties of coconut as observational trail in 2011. The maximum plant height was recorded in Kera Bastar (353.3cm) [whereas minimum was in Kalpadhenu (167 cm), maximum plant girth was in Kalyani coconut hybrid 1 (116.2 cm) and the average no. of annual leaf production were (11.8 cm). The maximum number of functional leaves was in Kerakeralam (28.5 no's.). Kera Bastar recorded maximum no. of inflorescence (10.1 nos.) and no. of buttons (106.7 nos.). The variety Konkan Bhatye coconut hybrid 1 recorded maximum nuts yield (57.9 nuts).

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

Centers: Aliyarnagar, Ambajipeta, Arsikere, Jagdalpur, Kahikuchi, Mondouri, Pilicode, Port Blair, Ratnagiri and Veppankulam.

The goal of this activity is to create nucleus seed gardens of important varieties for the production of good quality planting materials.

Table 22 : Varieties for large scale multiplication

Centre	Genotypes
Aliyarnagar	ALN (CN) 1, Tiptur Tall, Kalpa Pratibha, Kerakeralam, COD, KTD, MYD, GBGD, MGD and San Raman
Ambajipeta	Gautami Ganga, Kalpa Pratibha and Kera Bastar
Arsikere	COD, GBGD, MYD, MOD, Fiji Tall, Kulashekar Green, MGD, ECT and Kalpatharu
Jagdalpur	Kera Bastar
Kahikuchi	MYD and Kamrupa
Mondouri	Kalyani coconut hybrid 1, Kalpamitra, Kerakeralam
Pilicode	MYD, MGD, MOD, GBGD, COD, CYD, CGD,
Port Blair	CARI - Annapurna, CARI- Omkar, CARI-Surya, CARI-Chandan
Ratnagiri	Gautami Ganga, East Coast Tall, Kera Bastar
Veppankulam	Kerakeralam, Kalpa Pratibha

Aliyarnagar

The quality seed nuts were harvested from the mother palms of West Coast Tall in a phased manner and sown in the nursery regularly and elite seedlings produced are distributed to the farmers. The nucleus seed gardens Kalpa Prathiba, Kalpa Shatabdi, Tiptur Tall, MGD, MYD, MOD and were planted in this area in establishment stage.

Ambajipeta

Under this project multiplication of Gauthami Ganga, Kera Bastar and Kalpa Prathiba was allotted for Ambajipeta. During 2013-14, the *interse* crossed seedlings of Gauthami Ganga (300nos.) and Kalpa Prathiba (150 nos.) were planted at Horticultural Research Station, Ambajipeta for future production of quality planting material. However, instead of Kera Bastar, variety Double century 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).

Arsikere

The coconut nucleus seed garden block consisting of varieties viz., COD (50 nos.), GBGD (50 nos.), MYD (40 nos.), MOD (40 nos.), Fiji Tall (10 nos.), Kulashekar Green (25 nos.), MGD (15 nos.), ECT (15 nos.) and Kalpatharu (50 nos.) have been established at Arsikere. Among the different dwarf varieties, GBGD recorded highest number of buttons (80 nos.), number of spikes (27 nos.) and nuts yield (75 nuts) compared to the other varieties. The demonstration block consist of 6 variety was established during 2013 and with the objective is to production of improved variety of coconut and distribution to Karnataka farmers.

Jagdapur

Coconut varieties, CCS 8, Kera Bastar are being multiplied for the distribution of planting materials among the farmers of Chhattisgarh. The seed gardens were established during the year 2008 onwards and are being monitored. The observation on morphological characters and survival percentage is continued. Gap filling and package of practices as per recommendation of CPCRI is being adopted in the entire seed garden.

Kahikuchi

As the female parent for the hybrid MYD x WCT is limited at the centre, a mother block 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 Kahikuchi centre during 2010 for establishment of nucleus seed garden. Growth of the seed garden is satisfactory. Most of the palms have already been started flowering.

Mondouri

A total of 50 palms of varieties viz., Kalyani coconut hybrid 1, Kerakeralam and Kalpamitra planted in 2010 and the mother palm blocks are in established phase.

Pilicode

A five year old seed garden of dwarf coconuts comprising 20 dwarf genotypes which include 10 existing dwarf genotypes namely, MYD, MGD, MOD, GBGD, COD, CYD, CGD, SSA, Sannagi and Gudanjali and 10 new dwarf ecotypes collected from various districts of Kerala namely, Chulliyode, Mannukusumbil-2, Azheethala, Nirvaram, Thonnooran, Chakkittapara local, Pulpally, Kanichikulangara, Achankolly and Thondupali.

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. For production of quality planting material of improved varieties of coconut viz., CARI-Annapurna, CARI-Omkar, CARI-Surya and CARI-Chandan were planted at Port Blair 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 on large scale in the orchard. About 175 seedlings each of ECT and GBGD and 290 seedlings of Fiji Tall have been planted for establishment of mother palm garden.



4.2 CROP PRODUCTION

Coc. /Agron. 5: Studies on fertilizer application through micro-irrigation technique in coconut

Sabour

Treatments details:

T₁: No fertilizer; T₂: 25% Recommended dose of fertilizer (RDF) (NPK) through drip system; T₃: 50% RDF (NPK) through drip system; T₄: 75% RDF NPK through drip system; T₅: 100% RDF (NPK) through drip system; T₆: 100% RDF (NPK) through soil application; Recommended dose of fertilizer (g): N: P: K- 500:320:1200; No. of split doses: 8; No. of replications: 4; No. of plants/treat./ replication: 4. Variety: Shakhigopal

Experiment was comprised of six fertigation level with four replication. The maximum plant height of 552.50 cm was recorded with application of 100% RDF fertigation which was at par with 75% RDF through fertigation having plant height of 537.0 cm. Treatment T₅ (100% RDF fertigation) and T₄ (75% RDF through fertigation) produced highest number of inflorescence with 10 inflorescence per plant. Similarly number of fruit per bunch and nut yield per plant was also found highest with T₅ (100% RDF fertigation) with 12.2 nuts per bunch and nut yield of 45.5 nuts per palm. It was followed by T₄ (75% RDF through fertigation) and significantly minimum yield was recorded in T₁ (without fertigation) with 5.5 inflorescence production /palm with yield of 8 nuts per bunch and 23 nuts a yield per palm. Effect of winter was more severe in control and minimum severity of cold injury was noted in 100% fertigation level.

Coc. /Agron. 10: Evaluation of nutrient management under coconut based cropping system for different agro-climatic regions

Centres: Ambajipeta, Bhubaneswar, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour and Veppankulam

Treatments:

T₁ - 75% of RDF + 25% N through organic recycling with vermicompost.

T₂ - 50% of RDF + 50% N through organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring.

T₃ - Fully organic: 100% of N through organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring and green leaf manuring (glyricidia leaves) + composted coir pith, husk incorporation (once in 3 years) and mulching with coconut leaves.

T₄: Control (monocrop of coconut with recommended NPK and organic manure).

Ambajipeta

A trial was initiated during 2012 in 24 years old Godavari Ganga plot with cocoa, banana, pineapple, elephant foot yam and heliconia as intercrops and four treatments were imposed. Plot size per treatment was 6000 m² (Coconut: 24 palms, Cocoa: 36 plants, Banana: 108 plants, Pineapple: 24 beds, Heliconia: 9 beds, Curry leaf: 9 beds). Highest pooled nut yield of 27,848 nuts/ha was observed in T₁ (75% of Recommended NPK + Organic recycling with vermi-compost), while it was followed by T₂ (50% of Recommended NPK + Organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring) with 26,725 nuts/ha. Lowest nut yield per palm was recorded in T₄ (Mono block of coconut) with 23,136 nuts/ha.

Performance of intercrops was studied under various nutrient management conditions, which revealed that irrespective of crop, the highest yields were observed in T₁, followed by T₂ and T₃ (Table 23). Highest pooled yields of 652.6 kg/ha (cocoa), 1,918.2 kg/ha (pineapple), 10.1 t/ha (banana), 2646.8 kg/ha and 9,720 spikes/ha (heliconia) were obtained in T₁.

Table 23 : Yield of coconut and intercrops as influenced by nutrient management practices under CBCS (Ambajipeta)

Treatment	Yield					Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	B:C ratio
	Coconut (No. ofnuts/ha)	Cocoa (kg/ha)	Pineapple (kg/ha)	Banana (t/ha)	Heliconia (No. of spikes/ha)			
T ₁	27,849	652.6	1,918.2	10.1	9,720	1,13,304	2,53,974	3.22
T ₂	26,725	609.5	1,848.1	9.3	8,910	1,10,848	2,36,598	3.11
T ₃	25,600	502.6	1,682.6	8.3	8,100	1,11,645	1,78,078	2.62
T ₄	23,136	-	-	-	-	72,973	72,153	1.99



Coconut based cropping system at Ambajipeta

Bhubaneswar

The coconut based cropping system comprising of coconut, guava, banana and pineapple was restructured during 2012-13 and three treatments of integrated nutrient management were imposed in the cropping system. *Colocasia* was added to the system for last four years. The performance of main

crop with respect to number of functional leaves, rate of production of leaves as well as flowering and yield was consistently better in T2. The performance of the intercrops like banana and guava was better in T2 followed by T1 and T3, whereas, pineapple and colocasia performed better in T1 followed by T2 and T3 treatments. The yield of main crop as well as the intercrops was higher in integrated nutrient management treatments (T1 and T2) compared to fully organic treatment (T3). The maximum net return of Rs.2, 41,193/ha was recorded in T1 followed by T2 (Rs.2, 09,761/ha) and T3 (Rs.1, 61,863 /ha) treatments. The net return from the sole cropping of coconut was only Rs.61, 663/ha) (Table 24). The low yield particularly in banana and pineapple resulting low net returns in different integrated nutrient management was mainly due to effect of cyclonic hit “FANI” held on 3rd May, 2019.

Table 24: Yield and economics of crops in coconut based cropping system (Bhubaneswar)

Treat ments	Coconut (nuts/ha)	Guava (kg/ha)	Banana (kg/ha)	Pineapple (kg/ha)	Colocasia (kg/ha)	Cost of production (Rs./ha)	Net income (Rs./ha)
T1	14963	1572.2	3475.5	3700.0	1370.4	1,38,502	2,41,193
T2	15533	1821.0	3874.9	2866.7	1298.5	1,52,296	2,09,761
T3	14156	1532.7	3335.3	2612.9	980.0	1,58,950	1,61,863
T4	13119	-	-	-	-	43289	61,663

Selling price: coconut @ Rs. 8/nut; banana @ Rs. 12/kg; guava @ Rs. 20/kg; pineapple @ Rs. 30/kg; colocasia @ Rs. 12/kg)

Kahikuchi

The trial was conducted from 2013-14 (var. Assam Green Tall) with black pepper (var. Panniyur- 1) as main crops and Banana (Chenichampa), Pineapple (var. Kew), Assam lemon and Turmeric(var. Megha) as intercrops on 0.4 ha. Data presented in Table 25 revealed that the average highest yield/ha as well as coconut equivalent yield/ha for all the intercrops were recorded in T₂ (50% of RDF +50 % N through this way organic recycling with vermicompost +

vermiwash application + *in situ* Green manuring + biofertilizer) followed by T₁, while yields were the lowest in T₃ (Fully organic). With regard to economics of intercropping system in different treatments the highest net returns of Rs.4,67,170/- per ha with benefit: cost ratio of 2.12 were recorded in T₂ followed by T₁ (Rs. 4,04,270/- per ha and 1.85), while the values were lowest (net return of Rs. 62,220/- per ha and B:C ratio of 1.15) in coconut monocropping (control).

Table 25: Yield and economics of coconut based integrated cropping system (Kahikuchi)

Treat ment	Yield						Cost of production (Rs./ha)	Net return (Rs./ha)	B:C ratio
	Coconut (No. of nuts/ha)	Pine apple (kg/ha)	Banana (kg/ha)	Assam lemon (kg/ha)	Turmeric (kg/ha)	Black pepper (kg/ha)			
T ₁	13,141	16,824	13,357	5,180	12,921	170	2,18,050	4,04,270	1.85
T ₂	13,857	18,311	15,734	5,860	14,144	187	2,20,850	4,67,170	2.12
T ₃	12,472	16,262	13,081	4,683	12,550	155	2,15,250	3,77,030	1.75
T ₄	11,647	-	-	-	-	-	54,250	62,220	1.15

Selling price: pineapple @ Rs. 8/kg; banana @ Rs. 8/kg; black pepper @ Rs. 250/kg; Assam lemon @ Rs. 20/kg; turmeric @ Rs. 8/kg; coconut @ Rs. 10/nut

Mondouri

Trial on coconut based integrated cropping system with banana, lemon, elephant foot yam and black pepper was conducted and performance of crops in response to various nutrient management treatments was studied during 2018-19. Data presented in Table 26 suggested that, amongst the four treatments studied, the highest nut yield of 18,408 nuts per ha was recorded in T₄ (Coconut monocrop), which was on par with T₁. However, all the treatments involving intercropping increased the nut equivalent yield per ha to as high as 60,971 (T₁). Further, all these treatments showed higher B:C ratio than coconut monocropping and highest B:C ratio of 2.11 was recorded in T₁ during the



Coconut based cropping system at Kahikuchi

studied year with highest net returns of Rs. 3,43,493/- per ha. Lowest B:C ratio of 1.71 with lowest net returns of Rs. 84,388/- per ha were obtained in T₄.

Table 26: Yield and economics of coconut and intercrops as influenced by nutrient management practices under CBCS (Mondouri)

Treatments	Coconut (nuts/ha)	Yield of intercrops (per ha)				Cost of production (Rs./ha)	Net return (Rs./ha)	B:C ratio
		Banana (kg)	Lemon nos.)	(Elephant foot yam(kg)	Black pepper (kg)			
T ₁	18,320	13,154	30,616	8,888	333	3,10,534	3,43,493	2.11
T ₂	17,789	9,776	20,648	6,933	242	2,98,083	2,44,905	1.82
T ₃	18,054	9,847	15,308	5,777	246	2,95,139	2,27,913	1.77
T ₄	18,408	-	-	-	-	1,18,100	84,388	1.71

Market price: 2018-19. Coconut@Rs11/piece, EF yam @Rs.15/kg, Lemon@Rs1.55/piece, Black pepper @Rs550/kg and Banana @ Rs 8/kg.

Navsari

Effect of different treatments on yield of component crops as influence by CBCS indicated that, highest yields of elephant foot yam (13.2 t/ha) and tannia (60,542 leaves/ha) were recorded in treatment T₂. No severe infestation of any pest or disease was noticed during overall crop period.



Coconut based cropping system at Navsari

However, minute infestation of mites, black headed caterpillar and brown spot on leaves were observed in coconuts, which were below the economic threshold levels.

Ratnagiri

Experiment was initiated during June 2013 with Coconut (D × T) + nutmeg (Konkan Swad) + cinnamon (Konkan Tej) + banana (Konkan Safed Velchi) + pineapple (Kew) as crop combination. Growth and yield attributing characters of coconut and yields of component crops are recorded and results revealed that, highest yield (24,518 nuts/ha), copra yield (23.8 kg/palm) and oil yield (16.2 kg/palm and 4.09 t/ha) were recorded in T₁, while these parameters were significantly lowest (18,253 nuts/ha, 17.7 kg/palm, 12.1 kg/palm and 3.54 t/ha, resp.) in coconut monocropping (T₁). All the component crops recorded highest yield in the treatment T₁. Further, highest coconut equivalent

yield of 20559.6 nuts/ha was also observed in the same treatment.

Economics of the coconut based integrated cropping systems revealed that the maximum B: C

ratio (3.12) was recorded in the treatment T₁ followed by T₂ (3.05) and the lowest B:C ratio was recorded in the treatment T₄ (2.04) (Table 27).

Table 27: Yield and economics of component crops under coconut based integrated cropping system (Ratnagiri)

Treatment	Yield					Net returns (Rs./ha)	B:C ratio
	Coconut (No. of nuts/ha)	Pine apple (kg/ha)	Banana (kg/ha)	Cinnamon bark (kg/ha)	Cinnamon leaves (kg/ha)		
T ₁	24,518	10,967.2	4,867.4	2,309.6	1,164.4	4,38,184	3.12
T ₂	22,348	10,402.0	4,834.2	2,161.5	1,112.7	4,21,690	3.05
T ₃	20,493	10,731.1	4,430.5	1,956.5	1,088.2	3,91,483	2.93
T ₄	18,253	-	-	-	-	1,37,714	2.04

Sabour

The trial was started during 2013 with four treatments of integrated nutrient management consisting different dose of fertilizer with organic inputs as per technical programme under the crop combinations of coconut, banana, turmeric, guava, elephant foot yam and cow pea including mono cropping with inorganic nutrient input. The biomass produced from the system was recycled and used in the cropping system. Significant treatment effect was noticed regarding plant growth, leaf and inflorescence production. It was observed that treatment T₂ (50 % inorganic + 50 % organic fertilizer application) had highest number of inflorescence production (7.80/plant) and nut yield (32.50/palm) followed by T₃ and minimum was noted in T₄ (100% RDF through 100% inorganic fertilizer in solo crop. Better soil microclimate and moisture availability under organic management probably improved the plant growth in later period of flowering and fruiting resulting in better yield under this treatment. The economics of the coconut based cropping system revealed maximum net return of Rs. 177362.0 only under T₂ (50 % inorganic + 50 % organic fertilizer application).

Veppankulam

Among the treatments studied, T₂ recorded highest number of functional leaves (30 per palm per year), number of bunches (11 per palm per year) and number of nuts (122 per palm per year). A total of 19,758 nuts/ha were obtained in T₂ treatment as against 18,050 nuts/ha in monocrop.

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

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

Arsikere

Treatment details:

T₁: Coconut + fodder crops – cows

T₂: Monocrop of coconut

Area for each treatment: 0.40 ha; cows: 5 No's

Fodder grass: Hybrid Napier (Co-3) in the inter space of coconut

Fodder legumes: *Stylosanthes hamata* in intra space of coconut

Fodder trees: Drumstick and Agase (*S. grandiflora*) (in the border of the plot).

Experiment was initiated during September 2013. The integrated farming system with coconut, fodder and cows recorded more number of nuts 7,154/ acre and higher copra content 150.2 g/ nut as compared to monocrop during 2018-19. The coconut based integrated farming system has found remunerative over other monocrop of coconut. The IFS model has recorded a highest net return Rs. 2, 87,510/- per acre compared to Rs.74, 900/- in monocropping.

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

Arsikere

Treatment details:

T₁: Coconut + pasture crops – sheep

T₂: Monocrop of coconut

Area for each treatment: 0.4 ha; sheep: 20 No's; pasture crops: Anjan grass + Stylo (3:1).

Experiment initiated during May 2014 in which pasture crops viz., Anjan grass (*Cenchrus ciliaris*) and stylo (*Stylosanthes hamata*) were sown in the interspaces of coconut. The productions of pasture, sheep and sheep manure have been quantified. Integrated farming system with coconut, fodder and sheep recorded higher yield of nuts and fodder during 2018-19. A total 16 number of lambs were produced during this year. Integrated farming system with coconut has recorded higher net return Rs. 1, 73,020/- compared to Rs. 35,960/- in monocrop of coconut.



Grazing of sheep's in IFS trial (Arsikere)

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

Centres: Aliyarnagar and Veppankulam

Treatment details:

T₁: Coconut + fodder trees + pasture crops – goat

T₂: Monocrop of coconut

Aliyarnagar

An experiment was laid out during 2015-16. Fodder grass of Cumbu Napier hybrid (Co BN5) and legume fodder of Desmanthus were sown in the interspaces of coconut. Fodder trees of *Sesbania grandiflora*, *Leucaena leucocephala* and *Glyricidia* were planted as fodder trees in all border bunds. Highest annual leaf production, total number of leaves and total number of inflorescence per palm recorded in IFS (T₁), when compared with coconut monocropping. Total of 17,200 nuts/ha/year and 10,700 kgs of fodder was produced from one ha coconut garden. A total of 26 lambs were produced in the farming system. Dropping from goats were collected periodically and 6600 kg of goat manure was produced, which was applied in coconut basins. Integration of coconut with pasture crops + fodder trees + Tellicherry goats recorded gross income of Rs. 3,18,400/- per ha as compared to Rs.2,03,400/- per ha in the monocrop of coconut (Table 28).

Table 28: Economics of the coconut based IFS with goat

Component	Yield	Remarks	Gross income (Rs./ha)
IFS (T₁)			
Coconut yield (nos.)	17,200	Sale price of Rs. 12/ nut	2,06,400
Pasture production (kg)	10,700	Grazed by goats	—
Goat manure (kg)	6,600	Utilized in as manure in experimental block	—
Lamb production (nos.)	26	Weighed 448 kg which was sold at Rs. 250/- per kg	1,12,000
		Total	3,18,400
Monocrop (T₂)			
Coconut yield (nos.)	16,950	Sale price of Rs. 12/ nut	2,03,400



Cumbu Napier Hybrid in IFS Trial



Goats grazing in IFS Trial

Veppankulam

Integration of goat in coconut based cropping system was compared with coconut sole cropping. Tellicherry breed goats were purchased in the ratio of 6 (female): 1(male). Fodder crops were raised under irrigated condition. Pasture production and goat manure are being quantified. It was suggested that integrated farming system with coconut, fodder and goat recorded higher yields of nuts (8, 224) along with fodder grass yield of 2,610 kg during 2018-19. On the other hand, coconut monocrop recorded 8,016 nuts per acre. Pasture was grazed by goats and goat manure applied in coconut basins. Integration of coconut with pasture crops (*Cenchrus ciliaris* + *Stylosanthes hamata*) + Fodder trees (*Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia*) + goat recorded gross income of Rs.98, 688/- per acre. Monocropped coconut registered gross return of Rs.96, 192 /- per acre.

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

Expt. 4: Screening of black pepper varieties for their performance as intercrop in coconut garden

Centres: Kahikuchi and Mondouri

Black pepper variety: IISR Thevam, IISR Shakthi, Sreekara, IISR Malabar Excel, Panniyur – 1; design: RBD; replication; 4.

Kahikuchi

An experiment was initiated during September 2009. Planting material of black pepper varieties/hybrids was planted under coconut following randomized block design replicated four times. Pre-experimental yield data of coconut for last three years was recorded which ranged from 51 to 57 nuts/palm/year. Initial nutrient status of soil was determined and Highest vine length (6.3 m) and vine girth (7.9 cm) were recorded in Panniyur-1, whereas lowest values for vine length (5.4 m) and vine girth (6.6 cm) was observed in IISR Sakthi (Table 29). With regard to number of laterals/vine, the highest number of laterals (31.0 at one m column) was recorded in Sreekara, while it was the lowest (25.1 laterals) in IISR Malabar Excel. Among the varieties/hybrids, Panniyur-1 recorded significantly higher number of spikes (112.0 in one meter column height), spike length (14.4 cm), number of berries per spike (67.8) and yield (1.45 kg/vine) compared to other varieties/hybrid.

Table 29 : Growth, yield attributing characters of different pepper varieties

Black pepper varieties	No. of laterals (in 1 m column height)	No. of spikes (in 1 m column height)	Spike length (cm)	No. of berries/spike	Berry yield (dry weight) (kg /vine)
IISR Thevam	7.1	26.9	92.0	10.9	1.20
IISR Shakthi	6.6	27.8	87.0	11.6	1.25
IISR Malabar Excel	7.1	25.1	87.7	11.5	1.16
Sreekara	6.9	31.0	95.1	8.7	1.18
Panniyur-1	7.9	28.6	112.0	14.4	1.45
CD (P=0.05)	0.34	1.23	4.61	1.34	0.05

Mondouri

Performance of five improved varieties/hybrids was tested in irrigated conditions of Gangetic Alluvial Zone of West Bengal. Perusal of data suggested superior performance of Panniyur 1, when compared with other varieties tested. Panniyur-1 recorded highest

fresh berry yield of 2.91 kg/plant, followed by Sreekara (2.14 kg/plant). Lowest yield of 1.55 kg/plant/year was recorded in IISR Sakthi. Similar trend was observed in case of dry weight of berries as highest yield of 1.13 kg/plant was recorded in Panniyur 1, which was followed by Sreekara (0.83kg/plant).

Expt. 5: Evaluation of coconut based cropping system models

Centres: Goa and Port Blair

Experimental details: Goa

T₁: Coconut + Black pepper + Papaya + Drumstick

T₂: Coconut + Black pepper + Heliconia

- T₃: Coconut + Black pepper + Banana + Lemon
 T₄: Coconut + Black pepper + Passion fruit + Pineapple
 T₅: Coconut + Black pepper + Annona
 T₆: Coconut + Black pepper + Crossandra
 T₇: Coconut monocrop

Goa

Post-experimental nutrient data was recorded in the experimental block and potassium levels in the soils were found to be low. Pre experimental coconut yield in the experimental plot was 47 nuts/year/palm during Jul 2014-Jun 2015. Coconut yield after intercropping was observed to be 67 nuts/palm/year.

Port Blair

Experiment was initiated during 2018-19 to evaluate performance of improved varieties/hybrids of black pepper as intercrop in a neglected coconut (AOT) plantation under Andaman condition. Objective of the study is to identify suitable varieties for intercropping and to know influence of intercropping on coconut productivity of an unproductive orchard. Experiment was set up in RBD with eleven pepper varieties (Panniyur 1, Panniyur-2, Panniyur-5, Panniyur-6, IISR-Girimunda, IISR- Malabar Excel, IISR- Panchami, IISR- Sakthi, IISR- Sreekara, IISR- Subhakara and IISR-Thevum) as treatments and each treatment was replicated seven times. Planting of glyricidia standards was done at a spacing of 2 m × 2 m in coconut interspaces and black pepper vines were trained over them. Pre-experimental soil samples

were collected and are being analyzed. Pre-experimental yield of coconut was found to be 20.1 nuts/palm/year. Gap filling of glyricidia and pepper was undertaken.

Expt. 6: Performance of different tuber crops and spices in coconut based cropping system

Mondouri

Treatment details:

- T₁: Coconut+ black pepper + onion+ sweet potato
 T₂: Coconut + black pepper + turmeric + elephant foot yam
 T₃: Coconut + black pepper + ginger + colocasia
 T₄: Coconut + black pepper + coriander + sweet potato
 T₅: Coconut + black pepper + chilli + sweet potato
 T₆: Coconut + black pepper + onion + potato
 T₇: Coconut monocrop

Design: RBD; replication: 4; no. of palms per treatment: 4; Year of start: 2015-16.

Data presented in below indicated that of the various coconut based cropping system models studied, highest yield of 18,568 nuts/ha was recorded in treatments T₂ and T₃ (Table 30). Treatment T₃ recorded maximum B: C ratio of 2.34 with a maximum net returns of Rs. 4, 55,107/- per ha. Coconut + Black Pepper + Onion + Potato model (T₆) recorded lowest B: C ratio of 1.65, though the lowest net return of Rs. 1, 05,400/- per ha was recorded by coconut monocrop (T₇).

Table 30 : Yield economics of different tuber crops and spices under coconut based integrated farming system model (Mondouri)

Treatment	Component	Yield	Grossha return/ha (Rs.)	Expenditure/ha (Rs.)	Net returns/ha (Rs.)	B:C ratio
T ₁	Coconut (nos./ha)	17,346	4,06,281/-	1,90,452/-	2,15,829/-	2.13
	Black pepper (kg/ha)	90.75				
	Sweet Potato (t/ha)	6.96				
	Onion (t/ha)	6.12				
T ₂	Coconut (nos./ha)	18,568	7,47,628/-	3,29,861/-	4,17,767/-	2.27
	Black pepper (kg/ha)	113				
	Turmeric (t/ha)	8.88				
	EFY(t/ha)	27.55				
T ₃	Coconut (nos./ha)	18,568	7,93,669/-	3,38,562/-	4,55,107/-	2.34
	Black pepper (kg/ha)	112				
	Ginger (t/ha)	8.75				
	Colocasia (t/ha)	8.21				

T ₄	Coconut (nos./ha)	17,523	3,75,423/-	1,68,966/-	2,06,457/-	2.22
	Black pepper (kg/ha)	91				
	Coriander (t/ha)	0.66				
	Sweet Potato (t/ha)	6.96				
T ₅	Coconut (nos./ha)	17,523	4,35,509/-	2,02,914/-	2,32,595/-	2.15
	Black pepper (kg/ha)	101				
	Chilly (t/ha)	2.31				
	Sweet Potato (t/ha)	6.96				
T ₆	Coconut (nos./ha)	17,523	3,54,829/-	2,14,871/-	1,39,958/-	1.65
	Black pepper (kg/ha)	92				
	Onion (t/ha)	6.12				
	Potato (t/ha)	7.8				
T ₇	Coconut (nos./ha)	18,054	1,98,594/-	93,194/-	1,05,400/-	2.13

Expt. 7: Coconut based multispecies cropping systems under coastal littoral sandy soil

Centres: Bhubaneswar, Kasaragod and Ratnagiri

Design: Split plot

Number of palms per treatment: 6

Year of start: 2015-16



Tuber and spices crops under CBCS at Mondouri

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 + <i>Garcinia indica</i> + Vegetable Crops (Rainy season)
	CS ₂ : Coconut + sapota + flower crops	CS ₂ : Coconut + sapota+ Pineapple	CS ₂ : Coconut + <i>Garcinia indica</i> + Pineapple
	CS ₃ : Coconut + sapota + fodder crops	CS ₃ : Monocrop of coconut	CS ₃ : Monocrop of coconut
	CS ₄ : Monocrop of coconut		
Sub plot (Nutrient management practices)	N ₁ : Green manuring + bio-fertilizers + organic recycling + FYM		
	N ₂ : Green manuring + bio-fertilizers + organic recycling + soil test based fertilizers application		
	N ₃ : Green manuring + bio-fertilizers + organic recycling + 100% RDF		

Bhubaneswar

The experiment was conducted in littoral sandy soil at Coconut Research Station, Konark during January, 2016. The cropping system was developed by planting intercrops like pineapple and sapota during rainy season in 2016. Besides sapota and pineapple the other intercrop, cowpea was raised only in rainy season. The result revealed that, after three years of imposition of treatments, there was significant variation among the palms under different cropping systems as well as under different nutrient management practices for number of leaves, rate of production of leaves, inflorescences, female flowers

and nut yield. However, the interaction effect of cropping system and nutrient management was significant only for number of female flowers and nut yield. Significantly maximum nut yield (72.7nuts/palm/yr.) was recorded in CS₂N₂ treatment. The yield of pineapple (7926kg/ha) as well as cowpea (4680kg/ha) was maximum in plots receiving soil test based NPK nutrients (N₂). Except sapota, income was derived from all the crops in the system and maximum net return (Rs.2, 31,948/ha) was estimated in CS₂N₂ treatment (Table 31). The performance of all the crops except cowpea was significantly affected in the cyclonic hit “FANI” in 3rd May, 2019.

Table 31: Economics of coconut based cropping system (Bhubaneswar)

Treatments	Gross return (Rs./ha)	Cost of production (Rs./ha)	Net return (Rs./ha)
CS1N1	1,71,104	92,566	78,538
CS1N2	2,03,808	1,08,980	94,828
CS1N3	1,90,493	1,04,815	86,493
CS2N1	2,50,486	1,05,033	1,45,453
CS2N2	3,54,148	1,25,932	2,31,948
CS2N3	2,93,175	1,13,310	1,79,865
CS3N1	83,056	47,600	35,456
CS3N2	97,152	52,200	44,952
CS3N3	88,736	49,400	39,336

Sale price of Coconut @ Rs. 8/nut, Cowpea @Rs. 20/kg and Pineapple @ Rs. 30/kg

Kasaragod

This experiment is started with the objective to develop coconut based multispecies cropping system model under coastal littoral sandy soil. The experiment was laid out in split plot design. In the main plots, 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) and in the sub plots nutrient management (N-1: Green manuring + Bio fertilizer + Organic matter recycled + FYM@10t/ha+50% RDF, N-2: Green manuring + Bio fertilizer + Organic matter recycled + 100% Recommended dose of fertilizers+ FYM@10t/ha, N-3: Green manuring + Bio fertilizer + Organic matter recycled + 150% Recommended dose of fertilizers+ FYM@10t/ha).

Fodder yield of fodder sorghum (COFS 29) was recorded and the data showed that the treatment N3 recorded significantly higher yield (24.7 t/ha)



CBMCS under coastal sandy soil at Ratnagiri



Coconut based multispecies cropping system under coastal sandy soil

and significantly differed from the treatment N2(Organic recycling + 100 recommended chemical fertilizer) (20.3 t/ha) and N1 (15.4 t/ha). The coconut yield recorded revealed that and among the system tried, coconut+sapota+flower and coconut+ sapota+vegetable intercropping recorded higher coconut yield of 73 and significantly higher from monocropping of coconut.

Ratnagiri

Planting of Kokum has been done as per treatment details and initial soil samples have been collected for soil analysis. Mean annual leaf production was maximum (25.63 leaves/palm) in CS₁N₂. Highest yield (126.04 nuts/ palm) was recorded in CS₂N₁. Vegetable yield was highest (84.20 kg/plot) in CS₁N₃, while highest pineapple yield (100 kg) was recorded in CS₁N₂.

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

Treatment details:

T₁: Recommended practice (500:320:1200 g NPK/palm + FYM @ 50 kg/palm + TNAU micronutrient mixture @ 1 kg/palm + neem cake @ 5 kg/palm)

T₂: Bio-manures and biofertilizers (green leaf manuring @ 10 kg with Glyricidia loppings + organic recycling of coconut waste through vermicompost @ 10 kg + coconut frond mulching + *Azospirillum* @ 100 g + *Phosphobacteria* @ 100 g + VAM @ 100 g + green manuring with sunn hemp twice a year)

T₃: T₂ + soil test based NPK and micronutrient application

Coconut variety: Chowghat Orange Dwarf (COD); age of palms: 25 years; No. of palms per treatment: 6; design: RBD; replications: 7; year of start: 2014-15.

Experiment on INM technologies to enhance productivity and quality of tender nut in dwarf coconut was initiated during 2015 in 10 years old Chowghat Orange Dwarf (COD) at Avalchinampaalyam village, Pollachi, Coimbatore district. Initial soil sample analysis revealed that soil was low in nitrogen and potassium and medium in phosphorus.

Different nutrient management techniques did not show significant difference in growth attributes such as plant height, plant girth, and total number of leaves, annual leaf production and number of inflorescence production per palm per year. Application of soil test based nutrient application along with biomanures and biofertilizers (T₃) recorded significantly highest tender nut yield of 116 nuts/palm/year followed by biomanures and biofertilizers application (T₂) and recommended practices (T₁). Net returns were higher in T₃ (Rs.99,880/- per ha) followed by T₂ (Rs. 96,760/- per ha) and T₁ (Rs. 59,620/- per ha) treatments.

Expt. 2: Nutrient management through organics in coconut plantation under island conditions

Port Blair

Experiment was initiated with three coconut varieties (AGD, AOD, AYD) during 2015-16 and gap filling was taken up during 2017. Five nutrient management treatments were imposed following factorial RBD.

T₁: Control (FYM @ 20 kg and NPK @ 500:320:1500 g/palm/year)

T₂: Biofertilizer (Kera Probio @ 50 g, twice per year) + *in situ* green manure (cowpea) + recycling of biomass (VC @ 2 kg through external application)

T₃: Biofertilizer (Kera Probio @ 50 g, twice per year) + *in situ* green manure (cowpea) + recycling of biomass (VC @ 2 kg through external application) + FYM @ 15 kg

T₄: Biofertilizer (Kera Probio @ 50 g, twice per year) + *in situ* green manure (cowpea) + recycling of biomass (VC @ 2 kg through external application) + poultry manure @ 8 kg

T₅: Biofertilizer (Kera Probio @ 50 g, twice per year) + *in situ* green manure (cowpea) + recycling of biomass (VC @ 2 kg through external application) + FYM @ 8 kg + poultry manure @ 4 kg.

Considerable variations were noticed amongst the varieties and treatments for growth and yield related parameters. Palm height varied between 133.8 cm (AGD/T₄) and 509.5 cm (AOD/T₂). The lowest and highest value of girth at collar region was reported in AGD. In general, irrespective of the variety, palms receiving T₄ treatment exhibited poor growth performance and no flowering was observed with this nutrient treatment. No flowering was noticed in any treatment involving AGD variety. Additionally, flowering was not reported in palms of AYD receiving T₅ treatment. The AOD/T₅ combination produced 11.5 numbers of inflorescences and 28.5 nuts per palm, which was followed by AOD/T₃ combination (10.3 inflorescences and 28.3 nuts per palm).

Expt. 3: Organic farming in coconut based farming system

Centres: Aliyarnagar, Ambajipeta and Arsikere

Treatment details:

T₁: *In situ* organic matter recycling, + PGPR consortia + *in situ* green manuring + husk incorporation

T₂: *In situ* organic matter recycling + PGPR consortia + *in situ* green manuring + husk incorporation + FYM @ 25 kg

T₃: T₁ + 50% recommended K₂O through the application of sulphate of potash

T₄: T₂ + 50% recommended K₂O through the application of sulphate of potash

T₅: Conventional method (chemical fertilizer application)

T₆: Shredded coconut waste application

Design: RBD; replications: 4; no. of palms per treatment: 6; year of start: 2015-16.

Cropping system to be followed at different centres:

Aliyarnagar: Coconut + cocoa

Ambajipeta: Coconut + cocoa + banana

Arsikere: Coconut + sitaphal + lime + drumstick

Kasaragod: Coconut + cocoa + vegetables + cover cropping system

Aliyarnagar

Experiment was laid out as per the treatments for which trench of 15m length and 1.3 m width was formed in between coconut palms (T₁-T₄). PGPR consortia, organic manure, husk burial and 50% recommended K₂O through the application of sulphate of potash were applied as per the treatments. Growth and yield parameters were recorded and presented in Table 32. Total number of leaves and annual leaf production per palm differed significantly by different nutrient management techniques. Highest total number of leaves per palm and annual leaf production were recorded in T₄ treatment followed by T₃. Significantly highest nut yield (170 nuts/palm/year) was recorded in T₄ treatment and it was *on par* with T₃ treatment (165 nuts/palm/year). The lowest nut yield (147 nuts/palm/year) was observed in T₅ treatment (conventional method of chemical fertilizer application).

Table 32: Growth and nut yield of coconut under organic farming

Treatments	Palm height (m)	Trunk girth (cm)	Total number of leaves (No./palm)	Annual leaf production (No./palm)	Nut yield (nuts/palm/year)
T ₁	19.32	92.82	34	11	155
T ₂	19.01	94.54	35	11	159
T ₃	19.61	95.33	35	12	165
T ₄	19.78	95.35	36	12	170
T ₅	19.08	90.37	35	11	147
S.Ed±	0.28	6.29	0.28	0.33	2.36
CD (P=0.05)	NS	NS	0.59	0.70	5.01

Ambajipeta

The trial was initiated during 2015 in 30 years old East Coast Tall variety plantation with four replications. Cocoa cv. Foresterio and banana cv. T. C. Keli were planted as intercrops. Cocoa crop is four years old and is in bearing stage and the growth characters of cocoa were recorded. With respect to coconut, no significant differences were noticed for total number of functional leaves/palm. However, nut yield per palm differed significantly among the treatments. Treatment T₅ recorded significantly highest yield (124.19 nuts/palm/year), which was on par with T₄ (121.43 nuts/palm/year).



Field view of organic farming at Ambajipeta

With regards to banana, there was no significant variation for bunch weight, number of fingers per

bunch and total number of hands per bunch. However, higher bunch weight (5.55 kg) was recorded in T₄ treatment followed by T₃ (5.49 kg), T₂ (5.21 kg) and T₅ (5.13 kg).

Arsikere

The experiment was initiated with Coconut + custard apple + Lime + Drumstick as cropping system. Intercrops were planted during 2015; however, cocoa was subsequently replaced with custard apple due to scarcity of water during 2018. Application of PGPR consortia, *In situ* green manuring and husk burial was taken up. Application of FYM, 50% recommended SOP and inorganic fertilizer was added to the plants as per the treatments. Morphological data like plant height, plant girth, number of branches, canopy spread were significantly higher in T₄ followed by T₃ and T₂. The lowest morphological data were recorded in T₆ with chemical fertilizer application. The yield of coconut (76.5 nuts/ palm), lime (4 kg/ plant), Drumstick (5.1 kg/plant) were recorded significantly maximum in treatment T₄ followed by T₃ and T₂.

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

Aliyarnagar

Locations: 3 farmer's plots

1. Kanakkapillaivalasai village of Tirunelveli district
2. Manakkadavu village of Coimbatore district
3. Melagudalur village of Theni district

Year of start: 2015-16

Management practices as per the treatments were initiated in root (wilt) affected garden at two locations based on soil nutrient status (Manakkadavu village and Kanakkapillaivalasai village). The pH of samples from both locations was in the alkaline range. The organic carbon content is extremely low in the both sites and Zn was found to be low in both the sites. Based on the soil nutrient status the above

mentioned packages of practices were formulated by ICAR-CPCRI, RS, Kayamkulam and treatments were imposed at two locations.

Package practices adopted based on the soil test results:

- Addition of organic manure @ 25 kg per palm
- Application of *Trichoderma viride* @ 50 g per palm
- Sowing of dhaincha seeds @ 100 g/palm basin and incorporation with the initiation of flowering
- Application of recommended dose of fertilizers
- Addition of zinc sulphate @ 50 g/palm
- Insecticide (Imidachloprid @ 1 ml/l of water)

Management practices as per the package of treatments were initiated in root (wilt) affected garden at three locations based on soil nutrient status (Manakkadavu village of Coimbatore district, Kanakkapillaivalasai village of Tirunelveli district and Melagudalur village of Theni district). The pH of samples from the all sites is in the alkaline range. The organic carbon content is extremely low and Zn was found to be low in all three locations. Based on the soil nutrient status, the above mentioned packages of practices were followed and treatments were imposed during last year. 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.

The average root (wilt) disease index of 5.58 was recorded in Manakkadavu village whereas, 7.23 was recorded in Kanakkapillaivalasai village. Range of disease index was 0-30 in Manakkadavu village and 0-30 in Kanakkapillaivalasai village. During the year, nut yield under demonstration plot was higher (86 nuts/ palm) in Manakkadavu village compared to control plot (60 nuts/palm). In Kanakkapillaivalasai also under demonstration plot, the nut yield was higher (98 nuts/palm/year) compared to control (63 nuts/palm/year).

Particulars	Manakkadavu		Kanakapillaivalasai	
	Demonstration plot	Control plot (Farmers practice)	Demonstration plot	Control plot (Farmers practice)
Ranges of disease index	0-30	4-47	0-30	2-45
Average disease index	5.58	18.20	7.23	20.50
Nut yield (nuts/palm/year)	86	60	98	63

4.3 DISEASE MANAGEMENT

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

Centres: Aliyarnagar, Ambajipeta, Arsikere and Veppankulam

Expt. 1: Roving survey of coconut diseases Aliyarnagar

Roving survey was conducted in various villages of coconut growing districts viz., Coimbatore, Tiruppur, Dindigul, Theni, Tirunelveli and Kanyakumari to assess the incidence of major diseases of coconut viz., bud rot, basal stem rot, stem bleeding, leaf blight and leaf spot during September, 2019. Among the various villages surveyed, the maximum bud rot incidence of 8.3 per cent was recorded in Ragalbavi village of Udumalai block, Tiruppur district, the block average bud rot incidence was found to be high (3.5%) in Udumalai, Tiruppur district followed by Cumbum block of Theni district and Pollachi (North) block of Coimbatore district which recorded the bud rot incidence of 2.5 and 2.4 per cent respectively. The district mean incidence of 1.9 and 1.3 per cent was observed in Tiruppur and Coimbatore districts, respectively.

The maximum basal stem rot incidence of 12.7 per cent was recorded in Pulavadi village of Gudimanagalam block in Tiruppur district. Among the blocks, Gudimanagalam block, Tiruppur district recorded the highest block average of 8.1 per cent and the highest district average of 4.6 per cent was recorded in Tiruppur district.

The highest stem bleeding incidence of 12.7 per cent was recorded in Pulavadi village of Gudimangalam block, Tiruppur district. The mean disease incidence of the Gudimanagalam, Thovalai and Anamalai blocks were 4.0, 2.2 and 1.6 per cent, respectively. District average for the Tiruppur district was 1.7 per cent.

The intensity of leaf spot (25 PDI) was more in Bethanayakkanpaalyam village of Anamalai block, followed by Avalchinampaalyam village (23.5%) of Coimbatore district. Among the blocks, Periyakulam block of Theni district recorded the highest (15.9 PDI) leaf spot incidence. The leaf blight intensity was maximum (24.7 PDI) in Ponamlamthuuri village of Anamalai block and the maximum district average (13.9 PDI) was recorded in Coimbatore district (Table 33).

Table 33: Disease status in Tamil Nadu state during 2019

District	Disease incidence (%)				
	Basal stem rot	Stem bleeding	Bud rot	Leaf blight	Leaf spot
Coimbatore	1.2 ± 0.5	0.6 ± 0.4	1.3 ± 0.5	13.9 ± 0.2	9.5 ± 1.3
Tiruppur	4.6 ± 1.8	1.7 ± 0.9	1.9 ± 0.7	9.0 ± 1.0	5.7 ± 0.7
Dindigul	1.1 ± 0.2	0.6 ± 0.3	0.8 ± 0.1	9.9 ± 1.0	6.9 ± 1.7
Theni	1.1 ± 0.3	0.3 ± 0.2	0.9 ± 0.7	7.6 ± 1.3	9.6 ± 2.9
Tirunelveli	0.6 ± 0.1	0.2 ± 0.0	0.6 ± 0.2	4.8 ± 0.6	2.8 ± 0.4
Kanyakumari	1.7 ± 0.7	1.2 ± 0.4	0.7 ± 0.1	5.3 ± 0.9	4.1 ± 0.7

Data represented is mean ± standard deviation

Ambajipeta

Surveys were conducted in different mandals of four districts viz., East Godavari, West Godavari, Srikakulam, Vijayanagaram and Visakhapatnam districts of Andhra Pradesh during 2019. Major diseases observed in coconut gardens were basal stem rot, stem bleeding and bud rot along with minor incidence of grey leaf spot. Overall mean per cent incidence of basal stem rot, stem bleeding and bud rot diseases were 8.1, 2.0 and

0.8, respectively. High basal stem rot disease incidence was noticed in Pedavegi (11.0%) mandal of West Godavari district, Mamidikuduru (10.6 PDI) and Sakhinetipalli mandal (10.4 PDI) of East Godavari district and Kaviti (10.7 PDI) and Ranasthalam (10.7 PDI) mandals of Srikakulam district. The stem bleeding disease was severe in (4.0 PDI) Srikakulam district and lowest in Mallikipuram mandal (0.7 PDI) of East Godavari district. Further, the highest bud rot disease

incidence was observed in Chagallu mandal (1.1%) of West Godavari district and the lowest was in Payakaraopeta mandal (0.4%) of Visakhapatnam district (Table 34).

Table 34: Disease status of coconut in Andhra Pradesh during 2019

District	Disease incidence (%)		
	BSR	Stem bleeding	Bud rot
East Godavari	9.5 ± 0.5	1.3 ± 0.2	0.8 ± 0.1
West Godavari	8.8 ± 0.6	1.7 ± 0.1	0.7 ± 0.1
Srikakulam	6.9 ± 1.6	2.7 ± 0.4	0.7 ± 0.1
Visakhapatnam	4.1 ± 1.0	1.8 ± 0.3	0.6 ± 0.8

BSR- Basal stem rot; Data represented is mean ± standard deviation

Arsikere

The roving survey on major coconut diseases viz., basal stem rot, stem bleeding, bud rot, leaf blight and leaf spot was conducted in four major coconut growing districts of Karnataka namely, Hassan, Tumkur, Shivamogga and Chickmagalur during September, 2019. The basal stem rot disease was noticed in all the four districts and the disease incidence ranged from 0.0 to 6.1 per cent. The maximum incidence of 6.1 per cent was recorded in Turvekere taluk of Tumkur district. However, the incidence of stem bleeding ranged from 0.0 to 33.3 per cent. Maximum incidence of 33.3 per cent was recorded at Channarayapatna taluk of Hassan district. The bud rot disease incidence ranged from 0.3 to 5.8 per cent. Maximum disease incidence of 5.8 per cent was noticed in Hosanagara and Shivamogga taluk during September, 2019.

The foliar diseases of coconut namely, leaf blight and leaf spot were separately recorded. The incidence of leaf blight ranged from 1.4 to 26.9 per cent. The maximum incidence was recorded at Kadur taluk in Chikkamagloru district. Leaf spot disease incidence ranged from 4.4 to 30.3 per cent and the maximum incidence was recorded at Kadur taluk in Chikkamagloru district.

Veppankulam

During 2019, the roving survey conducted in two districts of Tamil Nadu viz., Thiruvarur and Nagapattinam implied that the incidence of basal stem rot disease ranged from 20.0 to 29.6 per cent. The maximum disease incidence recorded was at



Roving survey in Visakhapatnam dist (Stem bleeding symptoms)

Thillaivilagam in Thiruvarur district. The maximum incidence of bud rot disease was recorded as 6.7 per cent at Thillaivilagam in Thiruvarur district. Stem bleeding disease incidence was not noticed in any of the places where survey was undertaken. The leaf blight incidence was noticed in Thambikkottai-keelakadu (7.8%) and in Idumbavanam (11.1%). The incidence of lethal wilt was recorded from Thillaivilagam (4.4%).

Expt. 2: Fixed plot survey of coconut diseases

Aliyarnagar

Fixed plot survey was carried out at quarterly intervals from January to December, 2019 in two villages viz., Puliyanakandi and Aliyarnagar, Anamalai block, Coimbatore district. Observations were recorded on leaf blight and leaf spot diseases and weather parameters were also recorded viz., temperature and relative humidity. The intensity of leaf blight and leaf spot diseases were found to be high in Puliyanakandi compared to Aliyarnagar. The leaf blight incidence was positively correlated with temperature and negatively correlated with RH. The leaf spot severity was negatively correlated with the temperature (Table 35 and 36).

Table 35: Intensity of coconut diseases in fixed plot survey at Aliyarnagar

Month	Puliyankandi		Aliyarnagar	
	Leaf blight	Leaf spot	Leaf blight	Leaf spot
April	23.7	7.6	21.0	7.4
July	20.9	9.8	20.2	7.1
October	19.8	10.3	18.7	8.1

Table 36: Correlation of leaf blight and leaf spot with temperature and RH

Puliyankandi				Aliyarnagar			
Correlation coefficient							
Leaf blight		Leaf spot		Leaf blight		Leaf spot	
Temperature	RH	Temperature	RH	Temperature	RH	Temperature	RH
0.99	-0.687	- 0.44	0.56	0.92	-0.581	-0.11	0.856

Ambajipeta

Fixed plot survey was taken up for stem bleeding and bud rot diseases at HRS, Ambajipeta and for basal stem rot disease (*Ganoderma*) in farmer's field at P. Gannavaram village in East Godavari District at quarterly intervals from April to October, 2019. Per cent disease incidence of basal stem rot during April was 34.9 per cent which was increased to 36.5 per cent by the end of October. Per cent incidence of stem bleeding disease varied between 3.2 and 2.5 per cent during 2019. Bud rot disease incidence was observed from September to October, 2019 (2.0 %).

Arsikere

The Fixed plot survey on major coconut diseases was undertaken to assess the disease spread. The plot was managed as per general management practices and no disease management measures were undertaken. The observations on basal stem rot, stem bleeding and leaf blight were recorded at quarterly interval. The incidences of 39.5 per cent BSR, 23.2 per cent stem bleeding, and 9.0 per cent leaf blight were recorded during April, 2019. At the end of the October, 2019, the incidences of BSR and stem bleeding diseases increased to 40.0 and 23.9 per cent, respectively. However, the incidence of leaf blight disease increased to 10.0 per cent (Table 37).

Table 37: Fixed plot survey of coconut diseases at HRES, Arsikere

Month	Disease incidence (%)		
	Basal stem rot	Stem bleeding	Leaf blight
April	39.6	23.2	9.0
July	39.7	23.7	9.8
October	40.0	23.9	10.0

Veppankulam

Fixed plot survey was initiated at Mangadu village in Alangudi taluk of Pudukottai district during December, 2012. The total number of palms in the field was 85. The initial per cent incidence of basal stem rot (28.0%) was recorded. The observations were recorded at quarterly intervals and it was found that the per cent incidence of basal stem rot was increased to 90.6 per cent during October, 2019.

Coc./Path. 2: Basal stem rot disease

Centres: Ambajipeta, Arsikere and Veppankulam

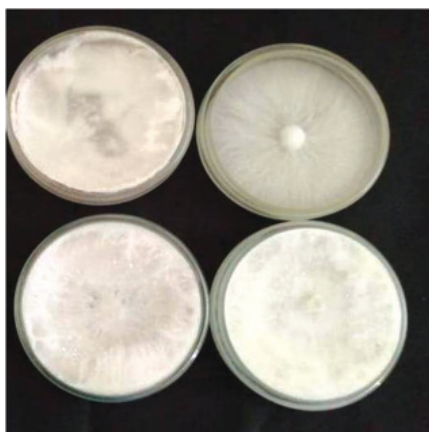
Expt. 1: Characterization of *Ganoderma* spp. associated with basal stem rot disease of coconut Ambajipeta

Four isolates of *Ganoderma* spp. representing varied geographical locations were collected and their variations with respect to morphological and cultural characters were documented. The radial growth of isolates was around 90 mm in 8 days in all the isolates and statistically there was no difference among the isolates with respect to growth. The colony characters of all isolates were white in colour and most of them showed cottony growth and a few produced leathery growth (Table 38).

Table 38: Morphological and cultural variations of *Ganoderma* isolates from Andhra Pradesh

<i>Ganoderma</i> isolate	Part of collection	Mycelial growth (mm) of <i>Ganoderma</i> *				Morphological character
		2 DAI	4 DAI	6 DAI	8 DAI	
Kaviti	Sporophore	5.0	30.0	70.0	90.0	leathery
Pedavegi	Root	5.0	40.0	60.0	90.0	White cottony
Mamidikuduru	Sporophore	10.0	30.0	70.0	90.0	White cottony
Chagallu	Root	10.0	30.0	60.0	90.0	Sparse cottony

*Mean of four replications; DAI- Days after inoculation



Isolates of *Ganoderma* from Andhra Pradesh

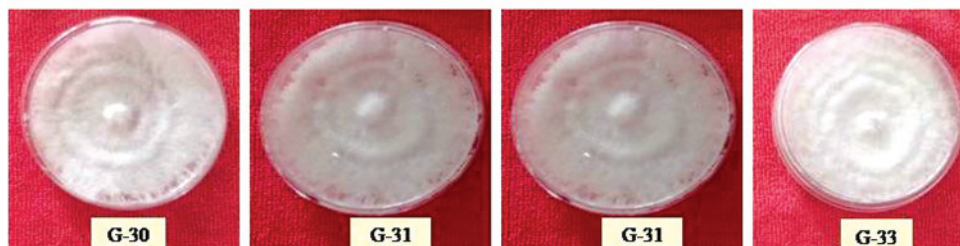
Arsikere

The roots samples from *Ganoderma* infected coconut palms were collected during roving survey. The isolation of pathogen from these samples was done under laboratory using PDA medium. Four isolates were obtained from the samples of Belur, Chikkanaykanahalli, Shivamogga and Thuruvekere region. The variations with respect to morphological and cultural characters were documented. The radial growth of isolates was around 90.0 mm in 9 days in almost all isolates and statistically there was no difference among the isolates with respect to growth. All isolates were white in colour and showed cottony growth (Table 39).

Table 39: Morphological and cultural variations of *Ganoderma* isolates collected from Karnataka

Place	Isolate code	Part used for isolation	Mycelial growth at different days after inoculation (cm)*				Colony character
			3 DAI	5 DAI	7 DAI	9 DAI	
Belur	G-30	Root	9.0	46.0	90.0	90.0	White, cottony growth
Chikkanaykanahalli	G-31	Root	8.3	40.0	82.0	90.0	White, cottony growth
Shimoga	G-32	Root	8.0	35.0	80.0	90.0	White, cottony growth
Thuruvekere	G-33	Root	9.0	50.0	85.0	90.0	White, cottony growth
CD (P=0.01)						NS	

*Mean of four replications; DAI- Days after inoculation



Isolates of *Ganoderma* collected from Karnataka

Veppankulam

The sporophores of *Ganoderma* were collected from surveyed villages viz., Thambikkottai-keelakadu, Jambuvanodai-vadakadu, Thillaivilagam and Veppankulam for the isolation of fungi and

morphological studies. The isolation of *Ganoderma* was done from the sporophore collected from Veppankulam and the cultural and morphological characters were documented (Table 40).

Table 40: In vitro isolation of *Ganoderma* isolates from Tamil Nadu

Places	Source	Mycelial growth (cm)*				Colony characters
		3DAI	5DAI	7DAI	9DAI	
Thambikkottai-Keelakadu	Sporophore	-	-	-	-	-
Jambuvanodai-Vadakadu	Sporophore	-	-	-	-	-
Thillaivilagam	Sporophore	-	-	-	-	-
Veppankulam	Sporophore	3.5	4.9	7.2	9.0	White cottony

*Means of five replications; DAI-Days after inoculation



***Ganoderma* isolate from Veppankulam**

Expt. 2: Epidemiology and disease forecasting

Influence of weather parameters on BSR disease incidence

Ambajipeta

The study was initiated in November, 2010 to study the impact of other palms and

intercrops in coconut on occurrence and spread of basal stem rot disease. Fifty palms in the field with sole coconut and field with coconut + banana were selected in 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 period is being recorded. In sole coconut plot, the PDI of 34.4 per cent during April, 2019 was increased to 35.3 per cent by the end of October, 2019. Mean vertical spread in sole coconut crop was recorded as 115.7 cm in April and as 119.3 cm in December, 2019. Over a period of 9 years, the percent disease incidence of 2 (November, 2010) in sole coconut was increased to 35.3 per cent (December, 2019). In the new plot selected for coconut and banana, the 20.2 per cent PDI during April, 2019 was increased to 25.2 per cent by the end of October, 2019. Mean vertical spread of the disease in coconut + banana plot was recorded as 129.3 cm in April and as 142.5 cm in November, 2019 (Table 41).

Table 41: Impact of intercrops on occurrence and spread of the disease in coconut (2019)

Month	Temp.(°C)		RH (%)		RF (mm)	Rainy days (No.)	Horizontal spread (%)		Mean vertical spread (cm)	
	Max.	Min.	Max.	Min.			SC	C+B	SC	C+B
	April	35.4	24.7	89.6			53.8	—	—	34.4
May	37.0	27.6	86.3	52.0	—	—	34.4	20.2	115.7	137.0
June	34.9	26.8	81.5	49.8	—	—	34.4	20.2	115.7	139.3
July	33.1	26.0	85.2	58.6	120.0	8	34.4	25.2	115.7	142.5
August	32.8	25.8	85.4	65.2	169.8	11	35.3	25.2	116.3	142.5
September	31.9	25.4	87.8	69.7	218.3	15	35.3	25.2	116.3	142.5
October	31.0	24.1	91.8	74.0	311.3	12	35.3	25.2	118.2	142.5
November	31.8	21.8	98.9	59.1	5.0	1	34.3	24.2	119.0	142.5
December	29.5	19.6	98.6	60.9	19.6	—	34.3	24.1	119.3	140.2

SC: sole crop; C+B: coconut + banana

Correlation of weather parameters with disease incidence

The monthly average of weather parameters such as relative humidity, temperature and rainfall were correlated with vertical and horizontal spread of basal stem rot disease. The result implied that, there was a positive correlation among relative humidity, rainfall and spread of disease and negative correlation with maximum temperature and spread of the BSR disease.

Arsikere

The study was continued with 76 palms to record the disease incidence at monthly interval. 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. The results revealed that the vertical spread of the disease ranged from 181.3 to 183.1 cm and horizontal spread from 9 to 10 palms (11.8 to 13.2 %) during nine months (Table 42).

Table 42: Influence of weather parameters on BSR disease incidence

Month	Temp. (°C)		RH (%)		Rain fall (mm)	Rainy days (No.)	Rate of VS (cm)*	HS	Rate of HS (cm)*
	Max.	Min.	Morning	Evening					
April	36.3	20.5	48.4	34.5	24.0	1	181.3	9	11.8
May	36.0	21.3	64.4	51.8	54.2	3	181.3	9	11.8
June	31.9	21.7	75.6	64.4	81.9	5	181.3	9	11.8
July	28.7	21.5	82.4	77.2	30.1	3	182.6	10	13.2
August	27.7	21.2	79.9	77.9	124.1	10	182.6	10	13.2
September	28.7	20.3	77.7	75.2	162.8	8	182.6	10	13.2
October	29.0	19.6	81.0	80.9	253.9	16	183.1	10	13.2
November	29.2	18.3	78.9	75.1	68.5	5	183.1	10	13.2
December	27.6	18.9	72.0	61.2	42.2	1	183.1	10	13.2

*Mean of ten palms; RH- Relative humidity; VS: vertical spread; HS: horizontal spread

Correlation of weather parameters with disease incidence

The monthly average of weather parameters such as relative humidity, temperature and rainfall

were correlated with vertical and horizontal spread of basal stem rot disease. The result implied that, there was a positive correlation among relative humidity, rainfall and spread of disease (Table 43).

Table 43: Correlation between weather parameters and BSR disease

Parameter	Vertical spread	Horizontal spread
Morning RH (%)	0.674	0.73
Evening RH (%)	0.729	0.785
Max. temp. (°C)	-0.877	-0.919
Min. temp. (°C)	-0.682	-0.5
Rainfall (mm)	0.41	0.40

Veppankulam

A plot having 263 coconut palms was selected to record the disease incidence at quarterly interval. The weather parameters such as relative humidity, atmospheric temperature, rainfall and number of rainy days were recorded to correlate with the vertical and horizontal spread of disease. The results revealed that the vertical spread of the disease ranged from 52.1 to 63.9 cm and horizontal spread from 72 to 82 (27.4% to 31.2%). The horizontal spread of basal stem rot of coconut has negative correlation with

maximum temperature (-0.22) and minimum temperature (-0.60). The vertical spread of basal stem rot of coconut also had negative correlation with maximum temperature (-0.03) and minimum temperature (-0.43). Relative humidity (both morning and evening) was positively correlated with the horizontal spread of basal stem rot disease (0.12 and 0.49, respectively). The morning relative humidity was negatively correlated (-0.07) with the vertical spread of basal stem rot disease in coconut. Whereas the evening relative humidity was positively correlated

(0.32) with the vertical spread of basal stem rot disease in coconut. Rain fall was positively correlated with both the horizontal and vertical spread of basal stem rot disease (0.80 and 0.67, respectively).

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

Effective bacterial endophytes were isolated from healthy coconut plant materials and one among them was found effective against *Ganoderma*. The endophyte isolate was kept for dual culture studies against different *Ganoderma* isolates. Among all the endophytes tested EP₄ isolate showed 51.1 per cent inhibition, whereas all other isolates showed 90.0 mm growth after 8 days of inoculation.

Based on dual culture studies with effective endophytic bacteria against seven *Ganoderma*

isolates, more than 50 per cent inhibition was found compared to control. Hence this endophytic bacterium was selected for field experiment against *Ganoderma* disease.

Field experiment: The bacterial bioagent named *B. amyloliquefaciens* was found to be promising in arresting the growth of *Ganoderma* sp. under *in vitro* conditions. The same isolate was taken to field conditions to test field efficacy against basal stem rot disease in coconut. The talc based formulation was applied in soil along with FYM 50 kg, whereas bacterial broth was fed through roots and root feeding of hexaconazole was used as standard check. The results revealed that among all the treatments, there was no significant variation with respect to disease index at three months after treatment (Table 44).

Table 44: Influence of bacterial bio-agents on basal stem rot disease of coconut

Treatments	Disease index	
	Before treatment	3 MAT
T ₁ : Soil application of 100 g talc formulation of <i>Bacillus amyloliquefaciens</i> along with 50 kg FYM	38.5 (38.3)	38.5 (38.3)
T ₂ : Root feeding of bacterial strain 50 ml broth (10 ⁸ cfu/ml) in 100 ml water	34.7 (35.7)	34.7 (35.7)
T ₃ : Root feeding of hexaconazole 3 ml in 100 ml water	41.5 (39.9)	42.3 (40.4)
T ₄ : control	52.4 (49.6)	53.5 (50.3)
S.Em ±	6.14	6.01
CD (P=0.05)	NS	NS

Arsikere

The bacterial bioagent named EP₁₀ was found to be promising in arresting growth of test pathogen *Ganoderma* sp. under *in vitro* conditions. The same isolate was taken to field conditions to test efficacy against BSR disease in coconut. The talc based formulation was applied to soil along with FYM 50 kg, whereas the bacterial broth was fed

through roots and root feeding of hexaconazole was used as standard check. Each palm constituted one replication and six replications were maintained under each treatment. The result revealed that among all the treatments there was no significant variation with respect to disease index at six month after treatment (Table 45).

Table 45: Influence of bacterial bio-agents on BSR disease of coconut

Treatments	Disease index*		
	BI	3 MAT	6 MAT
T ₁ : Soil application of 100 g talc based formulation of EP ₁₀ along with 50 kg FYM	34.7	34.1	34.1
T ₂ : Root feeding of bacterial strain 50 ml broth (10 ⁸ cfu/ml) in 100 ml water	34.6	35.0	37.3
T ₃ : Root feeding of hexaconazole 3 ml in 100 ml water	35.9	36.1	36.8
T ₄ : Control	35.3	37.3	38.1
S.Em ±	0.67	0.73	0.72
CD (P=0.05)	2.05	2.25	2.21

*Mean of six replications; BI: before initiation; MAT: months after treatment

Veppankulam

Based on the *in vitro* evaluation of biocontrol agents, effective bacterial strain EPC₅ was selected for the management of basal stem rot under field condition. The trial was laid out in randomized block design with four treatments and five replications. For each replication, four coconut palms were selected. The trial was initiated during October, 2018 at CRS, 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 EPC₅ (nutrient broth)/100 ml of water at 3 months interval was the most effective in containing the disease registering 1.0 per cent decrease in disease index as against 11.6 per cent in control in the field. The mean bacterial population was recorded as 0.95x10⁸cfu/gram of soil in April, 2019 and increased to 3.8x10⁸cfu/gram of soil in the treatment of soil application of 100 g talc based formulation of EPC₅ along with 50 kg FYM at 3 months interval.

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

Centres: Ambajipeta, Arsikere and Veppankulam

Ambajipeta

Evaluations of identified systemic fungicide from *in vitro* studies against basal stem rot disease under field conditions

Under *in vitro* screening of latest systemic fungicides viz., Thifluzamide 24 SC, Mancozeb 50% + Carbendazim 25% WS, Zineb 68% + Hexaconazole 4% WP, Myclobutanil 10% WP, Dodine 65% WP, Pyraclostrobin + Fluxa pyroxad 250 SC, Kresoxymethyl 44.3% SC, Isoprothiolone 40% EC against *Ganoderma* sp. at different concentrations (100 ppm, 250 ppm, 500 ppm and recommended concentrations), except

Kresoxymethyl 44.3% SC (12.96%), all chemicals showed cent per cent inhibition at recommended concentration.

Based on the mobility test, among all the effective systemic chemicals, Zineb 68% + Hexaconazole 4% WP showed good mobility. Hence it was selected for field studies. An experiment on field evaluation of Zineb 68% + Hexaconazole 4% WP fungicide at different dosages were initiated against basal stem rot disease of coconut at farmer's coconut garden at Peddapatnamlanka village of East Godavari district during the month of December, 2018. Pre and Post treatment data was recorded on disease index of basal stem rot disease. Among all the treatments evaluated, none of the treatments showed significant reduction in disease intensity compared to pre treatment data even after 6 months of treatment.

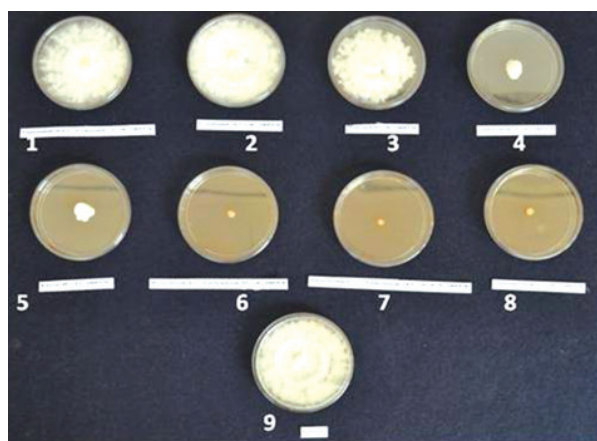
Arsikere

In vitro evaluation of fungicide molecules against *Ganoderma*

The new fungicide molecules with combi-products were tested against mycelial growth of *Ganoderma lucidum* at two concentrations (100 and 250 ppm) under *in vitro* condition. No growth (cent per cent inhibition) was observed in the plates treated with Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W and Carbendazim 46.27% SC at 250 ppm concentrations even after 9 days. However, in case of Mancozeb 35% SC (66.0 mm) mycelial growth was recorded. The fungicides viz., Thifluzamide 24% SC and Kitazin 48% EC at 250 ppm recorded only 12.0 mm and 10.3 mm growth with 86.7 and 88.5 per cent inhibition. In untreated control, there was 90.0 mm growth after 9 days of inoculation. Similar trend has been observed in 100 ppm concentration also (Table 46).

Table 46: *In vitro* evaluation of fungicides against *Ganoderma* sp.

Treatment	Mycelial growth after 9 days (mm)		% inhibition compared
	100 ppm	250 ppm	
Famoxadone 16.6% + Cymoxanil 22.1% SC	90.0	89.7	0.4
Cyazafamid 34.5% SC	90.0	90.0	0.0
Mancozeb 35% SC	68.0	66.0	26.7
Thifluzamide 24% SC	13.0	12.0	86.7
Kitazin 48% EC	11.0	10.3	88.5
Hexaconazole 4% + Carbendazim 16% SC	0.0	0.0	100.0
Azoxystrobin 11% + Tebuconazole 18.3% SC w/w	0.0	0.0	100.0
Carbendazim 46.27% SC	0.0	0.0	100.0
Control	90.0	90.0	0.0



In vitro evaluation of fungicides against *Ganoderma* sp.

Field evaluation of fungicides molecules against *Ganoderma*

The fungicide Zineb 68% + Hexaconazole 4% WP was found to be effective in arresting growth of pathogen under *in vitro*. The same fungicide was tested at field conditions through root feeding at 3 months interval at different concentrations. Each palm constituted one replication and total of four replications were maintained. Hexaconazole 5% EC was used as standard check. The result revealed that, disease index varied among different treatments. It

was observed that there was a significant difference among the control and treated palms with respect to disease index at six month after treatment, however there was no significant difference among the treatments.

Veppankulam

Based on the *in vitro* evaluation of eight fungicides, combination fungicide viz., Zineb 68% + Hexaconazole 4% WP was selected for the management of basal stem rot under field condition. The trial was laid out in randomized block design with six treatments and three replications. For each replication, four coconut palms were selected. The trial was initiated during September, 2018 at CRS, Veppankulam. The effective fungicide was given as root feeding at quarterly intervals. The results revealed that the root feeding of Hexaconazole @ 3 ml + 100 ml water at quarterly interval was the most effective in containing the disease by registering 23.4 per cent decrease in disease index over initial disease index followed by the root feeding of Zineb 68% + Hexaconazole 4% WP @ 4 g + 100 ml water at quarterly interval by registering 6.2 per cent decrease in disease index over initial disease index (Table 47).

Table 47 : Influence of fungicides on BSR disease of coconut

Treatment details	Disease index (%)*		
	June	September	Increase over initial
T ₁ : Root feeding of Zineb 68% + Hexaconazole 4% WP @ 2 g + 100 ml water at quarterly interval	22.8	21.4	-1.4
T ₂ : Root feeding of Zineb 68% + Hexaconazole 4% WP @ 4 g + 100 ml water at quarterly interval	23.6	17.3	-6.2
T ₃ : Root feeding of Zineb 68% + Hexaconazole 4% WP @ 6 g + 100 ml water at quarterly interval	17.9	22.1	4.2
T ₄ : Root feeding of Zineb 68% + Hexaconazole 4% WP @ 8 g + 100 ml water at quarterly interval	13.1	23.4	10.3
T ₅ : Root feeding of Hexaconazole @ 3 ml + 100 ml water at quarterly interval	36.5	13.1	-23.4
T ₆ : Control	49.0	50.1	1.1
CD (P=0.05)	9.06	7.95	

*Mean of three replications

Coc./ Path 3: Stem bleeding disease

Centres: Ambajipeta and Arsikere

Expt. 1: Management of stem bleeding disease in coconut through biological control

Ambajipeta

Evaluation of cake formulations of bio agent, *Trichoderma* was tested against stem bleeding disease of coconut at HRS, Ambajipeta. Effect of

T. harzianum and *T. reesei* cake formulation along with positive control (paste application of copper oxy chloride) was tested against stem bleeding disease of coconut. In case of cake application the treatment was given once during the study period. In case of paste application, the paste application was carried out every month. Every month the treated palms were observed for the disease

symptom and the per cent recovery of the treated palms was observed.

Application of *T. harzianum* and *T. reesei* cake formulation completely recovered the diseased palms compared to the paste application of copper oxy chloride. Disease index of 6.8 and 5.7 at HRS farm, Ambajipeta was brought down to 0.0 per cent

within 50 days of cake application (both *T. harzianum* cake (CPCRI cake) and *T. reesei* cake (Native isolate, HRS, Ambajipeta) formulation). Disease index of 7.0 was reduced to 5.2 in case of paste application of copper oxychloride; however the treatments differed significantly at 50 DAT (Table 48).

Table 48: Field evaluation of cake and paste formulations of *Trichoderma* species against stem bleeding disease of coconut (At Mukkamala)

Treatment	Disease index (%)	
	BI	50 DAT
T ₁ : <i>T. harzianum</i> cake application	6.8 (13.3)	0.0 (0.0)
T ₂ : <i>T. reesei</i> paste application (as swabbing)	5.7 (13.5)	0.0 (0.0)
T ₃ : Bordeaux paste application	7.0 (15.6)	5.2 (12.8)
T ₄ : Control	9.5 (19.5)	14.5 (23.0)
S.Em±	0.77	2.54
CD (P=0.05)	NS	7.65

DAT: days after treatment; BI: before initiation

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

Ambajipeta

In vitro evaluation of fungicide molecules against *Thielaviopsis paradoxa*

Under *in vitro* screening of different single and combi products viz., Thifluzamide 24% SC, Carbendazim 46.27% SC, Difenconazole 25% EC, Azoxystrobin 18.2% w/w + Difenconazole 11.4% w/w SC, Azoxystrobin 11% + Tebuconazole 18.30% SC, Hexaconazole 5% + Validamycin 2.5%

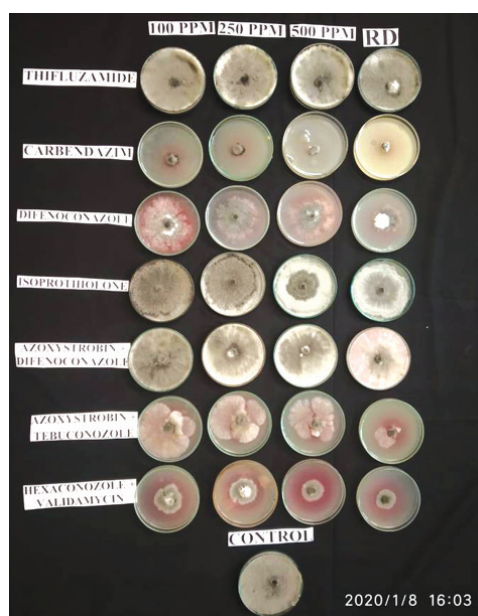
SC and Isoprothiolone 40% EC against *T. paradoxa* at different concentrations (100 ppm, 250 ppm, 500 ppm and recommended concentrations), Carbendazim 46.27% SC showed 94.4 per cent disease inhibition over control followed by Hexaconazole 5% + Validamycin 2.5% SC (73.6%) at recommended concentration. None of these chemicals viz., Thifluzamide 24% SC, Azoxystrobin 18.2% w/w + Difenconazole 11.4% w/w SC, Isoprothiolone 40% EC inhibited the growth of *T. paradoxa* (Table 49).

Table 49: *In vitro* evaluation of fungicide molecules against *T. paradoxa*

Treatments	Mycelial growth of <i>T. paradoxa</i> (mm)				Per cent inhibition over control			
	100 ppm	250 ppm	500 ppm	Rec. conc.	100 ppm	250 ppm	500 ppm	Rec. conc.
Thifluzamide 24 % SC	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	0.0	0.0	0.0	0.0
Carbendazim 46.27% SC	21.3 (27.3)	12.5 (20.6)	12.5 (20.6)	5.0 (12.9)	76.4	86.1	86.1	94.4
Difenconazole 25% EC	67.5 (55.3)	63.8 (53.0)	46.3 (42.8)	48.8 (44.3)	25.0	29.2	48.6	45.8
Azoxystrobin 18.2% w/w + Difenconazole 11.4% w/w SC	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	0.0	0.0	0.0	0.0
Azoxystrobin 11% + Tebuconazole 18.30% SC	55.0 (47.9)	50.0 (45.0)	45.0 (42.1)	42.5 (40.7)	38.9	44.4	50.0	52.8
Hexaconazole 5% + Validamycin 2.5% SC	45.0 (42.1)	42.5 (40.7)	33.8 (35.5)	23.8 (29.1)	50.0	52.8	62.5	73.6
Isoprothiolone 40% EC	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	0.00	0.00	0.00	0.00
Control	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	90.0 (71.6)	-	-	-	-
S.Em±	1.13	0.74	0.85	0.79				
CD (P=0.05)	3.33	2.14	2.49	2.31				

Evaluation of identified systemic fungicides from *in vitro* studies against stem bleeding disease under field conditions

Under *in vitro* screening of latest systemic fungicides viz., Thifluzamide 24 SC, Mancozeb 50% + Carbendazim 25% WS, Zineb 68% + Hexaconazole 4% WP, Myclobutanil 10% WP, Dodine 65% WP, Pyraclostrobin + Fluxapyroxad 250 SC, Kresoxymethyl 44.3% SC, Isoprothiolone



In vitro evaluation of fungicide molecules against *T. paradoxa*

40% EC against *T. paradoxa* at different concentrations (100 ppm, 250 ppm, 500 ppm and recommended concentrations), Mancozeb 50% + Carbendazim 25% WS showed cent per cent inhibition, Thifluzamide 24 SC and Kresoxymethyl 44.3% SC showed no inhibition at their recommended concentrations. Remaining chemicals were on par with each other with respect to percentage of inhibition at recommended concentration.

The experiment on field evaluation of Mancozeb 50% + Carbendazim 25% WS fungicide at different dosages were initiated against stem bleeding disease of coconut at farmer's coconut garden at Avidi village of East Godavari district during the month of December, 2018. Among all the treatments tested, there was no significant reduction in disease index compared to control.

Arsikere

The field experiment has been continued to test efficacy of fungicides against stem bleeding disease of coconut. Each palm of coconut constituted one replication and total of four replications were maintained under each treatment. The result revealed that, there was significant difference between the treatments and control. However, among the treatments there was no significant difference with respect to disease index at six month after treatment. (Table 50).

Table 50: Influence of fungicides on stem bleeding disease of coconut

Treatments	Disease index (%)*		
	Before initiation	3MAT	6MAT
T ₁ : Root feeding of Mancozeb 50% + Carbendazim 25% WP @ 2 g in 100 ml water at 3 months interval	27.7	27.2	28.4
T ₂ : Root feeding of Mancozeb 50% + Carbendazim 25% WP @ 4 g in 100 ml water at 3 months interval	25.1	26.4	26.6
T ₃ : Root feeding of Mancozeb 50% + Carbendazim 25% WP @ 6 g in 100 ml water at 3 months interval	26.0	26.3	26.7
T ₄ : Root feeding of Mancozeb 50% + Carbendazim 25% WP @ 8 g in 100 ml water at 3 months interval	27.2	27.8	28.6
T ₅ : Root feeding of Hexaconazole 5% SC @ 3 ml in 100 ml water at 3 months intervals	28.5	28.9	29.0
T ₆ : Control	28.1	28.7	33.9
S.Em±	3.85	1.33	1.61
CD (P=0.05)	8.59	4.00	4.86

*Mean of three replications; MAT: months after treatment

Coc./Path. 5: Leaf blight disease of coconut
Centres: Aliyarnagar

Expt. 1: Characterization of leaf blight disease in coconut
Aliyarnagar

Twenty five healthy and 25 leaf blight infected palms were selected in Puliyanakandi village, Anaimalai block, Coimbatore district and nut yield was recorded from June, 2018 to December, 2019. The per cent reduction in yield was assessed using the formula :

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

From the results it was found that the percent reduction in nut yield due to leaf blight disease in

coconut ranged from 10.4 to 16.6 per cent with an average yield loss of 13.5 per cent (Table 51).

Table 51: Assessment of yield loss due to leaf blight disease

Date of harvest	Nut yield*		% reduction in nut yield
	Healthy palms	Infected palms	
12.06.2018	22.3	20.2	10.4
30.07.2018	22.0	19.7	11.8
20.09.2018	15.1	13.0	16.4
07.11.2018	18.1	16.0	12.7
28.12.2018	19.6	17.4	12.4
20.02.2019	17.1	14.8	15.7
13.05.2019	23.1	20.1	13.0
04.07.2019	21.1	18.5	12.1
27.08.2019	21.5	18.8	12.4
14.10.2019	18.1	15.4	14.7
05.12.2019	17.1	14.3	16.6
Mean			13.5

* Mean of 25 palms


Field view of leaf blight management at Aliyarnagar
Expt. 2: Epidemiology of leaf blight disease in coconut
Aliyarnagar

The weather data viz., temperature, relative humidity and leaf blight disease intensity were recorded at weekly intervals. The results revealed that the intensity of leaf blight was the highest during April, 2019 and the lowest during December, 2019. The leaf blight incidence was positively correlated with temperature and RH (Table 52, 53 and 54).

Table 52: Monthly weather data and intensity of leaf blight during 2019

Month	Leaf blight incidence (PDI)	Temp (°C)		RH (%)		Rainfall (mm)	Evaporat ion(cm)
		Max.	Min.	Morning	Evening		
April	26.8	37.3	22.1	82.2	55.8	52.0	5.4
May	25.6	36.3	23.6	86.6	62.2	15.2	5.1
June	24.6	35.2	24.0	84.6	68.0	4.4	4.5
July	23.7	34.0	23.9	82.9	69.7	38.2	4.7
August	24.1	32.4	22.1	85.8	64.0	238.0	3.8
September	23.5	33.5	22.3	89.1	71.5	83.8	3.0
October	21.6	32.7	21.7	90.6	77.4	233.4	2.7
November	20.6	32.2	20.2	90.3	72.3	133.1	2.7

Table 53: Correlation between leaf blight incidence and weather parameters

Leaf blight incidence	Weather parameters	Correlation coefficient
	Temperature (Max.)	0.88
	Temperature (Min.)	0.76
	RH (Morning)	-0.87
	RH (Evening)	-0.18
	Rainfall	0.11
	Evaporation	0.56

Table 54: Multiple regression analysis for leaf blight incidence

Model	Particulars	Unstandardized coefficients	Standardized coefficients Beta	't' stat	R ²
1	(Constant)	5.452	-	-	0.88
	Temp. (Max.)	0.747	0.738	3.347	
2	(Constant)	18.199	-	-	0.74
	Temp. (Min.)	0.60	0.524	3.999	
	RH (Morning)	-0.175	-0.396	-3.763	
3	(Constant)	15.070	-	-	0.67
	Temp max	0.686	0.598	5.585	
	RH (Evening)	-0.174	-0.395	-3.899	
	RF	0.11	0.196	2.129	
Dependent variable: PDI of leaf blight					

Expt. 3: Management of leaf blight disease in coconut

Aliyarnagar

A field experiment was laid out at Puliyanandi village of Anaimalai block in Coimbatore district for evaluating the efficacy of fungicides against leaf blight disease with eight treatments and three replications in randomized block design. The treatments were imposed at appropriate time intervals. Pre-treatment

and post-treatment observations were recorded at 27 months after application. The results showed that root feeding with Propiconazole @ 5 ml in 100 ml of water at quarterly interval was effective in reducing the leaf blight incidence from 30.0 to 22.5 PDI which accounted for 7.5 per cent disease reduction. This treatment also recorded the highest nut yield of 132.0 nuts/ year as against 92.0 nuts/ year in control (Table 55).

Table 55 : Evaluation of systemic fungicides against leaf blight disease

Treatment details	Leaf blight intensity (%)			Adjusted mean of ANACOVA*	Nut yield** (nuts/palm/year)
	0MAT	27MAT	Difference		
T ₁ : Root feeding of Tebuconazole @ 2 ml + 100 ml water	32.1	28.6	3.5	29.0	107.0
T ₂ : Root feeding of Tebuconazole @ 5 ml + 100 ml water	33.4	27.4	6.0	27.4	117.0
T ₃ : Root feeding of Tebuconazole @ 10 ml + 100 ml water	33.3	28.6	4.7	28.6	101.0
T ₄ : Root feeding of Propiconazole @ 2 ml + 100 ml water	37.9	34.1	3.8	32.7	113.0
T ₅ : Root feeding of Propiconazole @ 5 ml + 100 ml water	30.0	22.5	7.5	23.5	132.0
T ₆ : Root feeding of Propiconazole @ 10 ml + 100 ml water	36.7	31.7	5.0	30.7	112.0
T ₇ : Root feeding of 2 g of Carbendazim in 100 ml water	23.6	20.4	3.2	23.5	110.0
* T control	39.8	40.1	-0.3	38.1	92.0

* T₁ Vs T₅ significantly different at 5% level; ** Mean of nine palms; MAT: months after treatment

Expt. 4: Sequential use of fungicides against leaf blight disease

Aliyarnagar

Based on the *in vitro* screening the effective fungicides (Carbendazim and Propiconazole) were selected for field evaluation at different time intervals. The experiment was laid out to evaluate the efficacy of sequential application of fungicides against leaf blight with five treatments and four replications in randomized block design at Puliyanakandi village of Anaimalai block in Coimbatore district.

The treatments were imposed as per the technical programme and the leaf blight incidence was recorded in the experimental plot. The results revealed that root feeding with Carbendazim @ 5 ml in 95 ml water during January and July followed by Propiconazole @ 5 ml in 95 ml water during April and October reduced the leaf blight incidence by 7.7 per cent after 27 months of application. This treatment recorded the highest nut yield of 135.0 nuts/palm/year as against 90 nuts/palm/year in control (Table 56).

Table 56: Evaluation of sequential use fungicides against leaf blight disease

Treatment details	Leaf blight intensity (%)			Adjusted mean of ANACOVA	* Nut yield** (nuts/palm/year)
	0 MAT	27 MAT	Difference		
T ₁ : Effective fungicide A (Carbendazim) @ 5 ml in 95 ml water during January, April, July and October	25.7	19.9	5.8	21.8	112.0
T ₂ : Effective fungicide B (Propiconazole) @ 5 ml in 95 ml water during January, April, July and October	29.0	25.4	3.6	25.6	120.0
T ₃ : Effective fungicide A (Carbendazim) @ 5 ml in 95 ml water during January, July and effective fungicide B (Propiconazole) @ 5 ml in 95 ml					
water during April and October	33.7	26.0	7.7	23.9	135.0
T ₄ : Effective fungicide B (Propiconazole) @ 5 ml in 95 ml water during January and July and effective fungicide A (Carbendazim) @ 5 ml in 95 ml water					
during April and October	32.6	28.4	4.2	26.8	123.0
T ₅ : Control	26.5	29.3	-2.8	30.8	90.0

* T₁ Vs T₄; T₁ Vs T₅; T₃ Vs T₄ are significantly different at 5% level; ** Mean of five replications; Each replication consist of 12 palms; MAT: months after treatment

Expt. 5: Demonstration of integrated disease management on leaf blight

Aliyarnagar

The demonstration trial for the management of leaf blight was laid out in 1 acre garden containing 72 palms at Aliyarnagar village of Anaimalai block in Coimbatore district. The integrated disease management strategy consisting of the following components was imposed.

- ❖ Removal and destruction of severely affected fronds (once in 3 months)
- ❖ Spraying of Bordeaux mixture 0.5% or copper oxy chloride 0.3% two times at 45 days intervals during summer months (February/April).

- ❖ Root feeding of Carbendazim @ 2 g in 100 ml water (root feeding to be done at three months interval during January, April, July and October)
- ❖ Basal application of *Pseudomonas fluorescens* @ 200 g along with 50 kg FYM per year.

Pre treatment (initial) and post treatment observations (27 months after application) were recorded on leaf blight intensity both in treated and untreated plots. The average intensity of leaf blight disease was reduced from 20.7 to 13.1 PDI after 27 months of application, whereas in control plot, leaf blight intensity slightly increased from 19.9 (initial) to 21.1 PDI after 27 months of application. This accounted for 7.6 per cent reduction of the disease (Table 57).

Table 57: Intensity of leaf blight disease in demonstration plot

Particulars	Demonstration plot		Control plot	
	Pre-treatment(0 MAT)	Post-treatment(27 MAT)	Pre-treatment(0 MAT)	Post-treatment(27 MAT)
Ranges of disease intensity	0.0 to 63.2	0.0 to 60.0	0.0 to 50.7	0.0 to 60.5
Average*	20.7 ± 1.8	13.1 ± 1.1	19.9 ± 2.3	21.1 ± 1.3

*Average of 72 palms; Values are mean ± Standard error

Ambajipeta

For the demonstration of integrated disease management on leaf blight, one acre coconut garden with leaf blight disease was selected in Jangareddygudem village of West Godavari district along with the control plot. The average intensity of leaf blight disease was reduced from 9.4 (initial year) to 5.2 per cent. However, in case of control plot, disease intensity was slightly increased from 10.3 (initial) to 13.6 per cent.

Arsikere

One acre garden with leaf blight incidence was selected at Boranakoppalu village in Arsikere Taluk for demonstration trial on management of leaf blight. A separate control plot was also selected in nearby place. The treatments were imposed at appropriate time. The initial incidence of disease was 12.2 per cent in treated plot and 11.9 in untreated control and demonstration is in progress.

Coc./Path. 6: Root (wilt) disease of coconut

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

Aliyarnagar

Roving survey was carried out during January to December, 2019 to assess the incidence of root (wilt) in different villages of Coimbatore, Tiruppur, Dindigul, Theni, Tirunelveli and Kanyakumari

districts. The highest root wilt incidence of 56.5 per cent was recorded in Melacudalooore village, Cumbum block, Theni district, followed by Anumanthanpatti (55.0%) and Cumbum villages (54.0%).

In Coimbatore district, among the four blocks surveyed, root (wilt) incidence was observed in three blocks viz., Pollachi South, Pollachi North and Anaimalai and it was absent in Kinathukadavu block. The root wilt incidence of Coimbatore district ranged from 3.0 to 53.7 per cent and the maximum incidence of 53.7 per cent was recorded in Amrapalayam village of Pollachi South block. Meagre incidence of root wilt was observed in Tiruppur district with district average of 0.53 per cent. The root (wilt) incidence was not observed in surveyed villages of Dindigul district.

In Theni district, severe incidence of root (wilt) was recorded in Melacudalooore (56.5%), Anumanthanpuram (55.0%) and Cumbum (54.0%) villages of Cumbum block. The mean root (wilt) incidence of Uthamapalayam block was found to be 12.4 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 16.7 per cent and the highest block average of 54.5 percent were recorded in Theni district and Cumbum block, respectively.



4.4 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, Dindugul, Theni, Tirunelveli, Kanyakumari and Thanjavur. The extent of damage in terms of per cent incidence and intensity was recorded for major pests of coconut during these surveys. The roving survey results (Table 58) revealed that the mean incidence of rhinoceros beetle was high (31.5%) in Coimbatore district followed by in Theni district (25.2%) and was low in Dindugul district (15.5%). In Kanyakumari district both leaf and spindle lead damage was high, 40.2% and 30.5%, respectively.

The leaf damage was low in Coimbatore and Theni district (15.2%) and the spindle leaf damage was low in Coimbatore and Tirunelveli district (18.5%). The percent nut damage by eriophyid mite was high in Tiruppur (63.5%) district followed by Tirunelveli district (60.5%). It was low in Coimbatore district (40.2%). The intensity of eriophyid mite damage was high in Tirunelveli and Kanyakumari (1.2) and it was low in Coimbatore and Dindugul (0.7). The invasive rugose spiralling whitefly (RSW) intensity of infestation was medium to low in all the districts surveyed. It was medium in Coimbatore, Tiruppur, Theni, Kanyakumari and Thanjavur districts. The percent parasitization by *Encarsia guadeloupae* was high (65.0%) in Coimbatore followed by Tirunelveli and Theni districts (60.2% each). The parasitization was low in Dindugul district (40.6%).

Table 58 : Mean incidence of major pests in Tamil Nadu

District	Rhinoceros beetle			Eriophyid	Eriophyid	RSW	
	Mean incidence (%)	Leaf damage (%)	Spindle damage (%)	mite (% nut damage)	mite (Grade index)	Grade	Parasitism (%)
Coimbatore	31.5 ± 3.2	15.2 ± 3.2	18.5 ± 3.7	40.2 ± 2.5	0.7 ± 0.2	1.2 (Medium)	65.0 ± 3.5
Tiruppur	20.5 ± 1.7	16.2 ± 1.5	18.7 ± 3.2	63.5 ± 2.3	1.0 ± 0.2	1.3 (Medium)	58.2 ± 3.2
Dindigul	15.5 ± 2.3	18.2 ± 1.5	21.5 ± 2.7	50.5 ± 3.5	0.7 ± 0.1	0.8 (Low)	40.6 ± 3.7
Theni	25.2 ± 1.5	15.5 ± 3.7	18.5 ± 2.8	45.7 ± 1.7	0.5 ± 0.1	1.3 (Medium)	60.2 ± 2.5
Tirunelveli	23.5 ± 3.5	15.2 ± 2.5	25.2 ± 1.5	60.5 ± 2.3	1.2 ± 1.0	1.0 (Low)	60.5 ± 2.7
Kanyakumari	20.2 ± 3.2	40.2 ± 2.7	30.5 ± 3.5	55.7 ± 1.5	1.2 ± 3.2	1.5 (Medium)	50.5 ± 4.5
Thanjavur	20.5 ± 1.7	25.3 ± 1.5	17.0 ± 3.7	60.2 ± 1.5	1.0 ± 2.5	0.7 (Medium)	55.2 ± 4.3

Values represent mean ± SE

Fixed plot survey

Fixed plot surveys were conducted in 3 locations, viz., Nadupunni (North pollachi), Angalakuruchi (Anaimalai block) and Puliyankandi (Anaimalai block). The fixed plot at Nadupunni is of Local tall variety with an age of around 24 years. The results revealed that Black headed caterpillar (BHC) damage in Nadupunni village of North pollachi was 24.2% during April month, there after the damage was reduced to 13.7% during December. The overall mean damage was 20%. The larval population was very low (1.5/100 leaflets) during August, 2019. During October to December no

larval population was observed (Table 59). The field at Angalakurichi is of 5 years old hybrid (GBGD x WCT). The palms started bearing. The rhinoceros beetle incidence was fluctuated between 40.7 to 28.5 per cent during April to December, 2019, the maximum leaf damage (40.7%) and maximum spindle leaf damage (30.5%) was observed during October, 2019. Besides the rhinoceros beetle the field was infested by RSW with low to medium intensity of infestation. In this particular field the aphelinid parasitoid, *E. guadeloupae* was released frequently and the *Encarsia* parasitoid started to build-up. The parasitoids tend to multiply faster and now the RSW population reached lower level.

The field at Puliyanakandi is of 11 years old yielding ALR 1 variety. The nut damage in the field varied from 72.3 to 55.7 per cent during different months with the maximum nut damage during April, 2019 (72.3%) and minimum nut damage during

December, 2019 (55.7%). The Mean Grade Index (MGI) fluctuated between 0.6 to 1.8 during different months and the maximum MGI (1.8) was recorded during April, 2019.

Table 59: Average per cent infestation of different pests in fixed plot survey in Tamil Nadu

Month	Nadupunni		Angalakuruchi				Puliyanakandi	
	BHC		Rhinceros beetle			RSW (Scale)	Eriophyid mite	
	Leaf damage (%)	Larvae/100 leaflets	Incidence (%)	Leaf damage (%)	Spindle damage (%)		% nut damage	MGI
April	24.2	2.8	28.5	20.3	20.5	0.8 (Low)	72.3	1.8
June	23.5	2.5	35.5	25.5	30.5	1.3 (Medium)	70.5	1.5
August	21.2	1.5	37.3	27.50	40.8	1.3 (Medium)	60.2	1.2
October	17.5	0	40.7	30.5	33.5	1.0 (Medium)	57.5	0.8
December	13.7	0	38.5	30.5	33.5	0.70 (Low)	55.7	0.6
Mean	20.0±1.8	1.4±0.5	26.9±1.7	26.9±1.7	31.8±3.1		63.2±3.1	1.2±0.2

Pest infestation in cocoa in Aliyarnagar centre

In cocoa, there was stem borer damage of 1.2%, mealy bug damage of 2.5%, RSW damage of 15.5% and leaf eating caterpillar damage of 17.2%.

Correlations of coconut pests with weather factors during 2019

Correlation studies depicted in Table 60, revealed that maximum temperature and minimum temperature were positively correlated to BHC,

spindle leaf damage by rhinceros beetle (RB), leaf damage by RB, nut damage by eriophyid mite and RSW incidence. The morning humidity was positively correlated to all the pests. The evening relative humidity was positively correlated with BHC and RSW incidence. RB leaf damage, spindle damage and eriophyid mite damage were negatively correlated. The BHC incidence and rhinceros beetle infestation were positively correlated to rainfall. However, eriophyid mite nut damage and RSW incidence were negatively correlated.

Table 60: Correlations of coconut pests with weather factors during 2019

Months	BHC leaf damage	Leaf damage by RB (%)	Spindle leaf damage by RB (%)	Nut damage by eriophyid mite (%)	RSW incidence (%)	Max. temp. (°C)	Min. temp. (°C)	Morning RH (%)	Evening RH (%)	Rain fall (mm)
June	21.7	22.5	33.5	65.5	38.3	32.8	23.3	98.6	74.1	4.4
August	20.3	28.5	50.8	52.7	29.2	31.4	22.0	95.1	60.0	245.0
October	18.5	15.5	33.5	45.3	24.4	32.1	21.3	93.9	76.1	233.8
December	12.5	17.3	25.8	55.7	20.5	30.0	18.2	94.1	59.3	31.3
Max. temp. (°C)	0.9	0.2	0.24	0.22	0.8					
Min. temp. (°C)	1.0	0.5	0.5	0.3	0.9					
Morning RH (%)	0.7	0.4	0.1	0.9	1.0					
Evening RH (%)	0.5	-0.40	-0.2	-0.01	0.4					
Rainfall(mm)	0.3	0.2	0.7	-0.8	-0.3					

Ambajipeta

Roving survey

Roving survey was carried out in West Godavari, East Godavari, Visakhapatnam, Vizianagaram and Srikakulam districts. Rhinoceros beetle infestation ranged between 11.2 and 15.3 per cent in the surveyed districts. A high per cent spindle damage and leaf damage of 7.3 and 14.4 per cent, respectively were recorded in Srikakulam district. While low spindle damage of 3.9 per cent was observed at West Godavari district. Maximum red palm weevil (RPW) damage was recorded in West Godavari district (5.7%) and coconut plantations of Visakhapatnam district had minimum per cent RPW damage (3.7%).

In the entire roving survey, eriophyid mite incidence ranged between 81.1 to 91.9 per cent and West Godavari district recorded the highest mite incidence of 91.9 per cent. During 2019, BHC incidence was recorded from East and West Godavari districts with a mean per cent incidence of 16.6 and 24.5, respectively. RSW incidence was observed from all surveyed districts and Srikakulam and West Godavari districts recorded high incidence and intensity of RSW *i.e.*, 55.3 and 43.9 per cent and 52.6 and 45.1 per cent, respectively. Coconut gardens of East Godavari district were observed to have a low per cent RSW incidence (34.5%) and intensity (22.6%) (Table 61).

Table 61: Mean incidence of major coconut pests in Andhra Pradesh

District	Rhinoceros beetle			RPW Incidence (%)	Eriophyid mite		BHC Incidence (%)	RSW	
	incidence (%)	Intensity (%)			Infested nuts (%)	Grade index		incidence (%)	Intensity
		Leaf damage	Spindle damage						
West Godavari	15.3±1.0	12.2±0.8	3.9±0.2	5.7±0.5	91.9±1.3	2.54±0.1	24.5±3.2	52.6±7.8	45.1±2.1
East Godavari	12.5±0.7	11.2±0.7	4.0±0.3	4.2±0.5	90.6±0.9	2.76±0.2	16.6±2.8	34.5±4.7	22.6±3.9
Visakhapatnam	11.2±1.3	13.5±1.1	6.2±0.8	3.7±0.3	89.1±2.5	2.6±0.2	0	49.8±7.2	40.2±4.9
Vizianagaram	15.2±1.6	10.3±0.3	5.4±0.5	3.8±0.3	81.1±2.5	2.1±0.2	0	51.3±6.1	42.6±5.8
Srikakulam	15.1±1.6	14.4±0.9	7.3±1.1	5.3±0.2	83.1±0.6	1.5±0.1	0	55.3±7.9	43.9±6.1

Values represent mean ± standard error

Minor pests

During roving survey low termite incidence was observed in East Godavari (7.4%), West Godavari (11.3%), Visakhapatnam (5.8%), Vizianagaram and Srikakulam (10.5%) districts.

Fixed plot survey

Fixed plot survey was conducted at Samantha kurru and Munganda village of East Godavari to record incidence of major insect pests of coconut. The observations showed that BHC incidence of 9.5 and 10.6 per cent was recorded from Samanthakurru village during October and December, 2019, respectively. No BHC incidence was recorded at Munganda.

Among the fixed plots, high rhinoceros beetle damage (23.7%) was recorded at Munganda during December, 2019 and a low per cent damage was recorded during June (17.5%). No RPW incidence was observed in both the fields. Eriophyid mite incidence was in the range of 89.2 and 92.9 per cent. High mite incidence was recorded at Samanthakurru and Munganda during December (92.9%) and October (92.0%). High mite damage grade index of 2.3 was recorded during June, whereas a low mite grade index of 1.3 (moderate) and 1.7 (moderate) was observed in December at Samanthakurru and Munganda, respectively (Table 62).

Table 62: Mean incidence of coconut pests in fixed plot surveys of Andhra Pradesh in 2019

Month	BHC incidence (%)		Rhinoceros beetle leaf damage (%)		Eriophyid mite			
	Samanthakurru	Munganda	Samanthakurru	Munganda	Samanthakurru		Munganda	
					Incidence (%)	Grade	Incidence (%)	Grade
April	-	-	14.0±0.7	17.5±1.6	90.4±1.4	2.1±0.1	90.4±1.6	1.7±0.1
June	-	-	13.6±0.9	18.8±0.9	90.9±1.2	2.3±0.1	91.8±0.7	1.8±0.1
August	-	-	16.3±1.1	19.4±0.5	91.4±0.6	1.3±0.1	89.5±0.9	1.7±0.1
October	9.5±4.5	-	18.3±1.2	21.9±1.4	89.2±1.2	1.5±0.1	92.0±1.1	1.9±0.5
December	10.6±2.8	-	15.9±1.2	23.7±1.2	92.9±0.6	2.1±0.1	90.6±0.8	2.3±0.1

Values represent mean ± standard error

Correlation of coconut pests with weather parameters

Correlation analysis revealed that rhinoceros beetle damage had a non significant negative correlation with minimum temperature ($r = -0.79$) and morning humidity ($r = -0.77$) and a positive non significant correlation with evening relative humidity ($r = 0.84$) and rainfall ($r = 0.48$). A significantly negative correlation ($r = -0.91$) was recorded between rhinoceros beetle damage and maximum temperature. Eriophyid mite damage was negatively correlated with maximum temperature (r

$= -0.17$), minimum temperature ($r = -0.51$), morning relative humidity ($r = -0.66$) and rainfall ($r = -0.85$). Evening relative humidity was positively correlated to mite damage ($r = +0.47$). A significant positive correlation was observed between BHC incidence and evening humidity ($r = +0.90$) and a non significant negative correlation was noticed with maximum temperature ($r = -0.84$) and minimum temperature (-0.85). Further, positive non significant correlation was observed between incidence of BHC and morning humidity and rainfall ($r = 0.49$ and $r = 0.20$, respectively) (Table 63).

Table 63: Correlation of coconut pests with weather factors during 2019

Months	RB	Eriophyid mite	BHC	Max. temp.(°C)	Min. temp.(°C)	Morning RH(%)	Evening RH(%)	Rain fall(mm)
June	16.2	91.4	0	36.2	27.5	51.8	84.7	0
August	17.9	90.5	0	32.9	25.9	65.2	87.5	5.6
October	20.2	90.6	4.7	31.7	24.2	71.9	91.7	10.4
December	19.8	91.8	5.3	29.5	19.6	60.9	98.6	0
Max. temp. (°C)	-0.91*	-0.17	-0.84					
Min. temp. (°C)	-0.79	-0.51	-0.85					
Morning RH(%)	-0.77	-0.66	0.49					
Evening RH (%)	0.84	0.47	0.90*					
Rainfall (mm)	0.48	-0.85*	0.20					

*Correlation is significant at 0.05 levels

Arsikere

Roving survey

The roving survey was carried out in Chikkamagaluru, Tumkur, Mysore Mandya and Shivamogga districts and the extent of damage in terms of per cent incidence and intensity were recorded for major pests of coconut during these survey. The infestation of rhinoceros beetle was noticed mostly in all newly planted gardens in all the age group of 2 to 48 years. The highest incidence (15.3%) was noticed in Mandya district and an incidence of 12.4 per cent was recorded in the Mysore district. The incidence of RPW was maximum (up to 1.8%) in Chikkamagaluru district followed by Tumkur district (1.5%). The incidence

of RPW was also noticed in Mandya (0.9 %), Shivamogga (0.4%) and Mysore (1.1%) districts.

The infestation by coconut BHC was noticed in all the 5 major coconut growing districts of Karnataka in which moderate (11.2%) incidence was noticed in Chikkamagaluru district throughout the year. The other districts where the caterpillar incidence observed include Mysore (8.5%), Mandya (3.7%), Shivamogga (3.2%) and Tumkur (1.0%). The infestation of eriophyid mite was also noticed in all the surveyed districts, the incidence was as high as 100 per cent in the harvested nut samples. The highest mite incidence was recorded in Tumkur district (20.6%) followed by Chikkamagaluru (17.1%), Mysore (9.7%), Mandya (6.9%) and Shivamogga (4.4%) districts (Table 64).

Table 64: Mean incidence of major coconut pests in Karnataka

District	BHC (%)	Rhinoceros beetle (%)	RPW (%)	Eriophyid mite (%)
Chikkamagaluru	11.2 ± 3.3	6.0 ± 1.6	1.8 ± 0.5	17.1 ± 3.6
Mysore	8.5 ± 0.7	12.4 ± 2.5	1.1 ± 0.3	9.7 ± 3.0
Mandya	3.7 ± 0.6	15.3 ± 3.3	0.9 ± 0.7	6.9 ± 2.1
Tumkur	1.0 ± 0.3	8.5 ± 3.1	1.5 ± 0.5	20.6 ± 7.1
Shivamogga	3.2 ± 0.5	3.2 ± 1.1	0.4 ± 0.2	4.4 ± 2.1

Values are mean ± standard error

The per cent leaf damage by rhinoceros beetle was noticed in all the 5 major coconut growing districts of Karnataka and was ranged between 4.4 to 12.8 per cent. The highest per cent leaf damage (12.8%) was noticed at Mysore district followed by Mandya (11.7%), Tumkur (8.2%), Chikkamagaluru (8.0%) and Shivamogga (4.4%) districts. The mean grade index of mite ranged from 1.1 to 2.1. The highest

MGI of 2.1 was observed at Tumkur district followed by Chikkamagaluru (1.9), Mysore (1.1), Shivamogga (1.3) and Mandya (1.4%). The leaf damage by coconut BHC was ranged between 0.9 to 10.9 per cent in all 5 different districts and the highest per cent leaf damage (10.9%) was noticed at Chikkamagaluru district which recorded 2.3 larvae per 100 leaflets (Table 65).

Table 65: Mean intensity of major coconut pests in Karnataka

Districts	Rhinoceros beetle (%)		Eriophyid mite(MGI)	BHC	
	Leaf damage	Spindle damage		Active larvae /leaf let	Leaf damage (%)
Chikkamagaluru	8.0 ± 3.7	0.7 ± 0.2	1.9 ± 0.5	2.3 ± 1.1	10.9 ± 1.9
Mysore	12.8 ± 2.7	1.2 ± 0.5	1.1 ± 0.5	1.5 ± 0.6	6.3 ± 2.1
Mandya	11.7 ± 2.9	1.0 ± 0.2	1.4 ± 0.5	1.2 ± 0.7	4.9 ± 1.3
Tumkur	8.2 ± 3.1	0.9 ± 0.1	2.1 ± 0.7	0.8 ± 0.3	1.7 ± 0.9
Shivamogga	4.4 ± 2.1	0.4 ± 0.2	1.3 ± 0.3	0.5 ± 0.2	0.9 ± 0.3

Values are mean ± standard error

Minor pests

In addition to the major pests there were some minor pests noticed during the surveys. In Chikkamagaluru district, mealybug, termite and scale insects were noticed as a spot occurrence, the mealybug, *Pseudococcus* spp. infestation was observed (up to 4%) in the spindle leaf as well as harvested bunches. In Tumkur district, scale incidence was noticed in the range of 2.5 to 4.4 per cent, whereas white fly incidence was noticed up to 5 per cent. Incidence of an invasive RSW (42.0%) was noticed in coconut during December, 2019 in Mangala villages of Mandya district. Observations on the natural enemy fauna in the infested gardens revealed a diverse array of coccinellids along with an aphelinid parasitoid, *E. guadeloupae* and few numbers of Chrysopa were observed. Parasitisation by *E. guadeloupae* was observed to an extent of 15.3 per cent.

The rat damage was noticed mostly in all age group of palms. The highest incidence (10.1%) was noticed in Mysore district and mean incidence of 6.2 per cent was recorded in Mandya district followed by

Chikkamagaluru (4.1%), Tumkur (3.4%) and Shivamogga (1.2%). The incidence of termite was maximum (up to 2.5%) in Tumkur district followed by Chikkamagaluru district (1.8%). The incidence of termite was also noticed in Mandya (0.8%) and Mysore (1.2%) districts. The highest per cent dropped nut was noticed in Chikkamagaluru (6.1%) district followed by Tumkur (5.1%), Mandya (4.2%), Mysore (3.2%) and Shivamogga (1.7%) districts.

Fixed plot survey

To record the incidence and intensity of infestation of different pests of coconut fixed plot survey was carried out at two months intervals from April to December, 2019 in farmer's field locations at Habbanghatta and Bendekere villages of Hassan district. The palms were in the age group of 13 to 39 years. In Habbanghatta the highest incidence of rhinoceros beetle (23.1%) was observed whereas the highest incidence of coconut BHC (10.2%), eriophyid mite (23.6%) and RPW (1.4%) were observed at Bendekere village (Table 66).

Table 66: Mean incidence of different pests during fixed plot surveys in Karnataka

District	BHC (%)	Rhinoceros beetle (%)	Red palm weevil (%)	Eriophyid mite (%)
Habbanghatta	7.7 ± 2.0	23.1 ± 6.2	0.8 ± 0.2	14.0 ± 3.9
Bendekere	10.2 ± 3.5	16.9 ± 7.4	1.4 ± 0.3	23.6 ± 6.1

Values are mean ± standard error

The infestation by major pests was recorded 6 times in a year. Leaf damage by rhinoceros beetle fluctuated between 22.3 and 8.3 per cent, while the spindle damage ranged from 10.5 to 3.8 per cent during different months with the maximum spindle damage of 10.5 per cent during April at Habbanghatta village. The mite infestation was also noticed in both Habbanghatta and Bendekere.

The nut damage ranged from 4.8 to 26.4 per cent during different months and the highest nut

damage of 26.4 per cent was observed at Habbanghatta village during April month. The mean grade index of mite ranged from 1.1 to 2.5 and the highest MGI of 2.5 was observed at Habbanghatta village during December. The leaf damage by coconut BHC ranged between 2.6 to 8.9 per cent during different months and the highest per cent leaf damage (8.9%) was noticed during April month at Bendekere which recorded 6.0 larvae per 100 leaflets (Table 67).

Table 67: Extent of infestation by different pests during fixed plot surveys in Karnataka

Months	Rhinoceros beetle		Eriophyid mite		BHC	
	Leaf damage (%)	Spindle damage (%)	Infested nuts (%)	MGI	Active larvae / leaflet	Leaf damage (%)
Habbanghatta						
April	17.1 ± 2.8	10.5 ± 1.4	26.4 ± 2.0	2.2 ± 0.4	1.5 ± 0.4	4.6 ± 0.6
June	16.1 ± 5.6	7.9 ± 1.6	8.5 ± 2.8	1.1 ± 0.6	1.2 ± 0.3	2.6 ± 0.7
August	19.4 ± 4.4	8.2 ± 2.1	9.1 ± 3.6	1.3 ± 0.5	1.8 ± 0.6	3.5 ± 1.1
October	22.3 ± 7.0	9.4 ± 1.6	10.2 ± 2.0	1.7 ± 0.2	2.6 ± 1.0	4.3 ± 1.2
December	21.3 ± 3.6	6.8 ± 1.3	11.4 ± 2.2	2.5 ± 0.5	4.6 ± 1.8	4.8 ± 1.4
Bendekere						
April	9.4 ± 2.1	5.2 ± 1.3	18.8 ± 0.8	2.1 ± 0.5	6.0 ± 1.3	8.9 ± 1.5
June	8.3 ± 2.5	3.8 ± 2.1	4.8 ± 1.6	1.3 ± 0.6	2.3 ± 0.9	3.8 ± 2.0
August	10.9 ± 2.9	4.7 ± 1.8	5.7 ± 1.8	1.8 ± 0.7	3.6 ± 1.3	5.1 ± 1.1
October	13.2 ± 2.7	8.3 ± 2.2	7.4 ± 1.5	2.1 ± 0.5	5.2 ± 1.7	6.8 ± 1.8
December	12.5 ± 2.9	5.6 ± 1.9	10.7 ± 3.4	2.4 ± 0.2	1.2 ± 0.4	7.3 ± 1.7

Values are mean ± standard error

Correlation of coconut pests with weather parameters

Correlation studies indicated that maximum temperature was positively correlated with rhinoceros beetle and eriophyid mite. However, it was negatively correlated with BHC. The minimum

temperature was negatively correlated with rhinoceros beetle, BHC and eriophyid mite. The BHC incidence was significantly positively correlated with morning humidity. Whereas, remaining pests were negatively correlated. However, evening humidity was positively correlated with BHC and eriophyid mite (Table 68).

Table 68: Correlations of coconut pests with weather factors during the year 2019

Month	BHC leaf damage (%)	Rhinoceros beetle		Eriophyid mite nut damage (%)	Max temp. (°C)	Min. temp. (°C)	Morning RH (%)	Evening RH (%)	Rain fall (mm)
		Leaf damage (%)	Spindle damage (%)						
April	6.8	13.3	7.9	22.6	36.3	20.5	48.4	34.5	24.0
June	3.2	12.2	5.9	6.7	31.9	21.6	75.6	64.4	81.9
August	4.3	15.2	6.5	7.4	27.7	21.1	79.9	77.9	124.1
October	5.6	17.8	8.9	8.8	28.9	19.5	81.0	80.9	253.9
December	6.1	16.9	6.2	11.1	27.5	18.9	71.9	61.2	42.2
Max. temp. (°C)	-0.70	0.77	0.27	0.24					
Min. temp. (°C)	-0.83	-0.17	-0.72	-0.37					
Morning RH (%)	0.46	-0.97	-0.63	-0.17					
Evening RH (%)	0.54	-0.90	-0.53	0.00					
Rainfall (mm)	0.58	-0.52	-0.19	0.59					

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. The infestation of rhinoceros beetle was noticed in all age palm groups which ranged from 3.5 to 8.8 per cent. The highest rhinoceros beetle incidence of 8.8 per cent was noticed in Sindhudurg district and minimum incidence of 3.5 per cent was recorded in Raigad district. The maximum spindle damage was noticed in Ratnagiri (1.8%), whereas minimum spindle damage was observed in Raigad district. Incidence of red palm weevil was the highest (0.9%) in Ratnagiri district followed by Sindhudurg, Raigad

and Palghar (0.7, 0.6 and 0.5%, respectively) districts (Table 69).

The infestation of BHC was observed only in Palghar district (1.5%). The eriophyid mite infestation was recorded in the range of 18.0 to 28.2 per cent. The highest eriophyid mite incidence was recorded in Ratnagiri district (28.2%) with a mean grade index (MGI) of 0.4. The MGI was noticed mild in all the districts. The RSW incidence was observed in all the districts of Konkan which ranges from 8.0 to 13.5 per cent. Maximum incidence was noticed in Sindhudurg (13.5%) followed by Palghar (12.4%), Ratnagiri (8.0%) and Raigad (8.0%). The average percent spindle damage by rhinoceros beetle, red palm weevil, eriophyid mite and RSW were recorded 0.5, 0.6, 23.8 and 10.4 per cent, respectively in Konkan region of Maharashtra.

Table 69: Mean incidence and intensity of major pests in Konkan region

District	Rhinoceros beetle			RPW incidence (%)	BHC infestation (%)	Eriophyid mite		RSW	
	Infestation (%)	Leaf damage (%)	Spindle damage (%)			Infestation (%)	MGI	Incidence (%)	Intensity
Ratnagiri	7.7 ± 1.8	1.7 ± 0.2	1.2 ± 0.3	0.9 ± 0.3	0.0	28.2 ± 1.9	0.4 ± 0.0	8.0 ± 2.0	3.9 ± 1.9
Sindhudurg	8.9 ± 1.1	2.5 ± .4	0.4 ± 0.1	0.7 ± 0.3	0.0	28.1 ± 3.0	0.4 ± 0.0	13.5 ± 0.3	3.4 ± 0.4
Raigad	3.5 ± 0.5	1.0 ± 0.1	0.1 ± 0.1	0.6 ± 0.2	0.0	25.3 ± 3.5	0.4 ± 0.0	8.0 ± 3.4	4.5 ± 1.8
Palghar	4.2 ± 0.6	1.2 ± 0.1	0.4 ± 0.0	0.52 ± 0.0	1.5 ± 1.0	18.0 ± 1.0	0.3 ± 0.0	12.4 ± 5.4	5.2 ± 1.6

Values are mean ± standard error

The minor pests *viz.*, mealy bug, arecanut whitefly, scale insect, termites and rats were noticed i.e. 3.3, 4.3, 5.6, 8.9 and 1.4 per cent, respectively. Cocoa plots were also surveyed and monitored the pest status *viz.*, stem borer, fruit damage, mealy bug, RSW and leaf eating caterpillar which recorded 4.5, 12.2, 1.9, 12.9 and 14.1 per cent infestation, respectively.

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 April 2019 to December 2019 at Regional Research Station, Bhatye, Ratnagiri. Two plots were selected for observations, one was scientifically managed and another was unmanaged. The average data of two fixed plots are presented in Table 70. The data revealed that the incidence of rhinoceros beetle was in the range of 5.2 to 8.5 per cent and maximum

infestation (8.5%) was observed in the month of June, 2019, whereas minimum incidence was observed (5.2%) in October, 2019. The average leaf and spindle damage were 3.9 and 1.9 per cent, respectively.

The infestation of red palm weevil was 0.4 per cent in April and June, 2019. The eriophyid mite incidence was recorded in the range of 30.2 and 56.7 per cent and the highest infestation (56.7%) was noticed in April, 2019 and the least incidence was observed in December, 2019 (30.2%). The highest mite damage grade index of 1.5 (Moderate) was recorded in April, 2019. However, the lowest MGI (0.5) was observed in December, 2019. The RSW incidence showed an increasing trend from August, 2019 onwards and maximum incidence (29.4%) was recorded in December, 2019. Average per cent incidence of RSW was 10.4 per cent in Konkan region.

Table 70: Infestation of different pests during fixed plot survey in Maharashtra

Month	Rhinoceros beetle			RPW incidence (%)	Eriophyid mite		RSW	
	Incidence (%)	Leaf damage (%)	Spindle damage (%)		Infestation (%)	MGI	Incidence (%)	Intensity
April	8.2	1.2	1.5	0.4	56.7	1.5	0.0	0.0
June	8.5	4.8	1.8	0.4	36.1	0.8	0.0	0.0
August	7.5	4.0	1.2	0.0	31.8	0.7	6.8	1.5
October	5.2	5.1	1.1	0.0	48.0	1.1	16.0	20.5
December	6.9	4.4	4.0	0.0	30.2	0.5	29.4	13.3
Mean ± SE	7.2 ± 0.6	3.9 ± 0.7	1.9 ± 0.5	0.1 ± 0.1	40.5 ± 5.7	0.9 ± 0.1	10.4 ± 6.2	7.0 ± 4.6

Values are mean ± standard error

Correlations of coconut pests with weather parameters

Correlation studies depicted in Table 71 revealed that maximum temperature was positively correlated with rhinoceros beetle, eriophyid mite and RSW. However, it was negatively correlated with RPW and BHC. The minimum temperature was positively correlated with RB, However it was negatively

correlated with rests of the pests. It was significantly correlated with BHC and EM. The eriophyid mite incidence was significantly negatively correlated with morning humidity. However, evening humidity was positively correlated with RB, RPW and EM except BHC and RSW. The rhinoceros beetle infestation was positively correlated with rainfall. The RSW was significant negatively correlated with rainfall.

Table 71: Correlations of coconut pests with weather factors

Months	Pest incidence				RSW (%)	Weather Parameters				
	Rhinoceros beetle (%)	RPW (%)	BHC (%)	Eriophyid mite (%)		Max. temp. (°C)	Min. temp. (°C)	Morning RH (%)	Evening RH (%)	Rain fall (mm)
February	7.6	1.1	0.6	59.3	35.1	30.8	17.0	85.7	57.9	0.0
April	8.2	0.4	0.0	51.4	46.5	32.8	24.0	88.2	63.4	0.0
June	8.5	0.4	0.0	50.9	9.1	32.7	25.7	86.5	753.6	674.1
August	7.5	0.0	0.0	42.7	2.8	30.3	24.5	90.0	81.6	774.9
October	5.1	0.0	0.0	44.1	27.3	32.1	23.2	93.0	73.8	269.9
December	6.9	0.0	0.0	52.9	22.2	33.5	19.1	82.1	57.9	0.0
Max. temp. °C)	0.02	-0.26	-0.48	0.17	0.27					
Min. temp. °C)	0.18	-0.46	-0.75	-0.71	-0.39					
Morning RH (%)	-0.47	-0.27	-0.24	-0.72	-0.04					
Evening RH (%)	0.47	0.11	-0.21	0.02	-0.46					
Rainfall (mm)	0.16	-0.34	-0.39	-0.64	-0.87					
R value			0.70							

Coc./Ent. 3: Integrated management of coconut eriophyid mite

Centres: Aliyarnagar, Ambajipeta, Arsikere and Ratnagiri

Aliyarnagar

Coconut eriophyid mite, *Aceria guerreronis* Keifer (Eriophyidae: Acarina) is an invasive pest of coconut causing heavy economic loss to the coconut

Industry. Within a short span of time the mite population had spread rapidly to all major coconut growing regions of the country and causes yield loss. Farmer's fields located in Puliyanakandi and Anaimalai block were selected for this trial and two blocks with 50 palms per block were demarcated for the trial. The following package of practices was followed for the trial and the trial is in progress.

Package of practices:

Integrated nutrient management (1.3 kg urea; 2.0 kg super phosphate; 3.5 kg muriate of potash and 20 kg FYM and 20 kg vermicompost and 5 kg neem cake and green manuring with cowpea/sunn hemp in the coconut basins and husk incorporation in the inter rows) and micronutrient application and Keraprobio (100 g/palm) in a well irrigated garden and root feeding with fenpyroximate 5% EC @ 10 ml and 20 ml water during March and spraying palm oil – sulphur emulsion during December. The control plots should be maintained with NPK and organic manures. The spraying of palm oil sulphur and root feeding will be taken up during December and March months, respectively.

The field trial at Puliyanakandi is of 10 year old AL1 (Arasampatti tall) variety which started yielding. The recommended IPM and INM strategies were imposed as per the technical programme in the trial plots. The pretreatment population of eriophyid mite at 24 MAT (September 2018) in the IPM plot was

24.2/16 mm² as against 28.5/16 mm² in control plot. The mite population showed a significant reduction to 20.2/16 mm² after imposing the treatment at 30 MAT (March, 2019), whereas the population was slightly increased to 20.5/16 mm² at 36 MAT (September, 2019). In control plot, the population was 30.5/16 mm² at 30 MAT and 32.7/16 mm² at 36 MAT, respectively. Similarly in the post treatment observation, the percent nut damage and MGI was significantly reduced to 30.6 per cent and 0.36, respectively during 30 MAT and it was 33.5 per cent and 0.45 during 36 MAT. The nut yield was high in IPM plot (115.4 no./year) and it was low in control plot (58.5 no./year). The yield parameters like annual leaf production, annual inflorescence production, yield and copra content were 12.7 no./palm, 13.5 no./palm, 115.4 no. of nuts/palm and 183 gram/ palm, respectively in the IPM plot. The soil nutrients status was more or less similar in both IPM and in control plots, because in untreated control also recommend dose of fertilizers has been applied (Table 72).

Table 72: Effect of IPM and INM on eriophyid mite infestation and yield of coconut (Aliyar Nagar)

Treatments	Pre-treatment			Post-treatment						Nut yield/palm (No.)	Copra content (g/nut)
	24 MAT (September, 2018)			30 MAT (March, 2019)			36 MAT (September, 2019)				
	Nut damage (%)	MGI	Mite population/16mm ²	Nut damage (%)	MGI	Mite population/16mm ²	Nut damage (%)	MGI	Mite population/16mm ²		
IPM garden	32.7	0.38	24.2	30.6	0.36	20.2	33.5	0.45	20.5	115.4	182
Control	45.3	0.68	28.5	48.6	0.91	30.5	52.7	1.0	32.7	58.5	142
Sig.	*	NS	*	*	NS	**	*	*	**	-	-
't' value	3.2		3.9	4.7	-	5.2	4.8	2.8	5.5	-	-

NS: Not significant; * Significant at P=0.05; ** Significant at P=0.01; MGI: mean grade index

Ambajipeta

The experiment on integrated pest management of eriophyid mite was implemented at Horticultural Research station, Ambajipeta in a plot with 50 palms for each treatment. The intensity of eriophyid mite was recorded from the 3rd bunch of coconut. Incidence of mite in IPM treated palms was 87.1 per cent and 88.3 per cent during September, 2018 and March, 2019, respectively. The mean eriophyid mite infestation in IPM treated palms during September, 2019 was 82.1 per cent while control palms had a high mite incidence (92.8%). During

March 2019, mean eriophyid mite population recorded in IPM treated palms was 56.9 no./16 mm² and it was reduced to 46.7 during September, 2019. The mean grade index during September, 2019 was 1.3 in IPM treated palms and untreated control had a mean grade index of 2.3.

The mean grade index in the IPM treated palms during March, 2019 was 2.0 which reduced to 1.3 during September, 2019. During September, 2019, the IPM treated palms had significantly low per cent nut damage, mite population and mean grade index over untreated control (Table 73). The annual leaf

production in the INM treated palm was 8.2 which was higher than the control palms (6.4 leaves). Annual inflorescence production in the INM and untreated palms was 9.1 and 6.9, respectively. The INM palms had a nut yield of 45.6 nut/palm while untreated palms recorded an average nut yield of

26.4 nut/palm. The copra content of the INM palms and untreated palms was 134.7 g and 118.2 g, respectively. Further, INM plot had a nitrogen, P₂O and K₂O content of 206.6 kg/ha, 19.4 kg/ha and 399.2 kg/ha, respectively.

Table 73: Effect of IPM and INM on eriophyid mite infestation and yield of coconut (Ambajipeta)

Treatments	Post-treatment								
	24 MAT (September, 2018)			March, 2019			September, 2019		
	Nut damage (%)	MGI	Mite population/16mm ²	Nut damage (%)	MGI	Mite population/16mm ²	Nut damage (%)	MGI	Mite population/16mm ²
INM package	87.1±1.9	41.7±3.3	1.8	88.3±1.5	56.9±5.9	2.0	82.1±0.6	46.70±1.3	1.3±0.1
Control	93.1±1.7	62.3±4.5	2.5	93.3±0.8	86.7±4.8	2.5	92.8±0.7	69.14±1.82	2.3±0.1
Sig.	*	*	*	*	*	*	**	**	*
't' value	2.5	3.7	8.0	2.7	3.9	2.6	14.6	10.81	6.43

* Significant at P=0.05; MGI: mean grade index; values are mean ± SE

Arsikere

The trial was conducted at Horticulture Research Station, Arsikere; the pre-treatment observations were recorded before imposing the treatments. Post treatment observations were recorded at six month's intervals. Data on per cent nut damage was recorded prior to the treatment and at six months interval. The experiment was conducted in a plot having 100 palms of 0.5 ha acreage at Horticultural Research and Extension Centre, Arsikere. IPM package for coconut mite was implemented in the plot as per the experimental protocol. Pre data on the intensity of eriophyid mite from 3rd bunch was recorded in the month of September 2017. Post treatment observations were recorded at half yearly interval. Simultaneous observations were also made in control plot. After six months interval, the mite infestation gradually decreased from 8.4 per cent to 4.1 per cent in treatment and in control the mite infestation increased from 36.2 to 39.5 per cent. Regarding eriophyid mite intensity, the initial MGI during pre-treatment was in the range 1.6 to 1.7 (moderate).

Average mite population in IPM (1.2/16 mm²) and control (36.2/16 mm²) was significantly

different. After post treatment observation, the grade index in IPM plot gradually declined to low with a grade index of 0.1 which was significantly lower compared to control. Similarly, with respect to average mite population after one year it was 0.8/16 mm² in IPM block which was significantly lower compared to control (39.5/16 mm²) (Table 74). The growth and yield attributes data indicated that maximum annual leaf (11.7/palm), inflorescence production (11.6/palm), maximum nuts (98.4/palm) and copra content (159.2 g/nut) was observed in INM treated plot. Whereas, minimum annual leaf (10.1/palm) and inflorescence (9.0/palm) was noticed in untreated plot. The lowest nuts and copra content was also found in untreated plot which recorded 41.4 nuts/palm and 128.6 g/nut, respectively. However, the higher nutrient contents viz., organic carbon (0.27 g/kg), nitrogen (292.2 kg/ha), phosphorus (29.3 kg/ha) and potash (278.1 kg/ha) were found in IPM plot. Whereas, lowest organic carbon (0.23 g/kg), nitrogen (241.6 kg/ha), P₂O (26.1 kg/ha) and K₂O (239.8 kg/ha) were recorded in an untreated control.

Table 74: Effect of IPM and INM on eriophyid mite infestation and coconut yield in Arsikere

Treatments	Pre-treatment			Post-treatment						Nut yield/palm (No.)	Copra content (g/nut)
	(March, 2018)			30 MAT (March, 2019)			36 MAT (September, 2019)				
	Nut damage (%)	MGI	Mite population/16mm ²	Nut damage (%)	MGI	Mite population/16mm ²	Nut damage (%)	MGI	Mite population/16mm ²		
INM package	51.2	1.6	20.4	8.4	0.2	1.2	4.1	0.1	0.8	98.4	159.2
Control	50.9	1.7	20.9	79.1	2.9	36.2	83.1	3.3	39.5	41.4	128.6
Sig.	NS	NS	NS	*	*	*	*	*	*		
t value				1.7	0.1	0.2	2.3	0.1	0.4		

* Significant at P=0.05; MGI: mean grade index

Ratnagiri

The experiment was conducted in a plot having 50 palms for each treatment at Regional Coconut Research Station, Bhatye, and Ratnagiri. IPM package was implemented as per the experimental protocol. The intensity of eriophyid mite was recorded from the 3rd bunch of coconut. The pre-treatment incidence of eriophyid mite in the treatment plots was 65.2 per cent as against 63.8 per cent in control plots. Post-treatment observations were recorded at half yearly interval. During February, 2019, the mite infestation significantly decreased up to 13.2 per cent in treatment. Later, it increased to 90.0 per cent over pre-count observations in untreated control. In August, 2019, similar trend was noticed (11.3%) in IPM plots over control (60.7%). In IPM treatment, nut damage was significantly superior over control in August, 2019.

Regarding eriophyid mite grade index and intensity, during February, 2019, the grade index in

IPM plot significantly declined to mild with grade index of 0.2. Similarly, average mite population was 4.0/16 mm² in treated plot compared to control (36.4/16 mm²). In August 2019, similar trend was noticed with respect to grade index 0.1 (mild) and intensity of mite population (3.0/16 mm²) (Table 75). The maximum leaf and inflorescence production was recorded in IPM plot (10.2 and 8.8 per palm, respectively). The maximum nuts (90.0/palm) and copra content (148g/nut) was also noticed in INM package. Whereas, minimum leaf (8.8/palm), inflorescence (6.7/palm), nuts (64.0 nuts/palm) and copra content (122 g/nut) was observed in untreated plot. Maximum nutrients contents viz., organic carbon, nitrogen, phosphorus and potash were found in IPM plot which recorded 3.0 g/kg, 295, 166 and 1342 kg/ha, respectively. Whereas, lowest organic carbon (1.1 g/kg), nitrogen (210 kg/ha), P₂O (153 kg/ha) and K₂O (302 kg/ha) were noticed in untreated control.

Table 75: Effect of IPM and INM on eriophyid mite infestation and yield of coconut

Treatments	Pre-treatment			Post-treatment						Nut yield/palm (No.)	Copra content (g/nut)
	(March 2017)			First Half (February, 2019)			Second Half (August, 2019)				
	Nut damage (%)	MGI	Mite population/16 mm ²	Nut damage (%)	MGI	Mite population/16 mm ²	Nut damage (%)	MGI	Mite population/16 mm ²		
INM package	65.2 ± 2.9	20.6 ± 1.1	1.0 ± 0.0	13.2 ± 2.4	4.0 ± 0.9	0.2 ± 0.0	11.3 ± 0.9	3.0 ± 0.9	0.1 ± 0.0	90.0	148
Control	63.7 ± 3.6	19.2 ± 1.3	0.98 ± 0.0	90.0 ± 1.9	36.4 ± 1.4	2.1 ± 0.1	60.7 ± 2.3	13.0 ± 1.9	1.6 ± 0.0	64.0	122
Sig.	NS	NS	NS	NS	*	*	*	NS	*	-	-
t value	0.7	0.4	0.0	1.3	7.5	7.3	2.0	0.0	7.8	-	-

* Significant at P=0.05; MGI: mean grade index; values are mean ± SE

Coc. /Ent. 4: Production and supply of parasitoids

Centres: Aliyarnagar, Ambajipeta, Arsikere and Ratnagiri

Aliyarnagar

The parasitoid of coconut BHC, *Opisina arenosella* viz., *Bracon brevicornis* is being mass cultured at the biocontrol unit of CRS, Aliyarnagar and the same is distributed to the needy farmers. About 2889 packets of *B. brevicornis* were

distributed farmers. For RSW management, coconut fronds or leaflets containing parasitized puparia were collected from the affected ecosystem and released in newer areas of infestation. About 10,471 packets of *Encarsia* were distributed to the farmers of all the coconut growing districts of Tamil Nadu. A consignment with 100 packets of *Encarsia* was sent to West Godavari district of Andhra Pradesh. The details of supply of parasitoids are given in Table 76.

Table 76: Production and supply of parasitoids for the management of coconut BHC and RSW in Aliyarnagar

Month	<i>Bracon brevicornis</i>		<i>Encarsia</i> sp.		
	No. of packets	Amount (Rs.)	Number of packets distributed	Amount (Rs.)	No of farmers benefitted
April	97	7275	2254	22540	333
May	325	24225	814	8140	107
June	815	61125	417	4170	45
July	711	53325	311	3110	18
August	130	9750	716	7160	45
September	292	21900	811	8110	63
October	6	450	1582	15820	120
November	290	21750	1855	18550	161
December	223	16725	1711	17110	221
Total	2889	216525	10,471	1,04,710	1113

(*B. brevicornis* @ 100 No. of parasitoids/packet)

Ambajipeta

Parasitoids viz., *B. hebetor*, *Goniozus nephantidis* and *Pediobius imbrues* are being multiplied on large scale at Parasite Breeding Station, Horticultural Research Station, Ambajipeta. A total of 13,100 numbers of *B. hebetor*, 1,19,600

numbers of *G. nephantidis* and 2000 numbers of *P. imbrues* have been supplied to the farmers of East Godavari, West Godavari, Visakhapatnam and Srikakulam districts of Andhra Pradesh and Bhadrakri Kothagudem, Medchal and Khammam districts of Telangana (Table 77).

Table 77 : Production and supply of parasitoids for the management of coconut BHC and slug caterpillar in Ambajipeta

Month	<i>Bracon hebetor</i> (No.)	<i>Goniozus nephantidis</i> (No.)	<i>Pediobius imbrues</i> (No.)
April	-	7500	2000
May	-	-	-
June	1000	6000	-
July	5500	23000	-
August	1500	18000	-
September	800	20800	-
October	-	-	-
November	3800	38300	-
December	1000	6000	-
Total	13,100	119600	2000



Bio control lab at HRS Ambajipeta

Arsikere

Wide spread incidence of coconut BHC infestation was recorded in Chikkamagaluru, Tumkur, Mysore, Hassan, Shivamogga and Mandya districts. Mass multiplication of *B. brevicornis* and *G. nephantidis* is being carried out at Biocontrol Laboratory and a total of 6,50 *B. brevicornis* and 60,000 *G. nephantidis* parasitoids were supplied to farmers for release in BHC infested coconut gardens.

Ratnagiri

The mass multiplication of *B. hebetor*, *G. nephantidis* and reduvid bug were carried out at Bio-control laboratory of Regional Coconut Research Station, Bhatye and a total of 2,48,400 numbers of *B. hebetor*, 57,770 numbers of *G. nephantidis* parasitoids 2,050 numbers of reduvid bugs were mass multiplied and released. Around 2,000 numbers of Goniozus and 1,000 numbers of Bracon parasitoids were sold to the farmers in Palghar district during the period.

Coc./Ent. 5: Integrated management of slug caterpillar

Centres: Ambajipeta and Arsikere

Ambajipeta

During April 2019, a very low incidence of slug caterpillar was observed at Poduru mandal of West Godavari district of Andhra Pradesh. This incidence was managed by release of *Pediobius imbrues*. Thereafter slug caterpillar was not observed and the experiment was not conducted due to lack of slug caterpillar population.

Arsikere

In Arsikere centre during 2019, slug caterpillar incidence was not noticed.



Light trap installation and Monitoring for Slug caterpillar adult trapping

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

Centres: Aliyarnagar, Ambajipeta, Arsikere and Ratnagiri

Expt. 1: Surveillance and assessment of natural enemies

Aliyarnagar

The surveillance and assessment of natural enemies and management RSW in coconut was conducted at Coconut Research Station, Aliyarnagar.

The RSW incidence was high (60.2%) during June, 2019, after the starting of South West monsoon, the incidence started declining up to 21.4 per cent during December, 2019. The mean incidence recorded was 40.5 per cent. Similarly, the intensity of infestation and the grade of pest intensity also decreased after the South-West monsoon. Similarly the highest intensity of infestation (45.5%) was recorded during June, 2019 and it also declined to 22.7 per cent during December, 2019. The grade of pest intensity was high (1.4) during June, 2019. The mean intensity of infestation and, grade pest intensity was 34.3 per cent and 1.0, respectively. The parasitization by *Encarsia* varied from 30.8 to 72.4 per cent. The highest per cent of parasitism was recorded in the month of August, 2019 (72.4%). Besides *Encarsia* meager number of predator population was also observed (Table 78).

Table 78: Extent of infestation by RSW in coconut and their natural enemies at Aliyarnagar

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)			Natural enemies/ 4 leaflets/palm (No.)		Parasitization (%)
				Egg	Nymph	Adult	Spider	Predators	
April	50.5	35.8	1.2	40.2	21.2	9.8	-	0.2	30.8
May	55.7	40.5	1.5	34.0	31.0	8.4	-	0.6	42.6
June	60.2	45.5	1.4	21.8	42.0	5.8	0.3	0.6	28.2
July	50.8	40.2	1.0	6.6	2.7	3.6	0.5	0.8	61.0
August	48.3	37.4	0.8	32.4	26.0	5.2	0.2	1.1	72.4
September	32.5	33.2	0.8	21.8	42.0	5.8	-	0.6	63.4
October	25.2	28.5	1.0	34.0	31.0	8.4	0.2	0.8	84.6
November	20.3	25.2	0.8	21.8	42.0	5.8	0.5	0.2	30.8
December	21.4	22.7	0.5	34.0	31.0	8.4	1.0	0.6	42.6
Mean ± SE	40.5±4.9	34.3±2.4	1.0±0.1	27.4±3.2	29.9±4.0	6.8±0.6	0.3±0.1	0.6±0.1	50.7±6.4

Ambajipeta

During 2019, RSW incidence ranged between 30.4 and 82.3 per cent. No fresh RSW incidence was recorded during June to August. Lowest RSW population was observed during May with a mean number of 9.1 adults, 8.5 nymphs and 16.8 pupae and the corresponding per cent incidence was 30.4. Thereafter no population was observed between June to August and incidence again started in

September with a mean per cent incidence of 36.4 and the corresponding grade of pest intensity was 0.8 (Low). A peak incidence of 82.3 per cent with a mean number of 39.2 adults, 53.6 nymphs and 19.8 pupae was observed during the month of December. The mean per cent incidence and intensity was 32.1 and 28.8, respectively while the mean grade of pest intensity was 0.8 (Low) (Table 79).

Table 79: Extent of infestation by RSW in coconut and their natural enemies in Ambajipeta

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)			Natural enemies/ 4 leaflets/palm (No.)	
				Nymph	Pupae	Adult	Spider	Predators
April	40.3	39.8	1.2	26.4	30.4	21.3	1.3	0.9
May	30.4	31.3	0.9	8.5	16.8	9.1	0.7	0.7
June	-	-	-	-	-	-	0.8	0.5
July	-	-	-	-	-	-	1.0	-
August	-	-	-	-	-	-	0.5	0.2
September	36.4	26.5	0.8	9.8	12.3	10.6	1.0	0.3
October	42.5	30.8	1.2	16.7	11.5	11.9	1.3	0.7
November	57.3	43.2	1.6	21.3	15.7	20.8	2.3	0.9
December	82.3	90.6	2.3	53.6	19.8	39.1	1.9	0.8
Mean ± SE	32.1±9.5	28.8±9.6	0.8±0.3	15.2±5.8	11.8±3.5	12.5±4.3	1.2±0.2	0.5±0.1

Arsikere

The infestation of RSW gradually increased from May, 2019 onwards and declined during October. However, maximum incidence, intensity

and grade pest intensity were recorded as 39.1 per cent, 27.5 per cent and 0.9, respectively in December, 2019 (Table 80).

Table 80: Extent of infestation by RSW in coconut and their natural enemies in Arsikere

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)			Natural enemies/4 leaflets/palm(No.)		Parasitized puparia/10 cm (No.)
				Egg	Nymph	Adult	Spider	Predators	
May	24.2	18.5	0.8	1.8	14.2	10.7	1.4	2.7	1.5
June	20.4	15.3	0.7	4.6	6.8	9.6	2.9	3.2	0.9
July	16.4	12.9	0.5	1.6	9.4	7.2	0.3	3.5	1.5
August	11.3	9.7	0.3	0.2	12.1	5.5	1.4	0.8	2.3
September	7.8	6.2	0.2	4.3	6.6	4.1	0.9	3.1	1.9
October	4.2	1.8	0.2	0.7	3.4	2.7	1.1	2.4	2.9
November	28.5	22.7	0.7	6.2	13.5	18.4	0.4	1.2	0.8
December	39.1	27.5	0.9	7.4	19.1	21.9	0.7	0.9	2.3
Mean ± SE	19.0 ± 5.2	14.3 ± 3.8	0.5 ± 0.1	3.4 ± 1.2	10.6 ± 2.3	10.0 ± 3.1	1.1 ± 0.4	2.2 ± 0.5	1.8 ± 0.3

Ratnagiri

The incidence of RSW was noticed in the range of 2.7 to 46.5 per cent. However, intensity of RSW was 0.1 to 46.8 per cent from April to December, 2019. The maximum incidence and intensity were recorded as 46.5 per cent and 46.8 per cent, respectively in April, 2019. However, minimum incidence and intensity were observed in July, 2019

which was 2.7 and 0.1 per cent, respectively. The average pest infestation *viz.*, incidence of RSW, intensity of RSW, grade pest intensity, adult, nymph, pupae, eggs, Encarsia parasitism, spider and predators were recorded as 19.5, 14.6, 0.3, 23.7, 15.4, 18.0, 15.0, 6.3, 3.5 and 2.6/ four leaflets, respectively (Table 81).

Table 81: Extent of infestation by RSW in coconut and their natural enemies in Ratnagiri

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)			Natural enemies/4 leaflets/palm (No.)	
				Egg	Nymph	Adult	Spider	Predators
April	46.5	46.8	0.3	11.6	13.0	27.6	7.3	9.6
May	19.2	33.3	0.2	4.0	12.6	9.3	2.3	2.6
June	9.1	22.8	0.1	5.6	14.0	16.0	2.3	1.3
July	2.7	0.1	0.1	0.0	7.0	9.3	1.6	0.3
August	2.8	0.1	0.1	0.0	5.3	11.6	3.3	2.3
September	19.0	2.9	0.8	21.3	42.3	45.0	4.0	2.3
October	27.3	8.2	0.5	39.6	12.3	34.3	4.0	1.3
November	27.0	8.4	0.5	42.0	13.6	37.3	4.3	1.3
December	22.2	8.4	0.5	11.3	19.0	23.0	2.6	2.6
Mean ± SE	19.5 ± 4.8	14.6 ± 5.7	0.3 ± 0.09	15.0 ± 5.6	15.4 ± 3.8	23.7 ± 4.6	3.5 ± 0.5	2.6 ± 0.9

Expt. 2: Integrated pest management of rugose spiraling whitefly (RSW)

Aliyarnagar

The IPM strategies for the management RSW was started during the month of November, 2018 in the COD palms (age 11 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 adopted plot, the incidence and intensity of RSW was significantly reduced to from 56.6 to

28.3 per cent and 64.3 to 32.2 per cent, respectively compared to the natural control where the per cent incidence and pest intensity increased from 48.2 to 60.2 per cent and 60.4 to 71.6 per cent, respectively. The grade of pest intensity was significantly reduced from 1.7 (medium) to 0.8 (low) in IPM plot compared to natural control (9 to 1.0). 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 (Table 82).

Table 82: Integrated pest management of RSW in Aliyarnagar

Treat ment	Pre-treatment observations						% paras itism	Post-treatment observations						% paras itism
	Incide nce of RSW (%)	Intensi ty of RSW (%)	Grade of pest inten sity	Pest stages/4 leaflets/palm (No.)				Inciden ce of RSW (%)	Inten sity of RSW (%)	Grade of pest inten sity	Pest stages/4 leaflets/palm (No.)			
				Egg	Nymph	Adult					Egg	Nymph	Adult	
IPM	56.6	64.3	1.7	16.9	22.7	9.3	32.4	28.3	32.2	0.8	8.5	11.3	4.7	45.4
Natural control	48.2	60.4	1.9	19.1	24.4	7.6	37.9	60.2	71.6	1.0	23.9	30.5	9.5	56.6
Sig.	NS	NS	NS	NS	NS	NS	*	*	*	NS	*	*	*	*
t value	0.6	0.1	0.2	0.7	0.2	0.004	6.2	6.2	4.5	1.3	0.001	2.3	0.1	6.5

Ambajipeta

The IPM strategies against RSW were implemented on 25 palms of Gangabondam variety. In natural control palms, the incidence increased from 62.7 to 69.4 per cent while in IPM imposed palms the incidence significantly decreased from 60.4 to 42.7 per cent. Along with the incidence, a decrease in intensity of RSW from 48.4 to 39.7 per cent was also recorded in IPM imposed palms

as against in control palms where it increased to 65.8 per cent. In IPM palms, low mean population of RSW was observed *i.e.* 15.4 adults, 19.4 nymphs and 9.7 pupae compared to natural control which had 29.6, 23.06 and 20.72 number of adults, nymph and pupae, respectively. No appreciable decrease of natural enemies was observed in IPM plots (Table 83).

Table 83: Integrated pest management of RSW in Ambajipeta

Treat ment	Pre-treatment observations						Post-treatment observations					
	Incidence of RSW (%)	Intensi ty of RSW (%)	Grade of pest inten sity	Pest stages/4 leaflets/palm (No.)			Inciden ce of RSW (%)	Inten sity of RSW (%)	Grade of pest inten sity	Pest stages/4 leaflets/palm (No.)		
				Nymph	Pupae	Adult				Nymph	Pupae	Adult
IPM	60.4± 2.6	48.4± 2.2	1.1± 0.1	20.6± 0.1	14.4± 0.7	22.6± 0.1	42.7± 0.9	39.7± 1.3	1.1± 0.7	19.4± 1.1	9.7± 0.5	15.4± 1.4
Natural control	62.7± 1.5	50.8± 1.2	1.37± 1.1	22.4± 0.8	15.3± 0.5	24.4± 0.8	69.4± 2.4	65.8± 3.3	2.01± 1.4	23.0± 1.8	20.7± 0.8	29.2± 1.9
Sig.	NS	NS	NS	NS	NS	NS	*	*	*	*	*	*
t value	0.81	1.06	1.91	1.81	0.94	1.38	10.43	7.06	4.84	1.79	10.26	6.27

Values are mean ± SE; *significant at P=0.1

Arsikere

The experiment was carried out at Hulukatte village of Tiptur taluk, 25 GBGD palms were selected for the experiment. IPM package for RSW was implemented in the plot as per the experimental protocol. Pre-treatment observation on the incidence and intensity of whitefly was recorded in the month of November, 2019. Post treatment observations were recorded on an incidence and intensity of whitefly. Simultaneous observations were

also made in control plot. After imposition of treatments, the whitefly infestation gradually decreased from 32.5 per cent to 11.7 per cent in treatment and in control plot the whitefly infestation increased from 31.2 to 52.3 per cent (Table 84). The IPM treatment recorded minimum adult (3.2), nymph (4.1) and egg (0.8) population which was significantly superior over natural control. The IPM treatment also registered the highest predator population (7.5) over the control (1.4).

Table 84: Integrated pest management of RSW in Arsikere

Treatment	Pre-treatment observations						Post-treatment observations					
	Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)			Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)		
				Egg	Nymph	Adult				Egg	Nymph	Adult
IPM	32.5 ± 2.7	37.4 ± 1.3	1.5 ± 0.86	2.8 ± 0.4	13.7 ± 2.5	11.4 ± 2.6	11.7 ± 1.3	10.2 ± 1.7	0.7 ± 0.2	0.8 ± 0.2	4.1 ± 0.6	3.2 ± 0.8
Natural control	31.2 ± 2.3	38.8 ± 1.1	1.7 ± 0.34	2.5 ± 0.8	13.4 ± 1.9	10.6 ± 2.2	52.3 ± 0.9	44.3 ± 2.5	2.45 ± 0.9	5.5 ± 0.3	28.4 ± 2.6	31.4 ± 3.5
Sig.	NS	NS	NS	NS	NS	NS	*	*	*	*	*	*
t value	2.6	2.9	0.5	1.4	2.2	1.6	5.8	4.2	1.5	0.4	4.5	3.7

Values are mean ± SE; * significant at P=0.1

Ratnagiri

A total of 25 GBGD variety palms were selected for the experiment. The present experiment was initiated in October, 2019. The IPM treatment reduced the incidence and intensity of whitefly (25.5 and 41.5%, respectively) over pre-count (46.4 and 44.5%, respectively). The incidence was found to be reduced significantly over the control. The grade pest intensity was reduced in IPM 0.4 (Low) as compared to pre-treatment count 0.6 (low). The IPM treatment recorded minimum adults, nymphs,

eggs and Encarsia population *i.e.*, 2.4, 3.6, 7.8 and 11.7 per cent, respectively which was significantly superior over natural control (4.4, 6.8, 14.0 and 17.8 %, respectively). The natural control registered slow decline of incidence and intensity of RSW and medium grade pest intensity which recorded 41.5, 9.7 per cent and 1.2 as compared to pre-count observation (44.5, 12.0% and 0.6 (low), respectively). The maximum natural enemy population like Encarsia was recorded in unsprayed plot (17.8%) over treated plot (11.7%) (Table 85).

Table 85: Integrated pest management of RSW in Ratnagiri

Treatment	Pre-treatment observations						Post-treatment observations					
	Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)			Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Pest stages/4 leaflets/palm (No.)		
				Eggs	Nymph	Adult				Eggs	Nymph	Adult
IPM	46.4 ± 2.3	10.7 ± 1.6	0.6 ± 0.1	10.2 ± 0.9	4.2 ± 0.0	5.0 ± 0.6	25.5 ± 1.3	4.0 ± 0.4	0.4 ± 0.2	7.8 ± 0.0	3.6 ± 0.3	2.4 ± 0.1
Natural control	44.5 ± 2.0	12.0 ± 1.4	0.6 ± 0.1	12.0 ± 0.3	5.8 ± 0.2	5.0 ± 0.5	41.5 ± 2.3	9.7 ± 1.3	1.2 ± 0.9	14.0 ± 0.3	6.8 ± 0.3	4.4 ± 0.2
Sig.	NS	NS	NS	NS	NS	NS	*	NS	NS	*	*	*
t value	0.5	0.5	1.0	0.0	1.5	1.0	7.1	1.5	1.0	9.7	2.7	5.7

Values are mean ± SE; * significant at P=0.05

Expt. 3: Studies on attraction of RSW towards coloured sticky traps

Aliyarnagar

The results of different colour traps revealed that yellow sticky traps attracted significantly the highest number of RSW (45.3) followed by green and red sticky traps (13.2) during June, 2019. Significantly

the least number of RSW was attracted in white and black sticky traps (5.5). Similar trend was observed in all the months. The overall mean indicated that higher number (11.3) of RSW was attracted to yellow sticky traps followed by green sticky traps (11.3) and the lowest numbers was observed in white colour (4.7) (Table 86).

Table 86: Attraction of RSW to different coloured sticky traps in Aliyarnagar

Treatments	June	July	August	September	October	November	December	Mean
Red colour	10.5	7.2	8.5	10.2	8.7	5.2	6.2	8.1
Yellow colour	45.2	28.5	32.7	37.6	32.3	22.6	18.5	31.1
Green colour	13.2	10.0	16.2	15.4	10.5	6.8	7.3	11.3
Black colour	5.5	6.0	7.2	6.2	8.2	7.5	6.3	6.7
White colour	5.5	6.5	4.2	5.5	4.5	3.5	3.2	4.7
Sig.	*	*	*	*	*	*	*	*
S.Ed±	1.2	4.7	1.2	1.4	1.2	1.7	2.9	4.2
CD (P=0.05)	2.7	1.8	2.7	3.3	2.9	0.8	1.2	1.8

* Significant at P = 0.05

Ambajipeta

The experiment on the attraction of RSW towards coloured sticky traps was conducted during November to December, 2019. Five coloured plastic sheets viz., red, yellow, green, black and white with dimensions of 100 x 50 cm were installed in the coconut garden and grease was applied to them and observations on mean number of RSW trapped was recorded as per technical program.

The observations revealed that the maximum catch of the whitefly was on yellow colour trap with a mean number of 17.1 and 25.5 during November and December, respectively. The next high numbers of RSW were trapped on green colour with a mean number of 13.9 and 19.7 during November and December, respectively. During December, these two treatments were followed by black colour (13.9), red colour (9.1) and white colour (6.4).

Arsikere

The present investigation was carried out at Hulukatte village of Tiptur taluk during 2019. Five coloured plastic sticky sheets painted with white grease with a dimension of 100 x 50 cm was hanged in between two palms in RSW infested garden at 1 m height from ground level and observations were recorded as per protocol of experiment. The data indicated that the maximum RSW (44.3) were caught on yellow sticky trap which was significantly superior over others. The second effective trap was green sticky trap which recorded 23.5 populations of RSW which was significantly superior over black sticky traps (16.9). The white sticky traps recorded the least (2.6) RSW catch compared to other sticky traps (Table 87).



Studies on attraction of RSW towards coloured sticky traps at HRS, Ambajipeta

Ratnagiri

The present investigation was carried out at RCRS, Bhatye during October to December, 2019. Five coloured plastic sticky sheets painted with white grease of dimension 100 x 50 cm was hanged in between two palms in RSW infested garden at 1 m height from ground level and observations were recorded. The data revealed that the maximum RSW catch (22.7) was on yellow sticky traps and was significantly superior over red, black and white colour sticky traps and on par with green sticky traps (17.2). The red, black and white sticky traps recorded 9.3, 4.5 and 4.2 RSW, respectively at five different points of dimensions 5 cm².

Table 87: Attraction of RSW to different coloured sticky traps in Arsikere

Treatments	April	May	June	July	August	September	October	November	December	Mean
Red colour	5.2 (2.3)	3.1 (1.8)	7.6 (2.8)	9.5 (3.1)	5.1 (2.3)	12.4 (3.5)	7.1 (2.7)	9.2 (3.0)	10.7 (3.3)	7.8 (2.8)
Yellow colour	9.5 (3.1)	7.9 (2.8)	14.2 (3.8)	19.5 (4.4)	22.4 (4.7)	31.9 (5.6)	37.4 (6.1)	40.2 (6.3)	44.3 (6.7)	25.3 (5.0)
Green colour	7.6 (2.8)	5.9 (2.4)	11.1 (3.3)	14.5 (3.8)	11.9 (3.4)	18.4 (4.3)	20.9 (4.6)	23.5 (4.8)	23.2 (4.8)	15.2 (3.9)
Black colour	3.4 (1.8)	4.3 (2.1)	7.6 (2.8)	10.5 (3.2)	8.4 (2.9)	16.6 (4.1)	12.7 (3.6)	15.7 (4.0)	16.9 (4.1)	10.7 (3.3)
White colour	1.5 (1.2)	1.2 (1.1)	1.6 (1.3)	2.9 (1.7)	2.8 (1.7)	3.3 (1.8)	2.4 (1.5)	3.2 (1.8)	4.7 (2.2)	2.6 (1.6)
S.Em ±	0.1	0.2	0.5	0.4	0.2	0.5	0.3	0.3	0.2	0.3
CD (P=0.05)	0.4	0.6	1.5	1.2	0.6	1.4	0.8	0.9	0.6	0.9

Figures in parenthesis are square root transformed values



V. EXPERIMENTAL RESULTS IN OIL PALM

5.1 CROP IMPROVEMENT

OP./Gen. 8: Studies on the comparative performance of different hybrid combinations of Oil palm

Pattukkottai

Studies on the comparative performance of different hybrid combinations of oil palm (NRCOP

11 to NRCOP 20) were undertaken since 2006 to evaluate *Tenera* hybrids for growth and productivity and to select most suitable oil palm hybrid for Cauvery delta zone. The experiment was laid out in RBD with three replications and six palms per treatment.

Pedigree of hybrid combinations:

1	49 x 66	(NRCOP 11)	6	131 x 66	(NRCOP 16)
2	25 x 214	(NRCOP 12)	7	350 x 66	(NRCOP 17)
3	25 x 66	(NRCOP 13)	8	107 x 214	(NRCOP 18)
4	68 x 36	(NRCOP 14)	9	61 x 66	(NRCOP 19)
5	21 x 214	(NRCOP 15)	10	28 x 68	(NRCOP 20)

Among the 10 hybrids evaluated for growth and yield parameters, the hybrid NRCOP 14 recorded significantly the highest palm height of 6.4 m and NRCOP 15 recorded the highest girth of 3.5 m. The lowest palm height (5.3 m) was recorded in hybrid NRCOP 16. Annual leaf production was the highest

in NRCOP 13 (25.5) and number of female inflorescence (10.7) was the highest in NRCOP 17. Data on yield attributes of oil palm revealed that the highest bunch weight of 192.0 kg/palm and per hectare yield of 27.5 t/ha was recorded in hybrid NRCOP 17 for the period of January to December, 2019 (Table 88).

Table 88 : Growth and yield performance of oil palm hybrids at Pattukkottai

Name of the hybrid	Palm height (m)	Palm girth (m)	Annual leaf production (No.)	No. of female inflorescence/ Plant	No. of bunches /palm	Weight /bunch (kg)	FFB yield	
							kg/palm	t/ha
NRCOP 11	5.4	3.3	24.6	10.3	11.3	14.2	160.5	22.9
NRCOP 12	5.6	3.4	23.5	9.9	11.2	14.2	159.0	22.6
NRCOP 13	5.9	3.2	25.5	10.6	13.6	12.4	168.0	24.0
NRCOP 14	6.4	3.5	24.3	8.6	11.2	12.6	141.3	20.2
NRCOP 15	5.5	3.5	24.6	10.1	10.2	14.6	149.1	21.3
NRCOP 16	5.3	3.0	23.6	9.0	13.3	12.1	160.9	23.0
NRCOP 17	5.6	3.3	23.4	10.7	13.5	14.2	192.0	27.5
NRCOP 18	5.3	3.3	23.4	10.1	13.2	13.0	171.9	24.6
NRCOP 19	5.3	3.3	24.1	10.3	12.2	13.4	163.5	23.4
NRCOP 20	6.0	3.4	24.8	10.4	12.3	14.1	172.9	24.7
S.Ed±	0.12	0.11	0.52	0.38	0.96	1.01	1.86	-
CD (P=0.05)	0.24	0.22	1.04	0.76	1.92	2.02	3.72	-

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

Centres: Mulde, Pattukkottai and Vijayarai

Mulde

Oil palm seedlings were planted during September, 2007 in RBD with 3 replications and 9 palms per treatment. Ten cross combinations of oil

palm showed significant variation for FFB yield only. Different genotypes showed significant difference for all yield characters under study. The number of bunches (9.9), yield of FFB per plant (221.8 kg/palm) and tons per hectare (31.7 t/ha) were maximum in genotype NRCOP 2. Genotype NRCOP.1 produced 26.9 tons FFB yield per hectare (Table 89).



Bunch yield of NRCOP 17

Table 89: Yield performances of different hybrid combinations at Mulde

Cross combination	Code number	No. of FFB	Weight of FFB (kg/bunch)	Yield of FFB	
				kg/palm	t/ha
78 D x 435 P	NRCOP 1	8.4	22.7	188.3	26.9
90 D x 557 P	NRCOP 2	9.9	22.5	221.8	31.7
158 D x 116 P	NRCOP 3	5.8	19.1	137.5	19.7
131 D x 435 P	NRCOP 4	7.7	19.4	150.5	21.5
5 D x 577 P	NRCOP 5	5.9	18.6	109.6	15.7
173 D x 435 P	NRCOP 6	9.2	18.4	168.4	24.1
183 D x 577 P	NRCOP 7	8.1	18.8	153.2	21.9
70 D x 557 P	NRCOP 8	7.4	18.9	140.7	20.1
28 D x 435 P	NRCOP 9	9.5	18.8	178.9	25.6
345 D x 577 P	NRCOP 10	5.3	19.2	102.7	14.7
S.Em±		0.87	0.73	14.28	2.04
CD (P=0.05)		2.5	2.11	41.30	5.90

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. The highest palm height (5.0 m) was recorded in the hybrid NRCOP 4 and the lowest palm height was recorded in the NRCOP

9 (4.4 m). The hybrid NRCOP 7 recorded the highest palm girth (3.7 m) and NRCOP 2 recorded the highest number of leaves (25.8/palm/year). The hybrid NRCOP 1 recorded significantly the highest number of female inflorescence (12.3). Bunch weight (15.8 kg/palm), FFB productivity (138.6 kg/palm) and FFB yield (19.8 t/ha) were maximum in the hybrid NRCOP 9 during the period January to December, 2019 (Table 90).

Table 90: Growth performance of oil palm hybrids at Pattukkottai

Name of the hybrid	Palm height(m)	Palm girth (m)	Annual leaf product ion(No.)	No. of female inflorescence	Bunch weight (kg)	No. of bunches /palm	FFB yield	
							kg/palm	t/ha
NRCOP 1	4.9	3.4	24.5	12.3	12.6	9.2	115.5	16.5
NRCOP 2	4.9	3.7	25.8	10.2	15.2	7.4	112.8	16.1

NRCOP3	4.6	3.5	23.8	10.7	14.9	8.0	119.6	17.1
NRCOP4	5.0	3.7	24.9	10.1	14.4	7.8	111.4	15.9
NRCOP5	4.8	3.6	25.2	11.1	13.3	8.7	115.3	16.5
NRCOP6	4.6	3.6	24.2	11.4	13.0	7.8	101.3	14.5
NRCOP7	4.6	3.7	24.4	10.7	12.8	8.0	102.4	14.6
NRCOP8	4.8	3.4	24.5	10.6	12.3	8.0	98.0	14.0
NRCOP9	4.4	3.4	24.5	10.8	15.8	8.8	138.6	19.8
NRCOP10	4.5	3.6	24.6	10.8	15.2	7.9	120.1	17.2
S.Ed±	0.12	0.21	0.68	0.56	0.62	1.13	1.65	-
CD (P=0.05)	0.24	0.42	1.36	1.12	1.24	2.26	3.30	-



Field view of experiment



Bunch yield of NRCOP9

Vijayarai

Ten cross combinations of oil palm (NRCOP 1 to NRCOP 10) were planted in square system at spacing of 9×9 m in RBD with 3 replications

and 6 plants per treatment during 2007. The entire cross combinations were at par with each other with respect to all vegetative and reproductive characters under studies (Table 91).

Table 91 : Performance of new cross combinations of oil palm at Vijayarai

Hybrid	Palm height (m)	Palm girth (m)	No. of leaves /palm/year	Sex ratio	Average bunch weight (kg)	No. of bunches /palm/year	FFB yield t/ha
NRCOP1	4.3	2.8	25.3	0.6	18.3	6.2	14.0
NRCOP2	3.6	2.7	24.2	0.7	16.7	8.3	16.9
NRCOP3	3.7	2.8	24.0	0.6	17.6	5.9	12.7
NRCOP4	4.3	2.9	26.0	0.6	19.1	5.2	11.9
NRCOP5	3.9	3.0	25.1	0.6	17.7	6.0	13.0
NRCOP6	3.8	2.8	24.2	0.6	17.7	7.1	15.4
NRCOP7	4.2	2.9	24.7	0.5	18.4	4.8	11.5
NRCOP8	4.0	2.8	24.6	0.5	19.6	6.8	16.8
NRCOP9	3.8	2.8	24.2	0.7	19.4	7.1	16.7
NRCOP10	3.7	2.7	24.2	0.7	17.1	6.2	13.0
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
S.Em±	0.25	0.08	1.35	0.07	0.93	0.87	2.10
CV (%)	11.05	4.90	9.51	19.89	8.91	23.60	25.62



Fresh fruit bunches on NRCOP 2

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

Pasighat

Then growth of the palms with respect to stem height was maximum (226.16cm) in NRCOP-23 and at par with NRCOP-29, NRCOP-27, NRCOP-24, NRCOP-22 and NRCOP-28 but statistically higher than NRCOP-30, NRCOP-26, NRCOP-21 and NRCOP-25. The stem height was recorded to be minimum (166.61cm) in NRCOP-25 closely followed by NRCOP-21 (174.36cm). Growth of all the palms with respect to collar girth was recorded to be at par with each other in the entire cross combination. Maximum number of leaves (23.70) was produced by the cross combination NRCOP-24 which was at par (23.46) with NRCOP-22 and significantly higher than any other treatment.

Minimum number of leaves (19.53) was produced by NRCOP-29.

Number of male flowers produced by the palms was found to be non significant. Maximum number of female flowers (12.16) were produced by the cross NRCOP-22 which was at par with NRCOP-25, NRCOP-26, NRCOP-24 and NRCOP-27 but significantly higher than the female flowers produced by other cross combinations. Minimum number of female flowers (7.16) were produced by the cross NRCOP-29. The sex ratio was recorded highest (0.89) in NRCOP-24 which was statistically at par with NRCOP-22, NRCOP-27, NRCOP-25, NRCOP-26 and NRCOP-30. Sex ratio was recorded least (64) in NRCOP-29.

Maximum number of Fresh Fruit Bunches (10.52) was produced by NRCOP-24 which was significantly higher than in any other cross combination except NRCOP- 22, NRCOP- 25, NRCOP- 26, NRCOP- 27 and NRCOP- 23 where as the NRCOP-29 produced the least number of FFB (6.35) per palm. The average bunch weight was recorded maximum (13.48Kg) in NRCOP-22 which was significantly higher than any other cross combination the bunch weight was least in NRCOP-21 (10.24Kg) and in NRCOP-24(10.61Kg) and NRCOP- 30 (10.63Kg). Highest yield was recorded in NRCOP-22 (20.2 t/ha) which was significantly higher than any other cross combinations. The yield (9.77t/ha) was minimum in NRCOP-29 (Table 92).

Table 92 : Growth and yield parameters of Oil palm plants (Pasighat)

Cross Com bination	Plant height (cm)	Collar girth (cm)	No. of leaves produced	Male flowers /palm	Female flowers /palm	Sex Ratio	No. of FFB/ plant	Bunch weight /Palm (Kg)	Yield	
									Kg/ palm	t/ha
NRCOP-21	174.36	240.33	20.76	2.70	10.23	0.79	9.94	10.24	101.11	14.46
NRCOP-22	205.93	265.90	23.46	2.08	12.16	0.85	10.48	13.48	141.25	20.20
NRCOP-23	226.16	258.36	20.36	2.76	9.33	0.76	9.04	11.03	100.79	14.41
NRCOP-24	208.96	260.93	23.70	1.33	10.66	0.89	10.52	10.61	111.42	15.93
NRCOP-25	166.60	271.06	20.93	2.23	10.96	0.83	9.72	12.21	118.72	16.98
NRCOP-26	185.90	277.46	20.50	2.75	10.83	0.81	9.35	12.38	115.93	16.58
NRCOP-27	209.33	254.76	20.66	2.06	10.66	0.83	9.33	10.83	101.17	14.46
NRCOP-28	200.60	272.10	19.86	3.66	9.10	0.71	8.27	11.72	96.94	13.86
NRCOP-29	223.26	264.90	19.53	4.03	7.16	0.64	6.35	10.79	68.37	9.77
NRCOP-30	187.33	274.86	20.33	2.01	9.76	0.81	8.44	10.63	89.36	12.78
CD at 5%	29.66	NS	1.083	NS	1.804	0.083	2.040	0.943	20.897	2.982
CV (%)	8.694	5.081	3.011	37.231	10.456	6.543	13.037	4.853	11.651	11.659

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

Centres: Mulde, Pasighat, Pattukkottai and Vijayarai

Treatments details:

Sl. No.	Cross combination	Sl. No.	Cross combination
1	NRCOP 31 (257 CD x 14 P)	6	NRCOP 36 (99 CD x 14 P)
2	NRCOP 32 (254 CD x 17 P)	7	NRCOP 37 (66 CD x 17 P)
3	NRCOP 33 (198 CD x 129 P)	8	NRCOP 38 (66 CD x 14 P)
4	NRCOP 34 (124 CD x 14 P)	9	NRCOP 39 (42 CD x 14 P)
5	NRCOP 35 (124 CD x 17 P)	10	NRCOP 40 (92 CD x 129 P)

Pasighat

The growth of the plants with respect to plant height and collar girth over a period of one year was found to be statically at par, in all the cross combinations. The number of leaves produced was recorded maximum (19.5) in NRCOP-35 followed by NRCOP-31 (18.5) which was statically higher than the leaves produced by other cross combinations. Minimum number of

leaves (15.3) was produced by NRCOP-38. The yield attributing characters such as number of female flowers/ palm and number of FFB/ palm was at par in all the crosses. The average bunch weight, yield/palm and yield t/ha also did not vary significantly in the cross combinations. However the mean yield/palm and yield t/ha was maximum (44.31kg/palm and 6.29 t/ha) in NRCOP-33 (Table 93).

Table 93: Growth and yield parameters of Oil palm plants (Pasighat)

Cross Combination	Stem height (cm)	Stem girth (cm)	No. of leaves produced	No. of male flowers /plant	No. of female flowers/ plant	Sex Ratio	No. of FFB/ plant	Bunch weight/ palm	Yield	
									Kg/palm	t/ha
NRCOP-31	51.40	155.53	18.5	5.7	6.9	0.54	6.0	6.8	41.46	5.94
NRCOP-32	57.96	164.93	15.9	4.5	5.6	0.55	5.6	6.8	38.79	5.54
NRCOP-33	57.13	162.93	17.4	5.1	6.8	0.57	6.1	7.1	44.31	6.29
NRCOP-34	57.03	167.06	17.8	6.2	5.9	0.48	5.7	6.6	37.93	5.42
NRCOP-35	57.40	160.50	19.5	5.6	6.5	0.53	5.5	6.6	36.80	5.26
NRCOP-36	59.00	169.13	16.8	6.3	5.6	0.47	5.4	6.6	36.81	5.17
NRCOP-37	59.33	162.96	16.2	6.4	6.5	0.50	6.2	6.8	42.98	6.16
NRCOP-38	59.20	162.16	15.3	5.8	6.0	0.50	5.8	7.1	41.41	5.92
NRCOP-39	58.30	155.56	16.2	5.9	5.8	0.49	5.6	6.8	39.00	5.58
NRCOP-40	57.06	159.60	16.5	6.0	6.1	0.50	5.3	6.4	26.66	5.00
CD at 5%	NS	NS	2.138	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.993	5.518	5.320	14.463	12.780	8.399	11.195	4.814	19.119	13.602

Mulde

Planting was carried out in the experimental field during October, 2011 by adopting RBD with 3 replications and 8 palms per treatment. The ten cross combinations of oil palm showed significant variation

for yield attributing characters. More number of FFB (9.1) and the highest yield of FFB (21.5 t/ha) were recorded in NRCOP 31 genotype. NRCOP 36 produced only 6.1 bunches and 12.9 tons per hectare FFB yield (Table 94).

Table 94: Yield performances of different hybrid combinations

Hybrids	Average No. of FFB	Average weight of FFB (kg/bunch)	Yield of FFB(t/ha)
NRCOP 31	10.1	14.9	21.5
NRCOP 32	9.5	13.7	18.4
NRCOP 33	7.9	15.3	17.0
NRCOP 34	6.9	14.4	14.1
NRCOP 35	7.6	14.0	15.2
NRCOP 36	6.1	14.9	12.9

NRCOP 37	8.5	14.7	17.9
NRCOP 38	7.1	13.9	13.9
NRCOP 39	7.6	15.0	16.4
NRCOP 40	9.6	13.8	18.8
S.Ed±	0.80	0.40	1.37
CD (P=0.05)	2.30	1.17	3.97

Pattukkottai

Nine hybrids *viz.*, NRCOP 31 to 39 were planted during 2013 in ARS, Pattukkottai. Among 9 hybrids received, only five hybrids (NRCOP 31, 32, 33, 38 and 39) had 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. Palms are in initial stage of bearing.

Among the replicated hybrids, the hybrid NRCOP 32 recorded significantly the highest palm height of 4.9 m and the palm girth was higher in NRCOP 38 (3.4 m). The lowest palm height (4.30 m) was recorded in the hybrid NRCOP 39. Number of leaves produced per year (24.9) was the highest in NRCOP 39. The highest FFB yield (120.4 kg/palm) and per hectare yield (17.2 t/ha) were registered in the hybrid NRCOP 38 during the period under report (Table 95).

Table 95: Performance of oil palm hybrids at Pattukkottai

Hybrids	Palm height(m)	Palm girth (m)	Total leaves(No.)	Leaf length(m)	Leaf breadth (m)	No. of leaflets/ leaf	FFB yield	
							kg/palm	t/ha
NRCOP 31	4.4	2.8	24.5	3.9	1.6	146.2	90.3	12.9
NRCOP 32	4.9	2.9	23.8	4.0	1.7	153.5	108.5	15.5
NRCOP 33	4.3	3.3	23.5	3.4	1.6	150.8	110.8	15.8
NRCOP 38	4.5	3.4	23.9	3.7	1.7	162.0	120.4	17.2
NRCOP 39	4.3	2.9	24.9	3.6	1.6	142.9	85.8	12.3
S.Ed±	0.10	0.9	1.13	0.09	0.04	6.78	4.53	-
CD (P=0.05)	0.21	1.8	2.26	0.18	0.08	13.56	9.06	-



Bunch yield of NRCOP 38

Vijayarai

Ten progeny cross combinations of oil palm (NRCOP 31 to NRCOP 40) were planted in triangular system at spacing of 9×9×9 m in RBD with 3 replications and 6 palms per treatment during 2011. There were no significant differences among the progeny cross combinations for number of leaves, sex ratio, average bunch weight (kg), FFB yield (kg/palm and t/ha). However, new progeny cross combinations differed significantly for palm height, palm girth and number of bunches. Palm height was significantly the lowest in NRCOP 36 (1.8 m) followed by NRCOP 31 and NRCOP 39 (2.0 m, each). Palm girth was significantly the highest in NRCOP 38 followed by NRCOP 36 and NRCOP 39 (3.1 m, each). The new progeny cross combination NRCOP 31 produced significantly the highest number of bunches (11.1) followed by NRCOP 34 (10.2) and NRCOP 37 (9.8) (Table 96).

Table 96: Performance of cross combinations of oil palm at Vijayarai

Hybrid	Palm height (m)	Palm girth(m)	No. of leaves	Sex ratio	Bunch weight(kg)	No. of bunches	FFB yield	
							kg/palm	t/ha
NRCOP31	2.0	2.7	24.6	0.5	14.7	11.1	162.3	23.2
NRCOP32	2.5	2.7	24.8	0.6	17.9	9.1	165.5	23.7
NRCOP33	2.5	2.8	26.8	0.6	18.5	6.2	112.6	16.1
NRCOP34	2.1	2.9	25.5	0.7	16.3	10.2	165.2	23.6
NRCOP35	2.4	2.8	26.0	0.6	17.3	7.1	123.6	17.7
NRCOP36	1.8	3.1	25.1	0.7	15.6	9.7	152.4	21.8
NRCOP37	2.4	2.9	26.9	0.6	20.6	9.8	200.1	28.6
NRCOP38	2.0	3.1	25.5	0.7	18.2	8.9	161.9	23.2
NRCOP39	2.0	3.1	26.9	0.7	17.6	9.3	164.4	23.5
NRCOP40	2.5	2.9	24.0	0.6	15.8	6.5	103.3	14.8
CD (P=0.05)	0.32	0.26	NS	NS	NS	2.89	NS	NS
S.Em ±	0.11	0.09	0.87	0.09	1.40	0.97	20.26	2.90
CV (%)	8.40	5.22	5.86	23.72	14.07	19.02	23.22	23.21

**Fresh fruit bunches of NRCOP 37**

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

Vijayarai

Twelve entries of oil palm including eleven D x

P hybrids (NRCOP 41 to NRCOP 51) along with one control (646) were planted in triangular system at spacing of 9x9x9 m in RBD with 3 replications and 9 plants per treatment during 2013. There were no significant differences among the entries for palm height; number of leaves, sex ratio, average bunch weight and number of bunches. However, D x P hybrids differed significantly for palm girth and FFB yield (kg/palm and t/ha/year). Palm girth was significantly the highest in NRCOP 43 (3.1 m) followed by NRCOP 45 (3.0 m) and NRCOP 47 (2.9 m). The D x P hybrid NRCOP 41 produced significantly the highest FFB yield (30.3 t/ha) followed by NRCOP 44 (28.9 t/ha) and NRCOP 50 (27.7 t/ha) compared to the check (646) (16.2 t/ha) (Table 97).

Table 97: Growth and yield parameters of D x P hybrids of oil palm at Vijayarai

Hybrid	Palm height(m)	Palm girth(m)	No. of leaves	Sex ratio	Bunch weight(kg)	No. of bunches	FFB yield	
							kg/palm	t/ha
NRCOP41	1.4	2.8	25.1	0.6	9.3	22.7	211.6	30.3
NRCOP42	1.5	2.4	24.8	0.6	10.4	18.4	191.3	27.3
NRCOP43	1.3	3.1	26.7	0.5	11.1	13.4	141.7	20.3
NRCOP44	1.6	2.8	25.7	0.6	12.7	15.9	202.2	28.9
NRCOP45	1.3	3.0	27.4	0.6	11.2	16.0	176.4	25.2
NRCOP46	1.3	2.8	27.2	0.5	7.8	17.0	132.6	19.0
NRCOP47	1.4	2.9	26.3	0.7	9.5	18.9	170.1	24.3
NRCOP48	1.2	2.7	26.6	0.6	8.7	12.3	112.2	16.0
NRCOP49	1.3	2.8	26.0	0.5	9.4	11.2	104.2	21.2
NRCOP50	1.3	2.7	24.8	0.5	10.0	19.8	193.8	27.7
NRCOP51	1.4	2.8	25.6	0.6	9.5	19.3	183.6	26.3
Control (646)	1.3	2.8	25.9	0.4	9.5	11.4	113.3	16.2
CD (P=0.05)	NS	0.30	NS	NS	NS	NS	74.00	9.21
S.Em±	0.12	0.10	0.89	0.11	0.91	2.57	25.07	3.12
CV (%)	15.34	6.26	5.91	33.67	15.84	27.18	26.96	22.94

5.2 CROP PRODUCTION

OP./Agron. 21: Plant geometry and optimisation of nutrients in oil palm

Bavikere

Expt. 1: Optimisation of fertiliser dose for oil palm plantation

Treatment details:

Name of the hybrid: 163D x 17P; Treatments: 16;
Replication: 3; Design: 3³ Factorial RBD



Fresh fruit bunches of NRCOP 41

Levels of nutrients	Dosage
N levels (N ₀ , N ₁ , N ₂)	0, 1200, 2400 g/palm/year
P levels (P ₀ , P ₁ , P ₂)	0, 600, 1200 g/palm/year
K levels (K ₀ , K ₁ , K ₂)	0, 1800, 3600 g/palm/year

Analysis of soil samples is in the process

Expt. 2: Plant geometry studies in oil palm

Treatment details:

Name of the hybrid: 165D x 11P; Replication: 5;
Design: RBD

M₁: 9m x 9m x 9m Triangular planting

M₂: 9m x 9m Square planting

M₃: 10m x 10m x 10m Triangular planting

M₄: 10m x 10m Square planting

Planting is done during 25-26th April, 2019

Both the experiments are in initial stage and the observations are yet to be recorded.

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

Pasighat

Treatments

1. 900:450:900 g NPK/ p/y
2. 1200:600:1200 g NPK/ p/y
3. 1500:750:1500 g NPK/ p/y
4. 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

Spacing: 9 m hexagonal, Design: RBD

Replication: 5 No. of palms/plot: 6

For starting this new trial the existing plantation has been uprooted. Field was prepared and maize was sown as per the guidance of IIOPR, to exhaust the soil to start the new trial. Oil palm sprouts was received in June 2017 from IIOPR Pedavegi and raised in nursery. Planting was done on 09/08/2019 as per the treatment details. First split of nutrient was applied three months after planting (November 2019.)

OP./Agron. 22 Studies on intercropping in bearing oil palm plantation

Mulde

Intercrops of ornamental plants and spices are planted as per the treatments during February, 2018 with the view to test the feasibility of growing different crops as an intercropping in oil palm garden.

Treatments: 7; each treatment in 3 oil palm block

- 1) Oil palm + heliconia + black pepper
 - 2) Oil palm + red ginger + black pepper
 - 3) Oil palm + lily + black pepper
 - 4) Oil palm + bush pepper + black pepper
- } At 60 x 45 cm spacing; 3 m x 2 m plot size
- (Bush pepper at 1.5 x 1.5 m spacing 3 x 3 m plot size)
- 5) Oil palm + nutmeg + black pepper
 - 6) Oil palm + *Dracaena* (foliage plants) + black pepper
 - 7) Oil palm (sole)

Replications: 3

Date of Planting: January, 2018

Growth of the plants is satisfactory. Flower crops and bush pepper crops are in flowering stage.

OP/Agron.13 Demonstration on oil palm production potential in North East Region

Pasighat

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 2019 as per the suggestion received from DOPR Pedavegi is 3.98 m , 2.67m and 22.8 leaves per palm respectively. Flowering and fruiting



Oil palm + Red ginger intercrop at Mulde

in all the palms have been observed to be satisfactory over the years. The number of FFB produced per palm was 9.20 with an average bunch weight of 18.50 kg and the yield was recorded to be 24.3 t/h



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, Swarna mangala, Madhuramangala and Sreewardhini planted during 2015 at Honnavile station were maintained and growth traits were observed after 48 months of planting. Out of seven varieties evaluated, variety Mohitnagar showed maximum plant height (485.3 cm), collar girth (65.4 cm) and more number of leaves (11.9 leaves/plant and 14.3 leaves/year), along with maximum leaf length (142.5 cm), leaf breadth (127.3 cm), leaf sheath length (75.5 cm) and leaf sheath breadth (62.9 cm).



Evaluation of released arecanut varieties at Shivamogga

Wakawali

Seven arecanut varieties were planted during August, 2015 at Asond Research Farm, Central Experiment Station, Wakawali. The plant height ranged from 70.8 to 128.9 cm with a mean of 94.6 cm. The variety Mohitnagar was found statistically superior and recorded maximum plant height (128.9 cm) which was at par with Sumangala (111.2 cm). The crown length ranged from 104.5 to 193.0 cm with mean of 135.6 cm. Mohitnagar was found statistically superior with maximum crown

length (193.0 cm) followed by treatment Sumangala (145.9 cm) and Sreemangala (142.0 cm). The Girth of palm ranged from 35.2 to 51.2 cm with mean of 43.4 cm. Sumangala was found superior and recorded maximum girth 51.1 cm. The number of leaves ranged from 6.4 to 8.3 with mean of 7.0. Mohitnagar was found statistically superior and recorded maximum number of leaves 8.3 followed by Sreemangala (7.4) and Sumangala (7.2), respectively. The leaf length ranged from 87.2 to 115.1 cm with mean of 100.5 cm. Sreemangala was found superior with maximum leaf length (115.1 cm) and it was at par with Mohitnagar (113.2 cm) and Sumangala (106.0 cm). The leaf breadth ranged from 73.2 to 93.3 cm with mean of 82.5 cm. The variety Mohitnagar was found superior which recorded maximum leaf breadth (93.3 cm) and was at par with Sreemangala (90.1 cm) and Sumangala (83.6 cm).



Evaluation of released arecanut varieties at Wakawali

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 271 surviving palms of which 72 are at reproductive stage. The vegetative characters recorded on 113 plants are given below. The mean height of the plant from plant base to base of crown was only 1.19 ± 0.07 m at 9 years of planting. Mean

spadix length and breadth in 133 inflorescences of the study were 32.38 ± 1.03 cm and 13.68 ± 0.29 cm, respectively. Mean number of female flowers per inflorescence in the experiment was 120.07 ± 0.22 . Foliar glucose content in the leaf sap extract was significantly different between Mangala (564.43 ± 79.04 microgram/ml) and Hirehalli dwarf (855.26 ± 67.40 microgram/ml). The results for the past two years confirm the hypothesis of association of the dwarf plant habit with high foliar glucose content and suggest the use as diagnostic biochemical assay.

Port Blair

Nucleus seed garden of the improved variety 'Samrudhi' was established at the Garacharmafarm, ICAR- CIARI, Port Blair. Gap filling was undertaken at few places and palms are growing well. Paddy straw mulching was done for optimum moisture conservation at the end of rainy season. As the block has been established on terraces, soil erosion was avoided by planting tapioca on the slopes, which were pruned during this year. No flowering was observed so far.

Shivamogga

Hirehalli dwarf variety, after 4 years of planting, showed a mean maximum plant height of 158.4 cm, collar girth of 40.0 cm, along with maximum number of leaves (9.2 leaves/plant and 11.8 leaves/year). Apart from that, the plant recorded a mean leaf length of 105.0 cm, leaf breadth of 38.6 cm, leaf sheath length of 38.0 cm and leaf sheath breadth of 31.6 cm.

Wakawali

Nucleus seed garden of the variety Hirehalli Dwarf was established at Wakawali farm. The plant height after thirty six months of planting ranged from (3.0 - 15.0 cm), number of leaves varied from 4.0 – 6.0, leaf length from 13.0 - 47.0 cm and leaf breadth from 25.0 - 55.0 cm.

The plant height of shriwardhani variety after thirty six months of planting ranged from 33.0 - 71.0 cm, number of leaves varied from 6.0 - 7.0, leaf

length from 66.0 - 101.0 cm and leaf breadth from 64.0- 89.0 cm. However, the plant height of Shriwardhani after thirty nine month of planting ranged from (72.00 – 104.00), number of leaves varied from (4.00 – 7.00), leaf length (67.00 – 104.00) & leaf breadth (76.00 – 92.00), respectively.



Nucleus seed garden of Hirehalli dwarf at Wakawali

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

In order to identify profitable intercrops in arecanut plantations of Andaman islands, new trial was initiated with three herbal spices as intercrops. The experiment aimed at comparing arecanut sole cropping (T_1) with intercrop combinations viz. arecanut + Burmese coriander 'CARI Broad Dhaniya 1' (T_2), arecanut + coriander 'Arka Isha' (T_3) and arecanut + mint (T_4). During the study period (April to December, 2019), intercrops were planted which have established in the field, but are yet to attain harvestable maturity. Arecanut palms could be harvested only twice as remaining bunches are still developing. Chali yield from these harvests was 4.2 t/ha (T_1), 3.5 t/ha (T_2), 3.0 t/ha (T_3) and 2.8 t/ha (T_4). Evaluation of intercrops and record of yield data of arecanut is in progress.



Arecanut + Coriander intercrop

Expt. 2: Intercropping in juvenile arecanut garden

Wakawali

An experiment was laid out in RBD with four treatments (three intercrops and a monocropping control) and five replications, with a plot size of interspaces in 12 areca plants. The planting of three intercrops (rose apple, lemon and nutmeg) has been done in December, 2018. The plants are in initial growth stage.



Intercropping in juvenile Arecanut garden

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

Shivamogga

Location: Anaveri (Bhadravathi Tq.)

Treatments

1. Providing better drainage (depth maintained 15 cm below the root zone)
2. Providing water through drip irrigation

3. Improving aeration by application of paddy/areca husk (5 kg/plant)
4. Root rejuvenation by soil application of microbial consortia (*Trichoderma harzianum* (IMI304056) + *Pseudomonas fluorescense* (NCIB9046) and *Bacillus megaterium* (NCTC 9848) @ 100g/plant along with 2 kg neem cake and 10 kg of FYM/decomposed compost.
5. Growing intercrops (such as cocoa and banana) in the arecanut garden
6. Two sprays of $ZnSo_4$ @ 0.5 % during May-June and September - October
7. Application of fertilizers based on soil and leaf analysis.

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 plants produced a mean number of 48.5 primary roots/ sq. ft. area, 12.7 healthy leaves and 5.9 bunches/plant. Whereas, affected plants showed partial recovery and produced a mean number of 36.9 healthy primary roots/sq. ft. area with a mean of 6.8 healthy leaves and 3.6 infected leaves/plant. The data obtained showed that, the management practices adopted to overcome crown chocking disorder influenced better root development as well as better uptake of nutrients by the plant resulting in improved root growth and reduced number of infected leaves and bunches in the affected palms.

Population dynamics of biocontrol agents (*T. harzianum*, *P. fluorescense* and *B. megaterium*) in the rhizosphere soils of crown chocking disorder demonstration garden showed considerable increase in their population after six months of imposition of the treatments. Among the biocontrol agents, *Bacillus sp.* showed comparatively higher population enumeration followed by *Trichoderma* and *Pseudomonas* species, respectively.

6.3 CROP PROTECTION

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

Roving survey was conducted during *Kharif* and *Rabi* season of 2019-20 in all the talukas of Shivamogga district to assess the incidence of different diseases in the areca gardens with the crop age ranging between 1 to 50 years. The data revealed that, among the diseases observed *Phyllosticta* leaf spot, Inflorescence die back and fruit rot found to be most common in majority of gardens surveyed with a mean incidence ranging

from 9.4 to 24.3, 32.5 to 85.1 and 10.40 to 95.4 percent respectively.

The diseases like leaf blight, bud rot and crown rot was appeared to be common in Thirthahalli, Hosanagara and Sagara taluks, Whereas, Bacterial leaf stripe was severe in Shivamogga (30.1%), Bhadravati (28.1), Shikaripura (25.2%) and crown chocking was severe in Shikaripura (25.5%), Bhadravati (24.1%), Shivamogga (22.2%) and Soraba (12.3 %) taluks, However, yellow leaf disease was not observed in any of the talukas surveyed in Shivamogga district (Table 98).

Table 98: Survey and surveillance of Arecanut diseases at Shivamogga district

Taluk	No. of gardens surveyed	Disease Incidence (%)								
		<i>Phyllosticta</i> leaf spot	Bacterial leaf stripe	Fruit rot	Bud rot	Crown rot	Inflorescence Dieback	Crown chocking	Leaf blight	<i>Ganoderma</i> wilt
Shivamogga	25	24.3	30.1	10.40	2.3	0.0	85.1	22.2	8.0	2.3
Thirthahalli	10	20.3	0.0	90.1	3.8	2.2	34.3	2.2	1.2	1.3
Hasanagara	8	18.4	0.0	95.4	4.6	1.3	40.1	1.8	1.3	1.4
Shikaripura	14	14.3	25.2	22.4	1.3	0.2	70.1	25.5	5.4	2.3
Soraba	12	9.4	5.3	30.2	1.3	0.0	45.4	12.3	3.8	2.7
Bhadravati	22	15.3	28.1	15.1	1.5	0.0	75.2	24.1	9.2	4.3
Sagara	11	11.6	0.0	75.4	1.3	2.2	32.5	1.6	1.1	1.8
Mean	-	16.23	12.67	48.43	2.30	0.84	54.67	12.81	4.29	2.30



VII. EXPERIMENTAL RESULTS IN PALMYRAH

7.1. CROP IMPROVEMENT

Palmy./Gen. 9: Survey, collection and evaluation of palmyrah germplasms

Centres: Killikulam and Pandirimamidi

Killikulam

Performance of palmyrah germplasms

Performance of collected palmyrah germplasm was evaluated during 2019. Much variation was observed among the 1995 planted germplasm accessions. Among them, accession 18 has recorded the maximum values in terms of palm height (497.4 cm) and leaf length (111.6 cm). Accession 01 recorded higher number of leaves (46.7 no's). Accession 21 recorded higher stalk length (157.7 cm). Accession 38 recorded lower values for palm height and Accession 05 for number of leaves and leaf length. Accession 34 recorded lower values for stalk length (105.9 cm). The data recorded from the germplasm planted in 1997 indicated that the accession 67 recorded maximum palm height (513.9 cm) and accession 58 recorded higher number of leaves (45.3 no's). The length of the leaf was found to be the highest in the accession 41 (129.9 cm). The length of the stalk was the highest in the accession 58 (216.7 cm).

Among the germplasm collected during 1999, the accession 74 recorded increased plant height (261.6 cm) and leaf length (114.2 cm). The accession 88 recorded increased number of leaves (41.6). Among the accessions planted during 2001, accession 92 showed maximum palm height (367.2 cm), number of leaves (40.5 no's), leaf length (96.4 cm) and stalk length (163.6 cm). Accession 96 recorded lower values for all the characters. Among the germplasm accessions planted during the year 2003, the maximum palm height (202.3 cm), number of leaves (41.2), leaf length (79.4 cm) and stalk length (916.7 cm) were recorded in accession 153.

The data collected from germplasm planted during the year 2004 showed variations for palm height, number of leaves and stalk length. Among the 2004 planted germplasm accessions, the accession 160 recorded increased palm height (157.8 cm). Accession 164 recorded the lowest plant height (100.4 cm). The stalk length was found

to be the highest (88.7 cm) in the accession 169 and leaf length was the highest (77.6 cm) in the accession 165.

Among the 2005 planted accessions, accession 176 showed the maximum palm height (172.6 cm), accession 174 for number of leaves and leaf length. The stalk length was maximum (103.5 cm) in the accession 180 and the lowest plant height, number of leaves and stalk length was recorded with the accession 179. The data collected from germplasm accessions planted during the year 2006 showed maximum palm height (171.5 cm) with the accession 196. The accession 180 recorded the lowest plant height. Accession 184 recorded more number of leaves and accession 192 recorded increased leaf length (86.3 cm). Among the germplasm collected during 2007, the accession 204 recorded maximum palm height (152.7 cm). The highest stalk length (75.5 cm) was recorded in accession 206.

Among the 2008 planted accessions, the accession 209 recorded maximum values in terms of plant height (07.1 cm), number of leaves (29.6), leaf length (98.4 cm) and stalk length (66.4 cm). Much variation was observed among the accessions planted during 2009. Among the 2009 planted accessions, palm height and number of leaves was the highest with the accession 219 and it was the lowest in the accession 224. However the leaf length was maximum in the accession 219 and stalk length recorded was the maximum (35.6 cm) with accession 225. Among the accessions collected during the year 2010, accession 256 recorded maximum palm height, number of leaves and stalk length. Minimum palm height was recorded in the accession 249. Among the germplasm collected during 2011, the accession 274 recorded maximum palm height (111.3 cm), leaf length (75.5 cm), whereas minimum palm height was recorded in the accession 263 (61.9 cm). The number of leaves (25.3) was the highest in the accession 275.

Among the germplasm collected during 2012, the accession 285 recorded maximum palm height (93.8 cm). Minimum palm height was recorded in the accession 282. The number of leaves was the maximum in the accession 279 and minimum in accession 284. Much variation was observed among

the accessions planted during 2013. Among the accessions planted during 2013, accession 290 showed maximum palm height (58.7 cm), and leaf length (43.8 cm). The maximum stalk length (31.4 cm) was also recorded in the accession 289. Accession 288 recorded lower values for palm height (Table 99).

Palms planted in the year 1995 and 1997 started flowering. Among 1997 planted palms, accession 01 yielded 9 bunch/tree, 210 nuts and 60 fruits. Accession 9 produced 5 bunch/tree, 60 nuts and 20 fruits. Accession 18, 21 and 27 produced male bunch. Among 1995 planted palms, accession 1, 5 and 28 produced male bunches.

Table 99: Abstract of biometrical observations recorded during January 2020

Year of planting	Plant height (cm)		Number of leaves		Leaf length (cm)		Stalk length (cm)	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1995	497.4 (Acc.18)	196.5 (Acc.38)	46.7 (Acc.01)	33.4 (Acc.05)	111.6 (Acc.18)	98.5 (Acc.05)	157.7 (Acc.21)	105.9 (Acc.34)
1997	513.9 (Acc. 67)	236.2 (Acc. 41)	45.3 (Acc. 58)	43.6 (Acc. 46)	129.9 (Acc. 41)	112.4 (Acc. 46)	216.7 (Acc. 58)	145.1 (Acc. 48)
1999	261.6 (Acc. 74)	111.7 (Acc. 80)	41.6 (Acc. 88)	38.6 (Acc. 79)	114.2 (Acc. 73)	65.6 (Acc. 84)	129.4 (Acc. 73)	47.5 (Acc. 86)
2001	367.9 (Acc. 92)	94.2 (Acc. 96)	40.5 (Acc. 92)	32.3 (Acc. 96)	96.4 (Acc. 92)	68.2 (Acc. 96)	163.6 (Acc. 92)	65.4 (Acc. 96)
2003	202.3 (Acc. 153)	99.2 (Acc. 149)	41.2 (Acc. 153)	37.3 (Acc. 149)	79.4 (Acc. 153)	66.3 (Acc. 149)	93.7 (Acc. 153)	55.5 (Acc. 149)
2004	157.8 (Acc. 160)	100.4 (Acc. 164)	33.4 (Acc. 168)	31.2 (Acc. 173)	77.6 (Acc. 165)	65.4 (Acc. 164)	88.7 (Acc. 169)	51.6 (Acc. 164)
2005	172.6 (Acc. 176)	101.7 (Acc. 179)	32.5 (Acc. 174)	29.3 (Acc. 179)	95.8 (Acc. 174)	71.4 (Acc. 179)	103.5 (Acc. 180)	64.4 (Acc. 179)
2006	171.5 (Acc. 196)	80.5 (Acc. 180)	32.3 (Acc. 184)	27.0 (Acc. 196)	84.3 (Acc. 192)	62.6 (Acc. 196)	71.8 (Acc. 186)	52.56 (Acc. 190)
2007	152.7 (Acc. 204)	97.3 (Acc. 208)	32.2 (Acc. 203)	24.5 (Acc. 197)	81.2 (Acc. 207)	65.365.3 (Acc. 198)	75.5 (Acc. 206)	40.5 (Acc. 202)
2008	107.1 (Acc. 209)	100.5 (Acc. 212)	28.6 (Acc. 209)	22.8 (Acc. 216)	98.4 (Acc. 209)	53.5 (Acc. 217)	66.4 (Acc. 209)	41.5 (Acc. 2017)
2009	116.8 (Acc. 219)	72.2 (Acc. 248)	30.8 (Acc. 226)	24.9 (Acc. 224)	68.7 (Acc. 219)	53.3 (Acc. 255)	35.6 (Acc. 225)	31.4 (Acc. 223)
2010	111.8 (Acc. 256)	71.2 (Acc. 249)	27.5 (Acc. 257)	23.6 (Acc. 249)	80.5 (Acc. 254)	52.5 (Acc. 255)	65.5 (Acc. 256)	30.7 (Acc. 258)
2011	111.3 (Acc. 274)	61.9 (Acc. 263)	25.8 (Acc. 275)	21.5 (Acc. 263)	75.5 (Acc. 274)	51.6 (Acc. 264)	48.22 (Acc. 272)	27.4 (Acc. 275)
2012	93.8 (Acc. 285)	68.3 (Acc. 282)	20.6 (Acc. 279)	19.3 (Acc. 284)	58.64 (Acc. 286)	42.9 (Acc. 287)	35.2 (Acc. 285)	33.1 (Acc. 279)
2013	58.7 (Acc. 290)	45.4 (Acc. 288)	21.6 (Acc. 291)	16.3 (Acc. 295)	43.8 (Acc. 290)	33.6 (Acc. 289)	31.4 (Acc. 289)	27.5 (Acc. 293)

Abstract of germplasm so far assembled

Block	Year of collection	Number of collections maintained
Block I (E)	1995	35
Block II (NA)	1997	26
Block III (NA)	1999	23
Block IV (EO)	2001	40

Block IVa (EO)	2001	8
Block V (EO)	2002	13
Block Va (EO)	2002	8
Block VI (EO)	2003	2
Block VII (EO)	2004	12
Block VIII (NA)	2005	9
Block VIII (NA)	2006	14
Block IX (NA)	2007	10
Block IX (NA)	2008	9
Acc. transferred from Pandirimamidi	2009	22
Block X 1(NA)	2009	9
Block X11 (NA)	2010	13
Block X111 (NA)	2011	15
Block X1V (NA)	2012	9
Block X V(NA)	2013	7
Block XVI (NA)	2014	6
Block XVII (NA)	2015	5
Total		265



Germplasm collection of Palmyrah at Killikulam

Pandirimamidi

Survey and collection of palmyrah germplasms were done to identify dwarf and superior palmyrah genotype 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.

Among 1991 planted germplasm accessions the highest number of bunches (7) was recorded with palm no. 1, Acc. no. 9/91 with 61 numbers of fruits

followed by palm no. 1, Acc. no. 12/91 with 50 numbers of fruits and low height of 8 m. Among the 10 accessions of 1993 planted germplasm, palm no. 7 of Acc. no. 13/93 has recorded maximum number of fruits (68) followed by palm no. 3 of Acc. no. 1/93 with 62 numbers of fruits and a height of 7 m. Among the 5 accessions of 1994 planted germplasm, palm no. 13 of Acc. no. 3/94 has recorded maximum number of fruits (66) followed by palm no. 4 of Acc. no. 2/93 with 65 numbers of fruits.

Among the accessions of 1998 planted germplasm, palm no. 7 of Acc. no. 1/98 has recorded maximum number of fruits (66). Among the accessions of 2002 planted germplasm, palm no. 9 of Acc. no. 2/02 has recorded maximum number of fruits (105). In the germplasm collected during 2003, the minimum plant height (5 m) was recorded in palm no. 5 of Acc. no. 6/03 with 13 number of bunches. In the germplasm collected during 2004, the minimum plant height (6 m) was recorded in palm no.1 of Acc. no. 8/04 with 11 number of bunches and 416 fruits during the year 2019. Palmyrah germplasm planted during 2007 started flowering during the year 2019.



Germplasm collection of Palmyrah at Pandirimamidi

Palmy./Gen. 10: Survey, *in situ* characterization and conservation of palmyrah germplasm for special traits
Centres: Konda Mallepally and Sabour

Konda Mallepally

Nalgonda district of Telangana state is very popular for palmyrah palm. The tree has huge population and being used for longer period by the tappers community of the region. To conserve these diverse germplasm in the region, a survey was undertaken for collection of palmyrah germplasm from Nalgonda district with the broad objective of collecting diverse germplasm and with specific focus on dwarf types. A total of 10 accessions were collected in the survey from Ratnavaram village of Nadigudem mandal. The data on unique traits of each accession as reported by the farmers were documented.

Ten palmyrah palm accessions were collected from Ratnavaram village and all these accessions were planted by the farmers in their fields. All the germplasm accessions were male. Among ten germplasm accessions, five showed dwarf phenotypes (HRSTSK-21, HRSTSK-23, HRSTSK-26, HRSTSK-28, HRSTSK-30) and five showed tall phenotypes (HRSTSK-22, HRSTSK-24, HRSTSK-25, HRSTSK-27, HRSTSK-29). Among the accessions, Acc. no. HRSTSK-23 recorded the highest neera yield (12.0 l/ palm) followed by Acc. no. HRSTSK-26 and

HRSTSK-29 (10.0 l/palm, each). The highest palm height was recorded in Acc. no. HRSTSK-29 (11.4 m) and the lowest palm height was recorded in Acc. no. HRSTSK-23 (3.8 m). The highest collar girth was recorded in Acc. no. HRSTSK-22 and HRSTSK-24 (1.5 m, each) and the lowest collar girth was recorded in Acc. no. HRSTSK-30 (1.0 m).

Sabour

Bhagalpur district in Bihar is one of the major palmyrah growing areas. It is observed that this crop is used as a source of livelihood for majority of tappers. However many of them has left tapping due to severe injury to their body parts and height of the tree. The crop has a vast potential so far, as the yield of the sap and other produce are concerned. This vast potential gives a feedback for the entrepreneurial development in this sector. In palmyrah palm the diversity is enormous and to know this a survey was undertaken. The palmyrah germplasm was collected from Bhagalpur district with a specific focus on dwarf type. A total of 18 germplasm were taken into consideration in which almost all were found to yield good quantity of neera; however none of them could be called dwarf type. Since the collection of dwarf type was the main objective of survey and collection of the elite germplasm of palmyrah in the first phase survey was undertaken in villages of Sabour and Nathnagar blocks of Bhagalpur district. The data on sap yield and phenotypic characteristics of the germplasm were recorded for reference.

7.2. CROP PRODUCTION

Palmy./Agron. 23: Standardization of rooting media and containers for palmyrah seedling production

Centres: Killikulam, Konda Mallepally, Pandirimamidi and Sabour

Killikulam

Objectives:

- To standardize the rooting media for multiplication of palmyrah seedling through seed.
- To standardize container for multiplication and field planting.

Treatment details:
Rooting media:

T₁: Soil (control) + Imdia 6 g/kg + GA₃ 1000 mg/l

T₂: Soil + scarification against sand + Imdia 6 g/kg + GA₃ 1000 mg/l

T₃: Soil, sand and FYM mixed in 2:1:1 ratio + Imdia 6 g/kg + GA₃ 1000 mg/l

T₄: Soil, sand and vermicompost mixed in 2:1:1 ratio + Imdia 6 g/kg + GA₃ 1000 mg/l

T₅: Soil, sand and poultry manure mixed in 2:1:1 ratio + Imdia 6 g/kg + GA₃ 1000 mg/l

T₆: Soil, sand and composted coir pith mixed in 2:1:1 ratio + Imdia 6 g/kg + GA₃ 1000 mg/l

Container:

T₁: Black polythene bag (12.5 x 50 cm)

T₂: Bamboo tube (12.5 x 40 cm)

T₃: PVC tube (12.5 x 50 cm)

T₄: Banana pseudo stem sheath (12.5 x 50 cm)

Replication: 4; Design: Completely Randomized Block Design

Observations to be taken:

- Days taken for sprouting (days)
- Percentage of germination (%)
- Number of leaves/seedling on 219 DAS
- Seedling height (cm) on 210 DAS

The trial was initiated during the month of October, 2019. The existing media viz., soil, sand, farm yard manure, vermicompost and composted coir pith were selected and the four types of containers were used for sowing. The sowing was done by placing uniform seed weight of palmyrah seed as well as by dipping in Imdia 6 g/kg + GA₃ 1000 mg/l as per the treatment requirement.



Germination and seedling growth of palmyrah

Pandirimamidi

Treatments imposed and data has to be recorded in February and March, 2020.

7.3. POST HARVEST TECHNOLOGY
Palmy./PHT. 1: Standardization and commercialization of inflorescence sap (neera) extraction and inflorescence sap based products (jaggery, palm sugar and candy)

Centres: Killikulam, Konda Mallepally, Pandirimamidi and Sabour

Konda Mallepally

In the study for standardization and commercialization of neera extraction method, neera was collected in earthen pots coated with lime. The pH of neera collected in pots was found to be 7.2 to 7.8 with TSS of 10 -12°B. CPCRI box will be procured in the next season for further studies.

Pandirimamidi

Fresh Neera collected through CPCRI method was further processed by pasteurization followed by PET bottle sterilization gave maximum shelf life of 30 days for neera under refrigerated conditions. Palmyrah Syrup/honey of 65° Brix made from sap collected through cooling box method stored in glass bottle recorded shelf life up to 6 months under ambient condition; it can be extended more than one year under refrigerated conditions.

Sabour


Preserved neera The observations were recorded at two hourly interval on shelf life, sensory evaluation and quality of raw neera collected in lime coated earthen-pot (traditional method) revealed that neera samples had a palatability up to 2 hrs, when kept at ambient temperature and at cool temperature (8±2°C), it was found to be palatable up to 8 hrs. However even the fresh sample of neera was found contaminated as they contained considerable amount of TPC along with the coliform and yeast and mould population.

Process parameters: Neera was processed at 120°C sterilization for 15 min., pasteurized at 85°C for 7 min., treated with KMS 0.01% alone and in combination with CA @ 0.1% and was compared with control. Result shows that the bottled neera without any treatment, deteriorated the next day of storage, whereas neera sterilized at 120°C for 15 minutes, had a better shelf life, but lost its flavor and attractive colour. Neera pasteurized in other treatments had slightly better shelf life at ambient and cold storage condition as compared to control.

Syrup/honey was prepared with 60°B, 65°B and 70°B. The result showed that the honey prepared from neera at different brix level had a good palatability at preparation and at room temperature storage. It was also found to maintain its quality up to six months of storage. The microbial analysis was also found to be satisfactory at preparation and after six months of storage.

Palmy./PHT. 2: Standardization of tuber flour based food products (like pizza, bakery items, confectionery, health mix etc.)

Pandirimamidi

Technology developed for dehydration of tuber and flour and same is being evaluated for commercialization. The technologies *i.e.* 'Dehydrated tuber' and 'Production of tuber flour' are about to be released for commercialization.



Palmyrah tuber flour

Palmy./PHT. 4: Standardization of preservation technique for palmyrah tender fruit endosperm (Nungu)

Pandirimamidi

A simple hand operated machine developed earlier was tested for nungu extraction. The machine is useful for all sizes of tender fruits and the fruit should be placed manually in the machine. Exertion of pressure from top by handle breaks the fruit in to three parts. The machine contains three blades with an angle of 120 degrees between two blades and having sharp edge to cut the hard tender fruit, without damaging endosperm, but it cuts the endosperm into two pieces and leads to loss of water in the endosperm. With this machine one person can perform the endosperm extraction activity with less stress compared to the traditional method and is useful for value added products.

Palmy./PHT. 5: Popularization of climbing device

Centres: Killikulam, Konda Mallepally, Pandirimamidi and Sabour

Konda Mallepally

The climbing devices (Joseph model) were procured to give training to the youths.

Pandirimamidi

Training on Joseph model climbing devices was conducted during May, 2019 and a total of 10 skilled and 10 unskilled laborers were participated. From their feedback, it was evident that the skilled labourers didn't prefer climbing device, young people and unskilled persons preferred to use climbing device. They suggested some modification of the climber to fit the device to girth of the palm.

Sabour

The Joseph model of climber was used for climbing palmyrah tree during a farmer's meeting organized in collaboration with KVK Sabour with about 25 local farmers. It was found that the farmers failed to climb the tree with the Joseph model climber. They mentioned that it was easier for them to climb palmyrah palm by traditional method. The difficulty in climbing was due to the girth of the tree at the base which was more up to 7-8 feet height from the ground, most of the trees were found highly tapering as compared to the even surface upwards, and it was the main hindrance in climbing.



VIII. EXPERIMENTAL RESULTS 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

Centres: Ambajipeta, Kasaragod, Navsari and Veppankulam

Experiment details:

Cocoa variety/hybrid: 6; VTLC-1, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3 and VTLCH-4 (Ambajipeta and Veppankulam centres).

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

Spacing: coconut: 7.5 m x 7.5 m; cocoa: 3.0 m x 7.5 m

Ambajipeta

Year of start: 2008-09

Experimental area: 0.80 ha

Six cocoa clones were planted in November, 2008 and gap filling was done during December, 2012 for evaluating their performance. There was no significant difference among the data pertaining to growth characteristics like girth, height at first branching and canopy spread for the year 2019-20. With respect to yield characters during 2018-19, VTLCH-2 recorded significantly higher dry beans yield (2.0 kg/tree/year) and number of beans per pod (38.4) followed by VTLCH-4 (38.3). VTLCC-1 recorded less number of beans per pod (33.1) and VTLC-1 recorded less dry bean yield (1.5 kg/tree/year) (Table 100).

Table 100: Performance of cocoa clones for growth and yield characteristics

Treatments	Plant height (cm)	Stem girth (cm)	Height at 1 st branching (cm)	Canopy spread (cm)		Pod weight (g)	No. of beans per pod	Dry bean yield/tree/year (kg)
				E-W	N-S			
VTLC-1	316.8	31.2	65.5	390.9	363.2	419.9	33.1	1.6
VTLCH-1	291.8	34.3	75.2	429.0	405.5	340.6	33.8	1.6
VTLCH-2	324.7	33.0	72.0	454.2	419.6	422.1	38.4	2.0
VTLCH-3	286.1	32.4	71.8	478.1	429.8	408.9	36.4	1.7
VTLCH-4	328.8	31.5	62.7	401.9	395.6	432.3	38.3	1.8
VTLC-1	313.2	30.9	65.0	407.7	396.7	437.2	33.8	1.5
S.Em±	16.5	1.44	8.89	19.98	20.59	36.74	2.22	0.05
CD (P=0.05) 5%	NS	NS	NS	NS	NS	NS	NS	0.14

Kasaragod

Cocoa variety/hybrid: 13; VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4, VTLCC-1, VTLC-61, VTLC-66, VTLC-11, VTLC-5, VTLC-19A, VTLC-30A, VTLC-1A and MH-1.

Design: RBD; Replications: 2; No. of plants per treatment: 6

Spacing: coconut: 7.5 m x 7.5 m; cocoa: 3 m x 7.5 m. Year of start: 2007-08.

The performance of thirteen clones was evaluated in the 52 year old coconut WCT coconut garden in RBD with two replications. Clones were planted during 2008. The yield data was analysed

and there was significant difference was observed. The highest dry bean yield was recorded in VTLCH 3 among plants raised from grafts.

Navsari

Year of start: 2009-10

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

The observations on growth as well as pod characteristics were recorded and presented in Table 101. Significantly the highest plant height (4.0 m) and stem girth (44.1 cm) was recorded in VTLCC-1 and it was at par with all the clones except VTLCH-3. Minimum height at first branching (25.5

cm) and maximum number of branches per plant (13.7) were recorded in VTLCH-4. Significantly maximum number of pods/tree/year (44.0), weight of pod (162.5 g), weight of single dry beans (1.3 g), number of beans/pod (26.6) and dry beans yield

per tree per year (1.7 kg) were recorded in VTLCH-4 and it was on par with VTLCH-2. Yield of coconut (WCT) was increased from 60 nuts/palm (2008-09) to 84 nuts/palm during the year 2018-19 *i. e.* 38 per cent increase over pre-treatment yield.

Table 101: Yield characteristics of different clones of cocoa as intercrop in coconut garden

Clones	No. of pods /tree/year	Weight of pod (g)	Weight of single drybean (g)	No. of beans/ pod	Drybeanyield/ tree/ year (kg)
VTLCC-1	34.5	131.2	1.1	22.9	1.3
VTLCH-1	30.4	140.1	1.1	24.7	1.3
VTLCH-2	38.9	156.7	1.2	26.3	1.4
VTLCH-3	31.6	154.4	1.2	19.4	1.4
VTLCH-4	44.0	162.5	1.3	26.6	1.7
S. Em ±	1.28	1.78	0.04	0.68	0.08
CD (P=0.05)	3.93	5.49	0.12	2.10	0.23



Yield of cocoa varieties/hybrids as intercrop in coconut gardens

Veppankulam

Year of start: 2008-09

Six cocoa varieties/hybrids planted as intercrop in coconut gardens are being evaluated. The trial was laid out in RBD with four replications. Among the cocoa clones and hybrids evaluated, the VTLCH-1 has performed well in terms of plant height (3.12 m), stem girth (34.5 cm) and canopy spread (E-W: 2.2 m; N-S: 2.7 m). yield attributes *viz.*, pod weight (145.6 g/pod), number of beans (29.0/pod) and dry beans yield (2.3 kg/tree) followed by VTLCH-2 and VTLCC-1. Due to 'Gaja' cyclone on 16.11.2018, most of the plants were damaged hence yield observations were not recorded. Plants are under rejuvenation stage.

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

Centres: Aliyarnagar, Kahikuchi, Ratnagiri and Vijayarai

Aliyarnagar

Cocoa clones: 14; VTLCP-1, VTLCP-3, VTLCP-5, VTLCP-6, VTLCP-8, VTLCP-9, VTLCP-10, VTLCP-11, VTLCP-12, VTLCP-13, VTLCP-14, VTLCP-15, VTLCP-16 and VTLCP-9 (control).

Design: RBD; Replications: 2; No. of plants/ treatment: 6; Spacing: coconut: 7.5 m x 7.5 m; cocoa: 3.75 m x 7.5 m; Year of start: 2013-14

Based on the observations recorded, there is a significant difference for plant height, stem girth, height at first branch, number of pods per tree, number of beans per pod, dry bean weight per plant and single dry bean weight. Among the genotypes VTLCP-16 recorded higher number of pods per tree (41.7), number of beans per pod (54.5), individual dry pod weight (386.3 g) and dry bean weight per plant (971.0 g) (Table 102).

Table 102: Growth and yield attributes of cocoa clones under palms

Clones	Plant height (cm)	Stem girth(cm)	Height at first branch (cm)	No of pods /tree	No. of beans/pod	Dry bean weight/ plant (g)	Single dry bean weight (g)
VTLCP-1	245.2	32.2	62.7	26.1	52.5	944.0	0.9
VTLCP-3	206.7	29.5	48.2	28.0	53.5	955.0	0.9
VTLCP-5	242.9	28.5	69.8	28.0	50.3	922.0	0.9
VTLCP-6	259.2	33.5	50.5	33.5	52.0	954.4	0.8
VTLCP-8	219.9	33.1	69.0	28.5	45.0	940.0	0.9
VTLCP-9	210.7	32.0	53.5	31.5	46.0	919.0	1.0
VTLCP-10	253.5	41.5	55.9	36.5	54.3	943.0	0.8
VTLCP-11	241.8	36.5	70.3	38.5	53.5	958.0	1.0
VTLCP-12	223.0	31.3	62.9	26.8	46.0	920.5	1.0
VTLCP-13	224.9	32.4	48.0	31.0	51.0	945.0	0.8
VTLCP-14	241.8	35.5	66.6	32.0	44.5	948.5	0.9
VTLCP-15	267.4	32.6	65.3	29.0	45.3	921.8	1.0
VTLCP-16	265.2	34.0	62.3	41.7	54.5	971.0	1.0
VTLC-9 (control)	268.1	35.2	57.3	32.0	48.5	954.8	0.7
S.Ed±	2.0	1.3	1.9	1.5	1.8	3.0	0.03
CD (P=0.05)	4.4	2.8	4.0	3.3	3.9	6.4	0.06

Kahikuchi

Cocoa clones: 16; VTLC-13, VTLC-15, VTLC-17, VTLC-18, VTLC-20, VTLC-23, VTLC-25, VTLC-28, VTLC-36, VTLC-38, VTLC-39, VTLC-40, VTLC-128, VTLA-4A, EYT, and VTLCH-1(hybrid).

Year of start: 2015-16

The cocoa clones and hybrid were collected from ICAR-CPCRI, Regional Station, Vittal and planted on 02.10.2015 in RBD with 2 replications in coconut

garden. The observations on plant height, girth, number of branches/ plant and canopy spread were recorded. The highest plant height (223.5 cm), stem girth (31.5 cm), number of branches per plant (4.5), canopy spread (E-W and N-S) and area (5.0 m²) were recorded in VTLC-20 followed by VTLC-18 and the lowest values for the above characters were observed in EYT. Cocoa clone VTLC-20 also registered maximum number of pod/tree (38.0), bean/pod (42.0) and dry bean yield/tree/year (2.2 kg) (Table 103).

Table 103: Growth and yield attributes of cocoa clones under palms

Clones	Plant height (cm)	Stem girth(cm)	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-13	190.0	27.0	31.5	397.0	1.1	34.6	1.2
VTLC-15	212.0	28.4	29.6	391.4	1.1	32.9	1.1
VTLC-17	216.0	29.0	30.0	407.5	1.2	37.0	1.3
VTLC-18	220.7	29.7	32.6	462.0	1.2	38.1	1.5
VTLC-20	223.5	31.5	38.0	482.0	1.4	42.0	2.2
VTLC-23	201.0	26.5	29.2	376.0	1.2	31.0	1.0
VTLC-25	203.6	25.8	27.0	366.5	1.1	29.0	0.9
VTLC-28	173.2	25.0	24.5	350.0	1.1	34.0	0.9
VTLC-36	170.8	23.1	29.0	370.4	1.0	36.4	1.0
VTLC-38	184.0	24.7	26.8	330.0	1.0	32.4	0.9

VTLC-39	194.4	24.0	29.0	315.0	1.0	35.0	1.0
VTLC-40	191.6	27.5	33.4	387.0	1.0	31.0	1.0
VTLC-128	171.8	22.5	34.0	412.0	1.0	28.6	1.0
VTLC-4A	173.6	23.0	28.5	397.0	1.1	29.1	0.9
VTLCH-1	183.2	24.8	30.0	387.6	1.1	32.0	1.0
EYT	163.0	21.7	22.0	310.6	1.0	27.0	0.6
CD (P=0.05)	9.08	1.93	2.14	21.3	0.11	1.26	0.31



MLT of Cocoa clones at Kahikuchi

Ratnagiri

Cocoa clones: 21; VTLC-1, VTLC-3, VTLC-5, VTLC-6, VTLC-8, VTLC-9, VTLC-10, VTLC-11, VTLC-12, VTLC-13, VTLC-14, VTLC-15, VTLC-16, VTLC-17, VTLC-18, VTLC-25, VTLC-37 and VTLC-128.

Year of start: 2013-14

The cocoa clones supplied by ICAR-CPCRI, Regional Station, Vittal were planted during

Cocoa clones/ hybrids: 14; VLTC-1, VLTC-9, VLTC-13, VLTC-17, VLTC-18, VLTC-20, VLTC-25, VLTC-36, VLTC-37, VLTC-57, VLTC-65, VLTC-128, VTLCH-3 and VTLCH-4.

Year of start: 2012-13

November, 2012 and February, 2014. The gap filling was done during September, 2016. The growth characters were not significantly different. The highest number of pods per tree

(17.2) and single dry bean weight per plant (2.0 g) were in VTLC – 17, maximum number of beans per pod (60.4) was in VTLC – 128 and the highest dry bean yield per tree (1.4 kg) was in VTLC – 25.

Vijayarai



Multi-location trial of cocoa clones under palms at Ratnagiri

Among the 12 varieties and 2 hybrids evaluated, there were no significant differences for all growth and yield characters (Table 104) except average bean weight (g). Average bean weight was significantly the highest in VTLC-17 (1.2 g) followed by VTLC-18 and VTLC-1 (1.1 g each).

Table 104: Growth and yield parameters of clonal varieties and hybrids of cocoa intercropped in oil palm

Variety/ hybrid	Plant height (m)	Stem girth (cm)	Canopy area (m ²)	No. of branches/ plant	No. of pods/ plant	Average pod weight (g)	Pod yield (kg/ plant)	No. of beans/ pod	Average bean weight (g)
VTLC-1	2.8	34.4	13.6	3.1	34.4	453.7	15.9	34.3	1.1
VTLC-9	3.0	32.7	12.3	3.3	36.1	454.8	16.7	41.4	1.0
VTLC-13	2.7	32.1	8.9	2.5	23.0	357.0	8.5	29.5	1.0
VTLC-17	2.7	30.4	10.3	2.1	31.3	364.0	11.1	38.9	1.2
VTLC-18	2.6	33.6	11.4	2.3	27.7	414.7	11.1	39.9	1.1
VTLC-20	2.9	32.1	11.5	2.7	23.2	408.0	9.5	35.6	1.0
VTLC-25	2.6	30.8	9.0	2.0	32.7	386.5	12.5	36.2	1.1
VTLC-36	2.8	33.6	12.4	2.8	32.8	477.6	15.4	36.7	1.1
VTLC-37	3.0	38.7	16.2	2.9	20.4	419.0	9.7	29.1	1.0
VTLC-57	2.5	32.0	13.0	2.8	23.2	438.8	10.3	37.1	1.0
VTLC-65	2.8	33.4	12.9	3.0	32.9	500.4	16.7	42.1	1.0
VTLC-128	2.8	34.7	13.5	2.7	34.9	475.3	16.7	39.7	1.0
VTLCH-3	3.1	35.5	16.5	2.8	25.7	410.6	10.7	40.8	1.1
VTLCH-4	2.6	31.8	11.3	2.4	27.0	412.8	11.3	40.9	1.1
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.03
CV (%)	17.65	13.14	26.32	22.33	19.47	17.58	21.58	10.44	1.36

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

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.

Budding details of varieties (April - November 2019)

Sl. No.	Variety	No. of plants budded	Bud take
1.	CCRP 1	400	275
2.	CCRP 2	200	169
3.	CCRP 3	200	146
4.	CCRP 4	100	52
5.	CCRP 5	100	39
6.	CCRP 6	480	336
7.	CCRP 7	150	100
8.	CCRP 8	400	191
9.	CCRP 10	50	40
10.	CCRP 11	200	114
11.	CCRP 13	200	114
12.	CCRP 14	120	109



Poly clonal seed garden of cocoa at 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.

Cocoa clonal gardens of KAU

	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	16	383	2018
Total	121	5283	

List of plants of newly planted polyclonal garden

VSD Genotype	PPR Genotype	High fat content Genotype
VSDI 5.11 (GVI 4 x GVI 55)	6.5 (SIV 1.26 x PII 12.11)	11.6 (SIV 1.26 x PII 12.11)
VSDI 10.10 (GVI 126 x GVI 18.5)	22.4 (GVI 188 x GVI 287)	12.6 (SIV 1.26 x PII 12.11)
VSDI 11.10 (GVI 126 x GVI 18.5)	27.4 (GVI 188 x GVI 304)	13.5 (SIV 1.26 x PII 12.11)
VSDI 11.23 (GVI 126 x GVI 18.5)	29.7 (SIV 5.20 x TISSA)	13.7 (SIV 1.26 x PII 12.11)
VSDI 14.6 (GVI 126 x GVI 55)	33.4 (GVI 216 x GVI 294)	14.6 (SIV 1.26 x PII 12.11)
VSDI 15.7 (GVI 137 x GVI 55)	34.4 (GVI 216 x GVI 294)	15.7 (SIV 1.26 x PII 12.11)
VSDI 16.10 (GVI 140 x GVI 55)	35.4 (GVI 216 x GVI 304)	16.4 (SIV 1.26 x PII 12.11)
VSDI 16.11 (GVI 140 x GVI 55)	35.5 (GVI 216 x GVI 304)	16.5 (SIV 1.26 x PII 12.11)
VSDI 21.27 (GVI 148 x GVI 55)	36.6 (GVI 216 x GVI 304)	16.7 (SIV 1.26 x PII 12.11)
VSDI 29.8 (GVI 188 x GVI 55)	38.4 (GVI 216 x GVI 304)	16.8 (SIV 1.26 x PII 12.11)
VSDI 31.9 (GVI 189 x GVI 55)	39.5 (GVI 216 x GVI 304)	28.6 (SIV 5.20 x TISSA)
	TOTAL 383	

These 33 clones are better combiners specially arranged for the mass production of genetically improved seeds and are laid out in isolation to prevent pollination from any inferior male parent nearby.

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, September - October, December and February)). Crop protection measures were taken up to maintain the garden free from pest and diseases on need basis.

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

These clonal gardens have a capacity to produce on an average of one lakh seed pods. The seedlings were supplied to different states through Mondelez International. An average of 35 lakh seedlings was produced in each year. Hence statistics shows that 90 percent of Indian cocoa farms are established with KAU seedlings.

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 and VTLC-68 obtained from ICAR-CPCRI, RS, Vittal were planted in RBD with three replication in 27 years old oil palm garden in August, 2017. The vegetative growth parameters like plant height, girth, east-west and north-south and canopy area did not differ significantly for at third year of planting under oil palm (Table 105).

Table 105: Growth parameters of cocoa clones planted under oil palm

Clones	Plant height(cm)	Stem girth(cm)	Canopy spread (cm)		Canopy area (m ²)
			East-West	North-South	
VTLC-5	115.4	11.3	106.6	103.9	2.1
VTLC-7	127.3	13.4	131.6	120.6	2.8
VTLC-8	117.5	12.6	122.2	124.3	2.6
VTLC-9	125.5	13.7	126.6	131.1	2.9
VTLC-10	118.6	12.5	159.2	115.4	3.0
VTLC-11	119.2	12.4	110.5	100.4	2.2
VTLC-15	128.7	13.8	129.3	132.4	3.0
VTLC-19A	118.3	13.0	112.3	117.3	2.4
VTLC-30A	118.9	12.7	118.3	120.7	2.5
VTLC-61	122.9	12.0	121.4	113.1	2.5
VTLC-63	124.5	13.1	135.5	128.2	3.0
VTLC-65	133.5	14.0	128.8	122.5	2.9
VTLC-66	132.3	13.3	123.2	123.7	2.8
VTLC-68	128.9	13.7	107.4	121.2	2.5
CV (%)	7.18	6.50	19.48	10.25	20.35
CD (P=0.05)	NS	NS	NS	NS	NS



Field view of cocoa polyclonal garden at Vijayarai



IX. MONITORING VISITS AND MEETINGS

Monitoring Visits

The project coordinator has made review visits to monitor the technical programmes of all the centres as per the need. 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 visit to centres, discussions were held with Vice Chancellor, Director of Research and Head of the Division of the SAU's of the concerned centre as well as with the scientists of ICAR-AICRP on Palms for the smooth functioning of the research programmes. During review meeting, front line demonstration plots in the farmer's field were visited and further after each visit, suggestions were given for improving the technical programmes.

Monitoring visits to centres :

Centre	Mandate crop	Visit period
Aliyarnagar (Tamil Nadu)	Coconut and Cocoa	06.05.2019 - 07.05.2019
Pilicode (Kerala)	Coconut	24.06.2019
Pattukkottai (Tamil Nadu)	Oil palm	02.07.2019
Veppankulam (Tamil Nadu)	Coconut	03.07.2019
Shivamogga (Karnataka)	Arecanut	03.10.2019
Bavikere (Karnataka)	Oil palm	
Arsikere (Karnataka)	Coconut	22.10.2019 - 24.10.2019
Ratnagiri (Maharashtra)	Coconut and Cocoa	24.11.2019 - 27.11.2019
Wakawali (Maharashtra)	Arecanut	
Thrissur (Kerala)	Cocoa	04-12-2019
Bhubaneshwar (Odisha)	Coconut	12/12/2019



Shivamogga



Bavikere



Arasikere



Ratnagiri



Wakawali



Aliyarnagar



Pattukkottai



Veppankulam



Thrissur

Meetings

28th Annual Group meeting of AICRP on Palms

The 28th Annual Group Meeting of All India Co-ordinated Research Project on Palms was organized at Tamil Nadu Agricultural University, Coimbatore during 6th & 7th, June 2019. The inaugural function was presided by Dr. N. Kumar, VC, TNAU and Dr. W. S. Dhillon, Assistant Director General (Horticultural Sciences), ICAR, New Delhi was the Chief Guest. Dr. P. Rethinam, Former Executive Director, Asian and Pacific Coconut Community, Jakarta, Dr. K. Muralidharan, Director (i/c), ICAR-CPCRI, Kasaragod and Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi were the guests of honour.

The programme had a pleasant beginning with invocation and ICAR theme song highlighting the glory of farmers. Dr. K. S. Subramanian, Director of Research, Tamil Nadu Agricultural University, Coimbatore welcomed the gathering in which he narrated the research accomplishment of Tamil Nadu Agricultural University in taking palm research to the next level. The Project Co-ordinator of AICRP (Palms), Dr. H. P. Maheswarappa in his report briefed the mission and achievement of AICRP on five crops - coconut, oil palm, palmyrah, arecanut and cocoa distributed across 30 centres of 14 states and one union territory covering 13 State Agricultural Universities, four ICAR Institutes and two central universities.

Dr. W. S. Dhillon, Assistant Director General (HS -I), gave a bird's eye view of the overall growth of horticultural sector and its significant contribution to GDP and nutritional security of the nation. Dr. N. Kumar, Vice Chancellor, TNAU, in his Presidential address underlined the need for the development of composite mother gardens for the production of quality seedlings and called on palm scientists to

develop drought mitigation strategies considering the weather extremities. Horticultural Research Station, Vijayarai was adjudged as the best AICRP (Palms) centre for the year 2018-19. Handful of publications which include three books on coconut and oil palm, two technical bulletins and seven folders and pamphlets were released by the dignitaries. Dr. L. Pugalendhi, Dean (Hort.), TNAU, Coimbatore proposed the vote of thanks.

Following technologies have been recommended for release during the meeting

- IND 010 S derived from the ICAR CPCRI accession IND 010 Federated Malay States has been recommended for release in Kerala and Tamil Nadu in the name Kalpa Ratna.
- Proposals for release of oil palm hybrids viz., NRCOP 4, NRCOP 17 and NRCOP 2 were recommended for release in the states of Maharashtra, TN and AP.
- Under Coconut based high density cropping system with compatible crops, application of 50% of RDF (NPK) + 50% N through organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring recorded higher system productivity followed by 75% of recommended NPK + 25% through organic recycling with vermicompost or fully organic is recommended in Aliyamagar, Ambajipeta, Arsikere, Bhubaneswar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour and Veppankulam centres.
- **Management of rhinoceros beetle:** CPCRI Botanical cake + paste @ 15g each/palm can be recommended against rhinoceros beetle in juvenile palms as it was found effective in reducing spindle damage and leaf damage in coconut.



Release of Publications during 28th AGM of ICAR-AICRP on Palms



Project coordinator's address during 28th AGM



X. EXTENSION, POPULARIZATION OF TECHNOLOGIES

Coconut

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 5 trainings were organized benefitting 490 farmers.



Farmer's training on IPM in coconut

Training programme organized for extension personnel

Date	Topic of training	Number of extension personnel trained
09.08.2019	Coconut production techniques and rugose spiraling whitefly management	50
26.11.2019	Lecture delivered to trainees of Agriclinic and agribusiness centre scheme, MANAGE, Hyderabad	33

Research - Extension - Farmer interface programme

18 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 850 farmers.

Exhibitions

Conducted 4 exhibitions at TNAU, Coimbatore, PA engineering college, Pollachi, Coconut State agriculture department. A total of 3100 participants were benefitted during the exhibition.



Awareness programme on RSW

Diagnostic field visit and farmers queries

Date	Location of field	Problem noticed in coconut palms
09.04.2019	Senjerimalai & Anamalai	Diagnostic field visit with CPCRI scientists for RSW
10.04.2019	Anamalai, Mangalakadu, Samathoor	Diagnostic field visit with CPCRI scientists for RSW
17.07.2019	Gomangalampudur	Basal stem rot
09.09.2019	Kinathukadavu, Coimbatore district	Rugose spiraling whitefly
21.10.2019	Mathukarai Coimbatore district	Rugose spiraling whitefly
24.10.2019	Thathur and Amrampalayam, pollachi	coconut leaf blight and Root wilt
05.12.2019	Pethappampatti, Gudimangalam Pulavadi Pollachi	Stem bleeding and Basal stem rot
12.12.2019	Mukkonam, Udumalaipettai	Basal stem rot
19.12.2019	Udayakulam, Pollachi	coconut leaf blight

Radio / TV programme/ press media

Three radio talks were broadcasted on Nursery production techniques on coconut in All India radio

station, Coimbatore. A total of 6 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

Field problems solved / Farmers queries answered

Field problems and farmers queries pertinent to crop improvement, crop production and crop

protection of coconut and groundnut were solved in the regions of Coimbatore, Tirupur, Thanjavur, Erode, Salem, Dindigul and Theni districts of Tamil Nadu.

Sl.No	Field problems solved/ farmers queries answered	Beneficiaries
Crop Improvement		
1.	Varietal selection of coconut and groundnut varied resource conditions	200
2.	Varietal selection in cocoa	10
Crop Production		
1.	Pencil Point disorder in coconut	25
2.	Nutrient management in coconut	75
3.	Button shedding in coconut	50
4.	Vermicompost technology	40
Crop Protection		
1.	Pests of coconut (Black headed caterpillar, Rhinoceros beetle, Red palm weevil, coconut scales, spiraling white flies in coconut)	4000
2.	Diseases of coconut (Thanjavur wilt, Kerala wilt, Bud rot, Stem bleeding, Leaf blight and Root wilt)	600

Ambajipeta

Training programmes / District level seminar

- **Scientist from 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 where, lectures on Seasonal crop condition of coastal zone – I and Management of Rugose Spiraling white fly in plantation crops respectively were delivered.**
- Participated in District level seminar on “Scientific coconut cultivation technologies and

value addition” organized by CDB, Vijayawada at Nidadavolu and delivered lectures on water management and soil conservation methods and pest & disease management in coconut on 20.12.19.



Participated in District level seminar on scientific coconut cultivation technologies and value addition

Exhibition/ Kisan mela

- An exhibition cum Rythu Sadassu was organized by the RHWEP students (final year B.Sc (Hort.) of COH, VR Gudem allotted to HRS, Ambajipeta as part of RHWEP programme at konaseema kalyanamandapam, Ravulapalem on 31.10.19.
- Centre Scientists have participated in Kisan mela at APRRI & RARS, Maruteru, and A.N.G.R.A.U. and arranged an exhibition stall displaying live samples of coconut varieties, crop production and protection technologies on 15.11.19.



Exhibition stalls at Kisan mela

Technology Demonstration

Field demonstrations were conducted for effective transfer of developed technologies on various aspects of coconut. Demonstrated entomopathogenic fungus (*Isaria fumosorosea*) spray against Rugose spiralling whitefly on coconut,

Arsikere

Training programmes

Sl. No	Training topic	Date	Number of participants
1	BHC and BSR management in coconut	28-06-2018	55
2	World Environment day	05-06-2018	61
3	World coconut day	02-09-2018	514
4	Disease and insect management in coconut	03-11-2018	25
5	Pest and disease management in coconut	27-11-2018	60
6	Soil Health management in Horticulture crops	08-03-2019	29
7	Value added products of coconut	29-03-2019	19

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.

Radio / TV programme/ press coverage

Four radio talks and 4 television programmes were broadcasted on *Eriyophid* mite damage to coconut and its management practices in coconut, present scenario of coconut Rugose spiralling whitefly and remedies to improve nut size and yield in All India radio station, Visakhapatnam and TV9, 10TV, Doordarshan, Vijayawada respectively. A total of 6 press coverages were made on RSW.

VIP visit:

Dr. H.P. Singh, Ex. DDG, ICAR visited Horticultural Research Station, Ambajipeta on 02.07. 2019. Monitored research achievements or status and interacted with AICRP scientists on various aspects of Coconut cultivation.



Dr. H.P. Singh, Ex. DDG, ICAR visited HRS, Ambajipeta



Training programme on Pest and diseases management in coconut

A scientist from centre has participated in 6 training programmes organized by various bodies like KVK, NABARD, and NIPHM as resource person. The interaction was made with farmers or participants on various aspects of recent advances in coconut, IPM on coconut, integrated crop management in coconut, pest and disease management in coconut, Coconut diseases and their management and future live in research for coconut.

Diagnostic field visits/ consultancy

Field visit/ consultancy	Problems identified and solution given on
Field visits: 70	<ul style="list-style-type: none"> ● 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: 150	
Farmers visit to HRES: 2000	

Exposure visit

Farmers from different coconut growing areas of Karnataka visited Horticulture Research Station, Arsikere individually or in groups through KVKs, Extension Education Units, Karnataka State Department of Horticulture/ Agriculture and NGOs and obtained information on coconut varieties, water and nutrient management in coconut, coconut based cropping system, integrated pest and disease management and value addition in coconut by the scientists of the research station.

“World Coconut day” celebration

The “world coconut day” was celebrated at Horticulture Research and Extension Centre, Arsikere

on 2th September 2019, and nearly 550 farmers attended the function.



World Coconut day celebration

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 from scientists of centre.

Krishi Mela/ Horticulture Mela/ Exhibition

Participated in 2 exhibitions conducted by Krishi mela, UAS, Bangalore and Thotagarika mela, UHS Bagalkot and approximately about 20225 farmers were attended the programmes.

Radio/ TV programme

A radio talk and 2 Television programmes were broadcasted on intercrops in coconut cultivation and recent advances in coconut cultivation.

Bavikere

State Level Workshop on Oil palm

The State Level Workshop on Oil palm was organized under AICRP (Palms), Bavikere Centre (Oil palm) on 08-08-2019 at University of Agricultural and Horticultural Sciences (UAHS), Shivamogga, in collaboration with State Dept. of Horticulture, Shivamogga and oil palm growers association. More than 180 oil palm growers came from 12 districts and three oil palm industrialists of

Karnataka were attended the workshop. The technical sessions were organized and farmers were enlightened about the good agricultural practices followed by question answer session.



State level workshop on Oil palm

Bhubaneswar

Training programmes

Organized training programmes on Livelihood improvement through integrated coconut farming and coconut farming for more profit at centre benefiting 96 farmers and also organized exposure visit of 50 farmers at centre to enlighten technologies developed.



Training programme organized at Bhubaneswar

Linkage with the District KVK and ATMA

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

Jagdalpur

Training programmes

SI. No.	Name of training	Place	Date	No. of farmers benefited
1.	Celebration of World Coconut Day 2019 cum one day farmers training	SGCARS, Jagdalpur	02/09/2018	88
2.	Exhibition cum Farmers training programme	SGCARS, Jagdalpur	07/12/2019	350
3.	Coconut production technology and Plant Protection	Tahkapal	24/12/2019	65

Demonstration of technologies

‘Integrated nutrient management of coconut plantation’ and ‘Development of coconut based farming system in the juvenile phase of palms’ were demonstrated benefitting 165 farmers.

Women empowerment activity

Conducted demonstration on Coconut Production Technology to empower women in horticulture sector and to create awareness about coconut cultivation and 100 members of women self help groups benefited



Distribution of seedlings to farmers under SCSP

Goa

Centre has involved in 6 farmers field visit to diagnose problems in Arecanut as well as Coconut. Participated in 2 exhibitions Raj ustava, Aquabe and demonstrated climbing devices to farmers under SCSP programme. World coconut day was celebrated.



Training programme conducted at Jagdalpur

TV programme

TV talk was broadcasted on Importance of Coconut in nontraditional area of Bastar on the occasion of World Coconut Day 2019 dated 2nd September 2019 News channel DHTV Dailyhunt.

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.

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 attended.



Women empowerment programme at Kahikuchi

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) Nursery raising & management	50

Publication of extension literature

Technology highlighted and title of publication	Type of extension publications
1. Remedial measures of coconut crown choke in Assam Title: Coconut crown choke in Assam and the remedial measures	1. Extension Bulletin
2. Byproduct utilization, value addition & management of fruits & spices Title: Urban Agriculture	2. Extension booklet

Research-Extension-Farmers interface programme

Date	Theme of interface programme	Agencies involved	No. of participants
03.09.2019	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 system ii) INM & IPM in coconut iii) Cultivation technique & management in coconut

Mondouri

Participation in seminar/symposium etc:

- Participated as resource person on Neera tapping at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra on 10th February 2018 as per request of the Director of Research of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli,
- Participated as resource person on Neera tapping at ICAR-CAARI, Portblair, Andaman on September 2018 as per request of the Director, ICAR-CAARI, Portblair, Andaman
- Participated in different seminar /symposium also. But all the expenditures were borne from other sources except AICRP as there was no fund

Mulde

Sr. No	Particulars	Numbers	Number of Participants
1	Farmers Visits		76
2	Students visit	3	150
3	Visit to framers plots	1	3
4	Participated in Exhibition	1	9000
5	Marathi Doordarshan Programme on Oil Palm Cultivation		

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

Exhibitions

Conducted two *Kharif Krishi Mohastav*-2019 at Tapi and Surat districts by Government of Gujarat and more than 2000 farmers were benefited.

World Coconut day

The “World Coconut Day” on the theme of “Coconut for Family Wellness” was jointly

Navasari

Training programmes

Training programme on ‘Production technology of coconut’ and ‘Value addition of coconut’ were conducted benefitting 400 farmers



Training programme at Navasari

organized by AICRP (Palms), Navsari centre on 9th September, 2019 with Okha Farmer Producer Organization (Okha), Tata Chemicals Society for Rural Development (Mithapur) and Department of Horticulture, GoG at Varvala village (Devbhumi Dwarka) while, the day was celebrated on 10th September, 2019 at Talala (Gir Somnath) with

collaboration of Department of Horticulture, GoG and Coconut Development Board, Gujarat state. In these farmers training programmes, more than 125 progressive farmers of coconut are participated and share their views and queries regarding improvement, production and protection of coconut crop.



Celebration of world coconut day

Pandirimamidi

Conducted training programme on palmyrah products and 400 farmers were benefited. High level committee on Neera and neera based products by Government of Telangana visited to monitor on Palmyrah research at HRS Pandirimamidi on 25.11.2019.



Training on palmyrah products

Pasighat

The scientist in charge of the center has under taken the following extension activities for popularizing the oil palm crop in North Easter Region of the country during the year 2019.

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 trainings programmes related to horticulture organized by CHF, CAU -07 no's.
4. Acted as Resource person in different training programme: 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: 20-no's

Pattukkottai

Training programmes/field days

Scientists from centre participated in 10 training programmes on oil palm cultivation technology as resource person. Over 423 ATMA farmers of 10 different districts were benefited.



Exposure visit of Farmer's to centre

Pedavegi

Monitor visit

Visited the AICRP on Palms Centre, Mulde, Maharashtra on 24-25 June, 2019, AICRP on Palms Centre, Pasighat, Arunachal Pradesh during on 16th Nov., 2019 and reviewed the progress of the research work on oil palm at the centre and field visit to oil palm gardens.

Workshop

Dr. R.K.Mathur, Director and Dr. B.N.Rao, Principal Scientist, ICAR-IIOPR, Pedavegi have participated in a workshop on oil palm organized by UAHS, Shivamogga in collaboration with AICRP on Palms centre, Bavikere on 8th Aug., 2019 and delivered the lecture on management of oil palm. About 200 farmers and extension functionaries and entrepreneurs were participated.

Pilicode

Training programmes

Training programmes on 'Women empowerment in farm mechanization', 'Production of virgin coconut oil', 'cashew apple processing' and 'Beekeeping and its potentials in farming' were conducted for farmers of Kannur and Kasaragod districts in north Kerala.



Women empowerment programme at Pilicode

Port Blair

Training programmes

Training programmes cum workshops on Spices and Plantation Crops based Entrepreneurship Development in the Islands and promotion of coconut and coir based enterprises in Andaman & Nicobar islands have been conducted to 220 farmers.



Organized training programme at Portblair

Demonstration of technology

Field demonstration on coir pith composting has been conducted to 30 farmers to enlighten developed technology and its importance.



Demonstration of Technology at Portblair

Ratnagiri

Training programmes

Six training programmes and seven training classes were arranged on different aspects of coconut plantation management benefitting 900 farmers.



SCSP Training Programme

Farmers rally and workshop

Organized farmers rally at State Agriculture Department Pomendi, Ratnagiri and RCRS Bhatye in coordination with District superintendent Agriculture officer, RCF, RDCC bank Ratnagiri benefitting approximately 400 farmers.

Participated in 8 monthly district workshops organized by state agriculture department on various aspects of coconut production technology including nutrient management and pest control in coconut benefitting over 600 farmers.



District level workshop on scientific coconut cultivation technology

Demonstration of technology

Organized about 11 method demonstrations on coconut production technology, preparation of vermicompost, pest management and biocontrol agent mass production and 556 farmers were benefited.

Radio/TV programme/ press coverage

- Two radio programmes were broadcasted on ‘Management of Eriyophid mite in coconut’ and ‘Present status of coconut farming’.
- Two TV programmes on ‘Intercrops in coconut’, and ‘World coconut day’ were telecasted in Doordarshan and Krishidarshan sahyadri.
- A total of 12 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 : 38 Telephone guidance: 128 Farmers visit to HRES: 2740	<ul style="list-style-type: none"> ● Coconut production technology ● Nursery management ● Drip irrigation in coconut ● Nutrient management in coconut ● Pest management in coconut ● Disease management in coconut ● Varieties of coconut

Shivamogga

Popularization of technologies

Awareness about the new technologies developed under AICRP on Palms (Areca) with respect to management of fruit rot of arecanut caused by *Phytophthora meadii* using fungicides (Sectin @3g/l) or microbial consortia were disseminated among the farming community, so that, they can utilize the same for the management of fruit rot disease during 2020-21 *Kharif* season.



Celebration of World Coconut Day at Ratnagiri

Sirsi

Diagnostic field visits are undertaken and advisory services are provided. It is being planned to conduct one training program on improved

production practices during first fortnight of March 2020. Two extension bulletins are kept ready for publications to be released during planned training programme.

Veppankulam

Training programmes

Title of the training	Date	Place	Source of fund
Seminar on Hi-tech coconut cultivation – Rehabilitation of Gaja cyclone affected coconut farmers through intercropping of vegetables World coconut day 2019	6.09.2019	CRS, Veppankulam	ICAR-AICRP on Palms
Orientation training on AICRP (Palms)	24.10.2019 to 26.10.2019	CPCRI, Kasaragod	ICAR-AICRP on Palms
FLD on integrated management of basal stem rot disease of coconut	18.12.2019	Nambivayal and Kasangadu	ICAR-AICRP on Palms

Diagnostic field visit

Sl. No.	Date	Place	Nature of the field problem
1.	07.09.2019	Ooranipuram, Pilaviduthi, Vettuvakkottai	Coconut hybrid field visit for finding off types.
2.	06.12.2019	Kottur Nagapattinam	Coconut field inspection

Research-Extension- Farmer interface programme

Date	Theme of interface programme	Agencies involved	No. of participants
02.05.2019	Awareness programme on Coconut Rugose Spiraling whitefly management – Rajendram	Pudukottai District Coconut Producers Company	50
17.06.2019	Training to Gaja cyclone affected farmers - Jambavanodai	NABARD	50
06.09.2019	Rehabilitation of Gaja cyclone affected SC farmers through intercropping of vegetables – World coconut day – 2019	ICAR-AICRP(P)-SCSP sub plan	50
15.09.2019	Rugose spiraling whitefly – awareness programme	Assistant Director of Agriculture, Madukkur.	40

Vijayarai

Training programme

Organized National level training programme on “Cocoa production and processing technologies” at Venkataramannagudem from 02-12-2019 to 04-12-2019 and Scientists of HRS, Vijayarai delivered lecture on Soil and climatic requirement in cocoa and also “Scientific cultivation with special emphasis on Good agricultural practices in cocoa”.

Attended as resource for 9 no’s training programmes for farmer’s organized by Office of DDH, Eluru and HRS, VRGudam on various aspects of coconut viz., quality planting material

production, establishment of clonal gardens & pruning techniques in cocoa, Cultivation of Ginger as intercrop in oil palm & coconut, Soil and climatic requirement of cocoa, Incidence of Rugose white fly on coconut and oil palm and production technology of coconut, oil palm & cocoa.

Radio talk/T.V Programme

- A radio programme was broadcasted on Oil palm production technology’
- Two TV programmes on ‘Cocoa cultivation practices’ and ‘Importance of organic fertilizers in Cocoa cultivation’ were telecasted in Doordarshan and ETV.



XI. PUBLICATIONS

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Awards/Fellowships

Best centre award: AICRP on Palms Centre, Horticultural Research Station, Vijayarai, Dr. Y.S.R. Horticultural University, Andhra Pradesh has received “The Best All India Coordinated Research Centre on Palms Award for the Year 2018-19” for the outstanding contribution in oil palm research from honorable Vice-Chancellor, Tamil Nadu Agricultural University, ADG-II, ICAR, New Delhi at XXVIII Annual

Group Meeting of AICRP on Palms held at TNAU, Coimbatore on 06-06-2019.

Best presentation award:

Alagar, M., Srinivasan, T., Rajamanickam, K., Venkatesan, K., Maheswarappa, H. P. and Jilu V. Sajan received best poster award for the paper entitled “Integrated management of coconut eriophyid mite (*Aceria guerreronis* Keifer) (Eriophyidae: Acari)’ in ‘International Conference on Plant Protection in Horticulture: Advances and challenges’, 24-27th July, 2019 at ICAR-IIHR, Bengaluru, India.

Dr. S. Rani, Assisatnt Professor (Agronomy) Coconut Research station, Aliyarnagar has won best poster presentation award in ‘National conference on climate smart agriculture for livelihood security’, 13-14th September, 2019 at ADAC& RI (TNAU), Tiruchirappalli.

Best Scientist Award

Dr. M. Kalpana, Senior Scientist (Hort.), received **Best Scientist Award** during the ITSR Foundation Award - 2019 held on March 31, 2019 at Jaipur (Rajasthan), India.

Dr. M. Kalpana, Senior Scientist (Hort.), received **Distinguished Scientist Award** from the Society for Scientific Development in Agriculture & Technology during *International conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences*, (GRISAAS, 2019), held during 20-22nd October, 2019 at ICAR-NAARM, Hyderabad.

Dr. M. Kalpana, Senior Scientist (Hort.), received **Outstanding Scientist Award - 2019** from the Society of Tropical Agriculture during *10th International conference on Agriculture, Horticulture & Food science*, held during 21-22nd December, 2019 at New Delhi.

Fellowship: Dr. Beena Singh, Scientist (Horticulture), SGCARS, Jagdalpur received **Fellow of CHAI** (Confederation of Horticulture Associations of India, New Delhi) Award-2019 on 28th May, 2019.



XII. WEATHER DATA OF COORDINATING CENTRES

Coconut centres

Aliyarnagar

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	37.1	22.6	82.5	56.9	52.0
May	36.4	23.6	85.3	62.6	15.2
June	35.1	24.1	83.8	67.4	4.4
July	33.5	23.1	84.2	71.4	47.2
August	32.3	22.1	84.8	68.8	245.0
September	33.5	22.3	86.4	76.4	83.8
October	32.5	21.9	91.1	80.2	233.8
November	32.1	21.1	88.0	73.0	133.2
December	29.8	19.9	91.5	75.2	31.3

Ambajipeta

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	24.7	35.4	53.8	89.6	0.0
May	27.6	37.0	52.0	86.3	0.0
June	26.8	34.9	49.8	81.5	0.0
July	26.0	33.1	58.6	85.2	120
August	25.8	32.8	65.2	85.4	169.75
September	25.4	31.9	69.7	87.8	218.25
October	24.1	31.0	74.0	91.8	311.25
November	21.8	31.8	59.1	98.9	0.0
December	19.6	29.5	60.9	98.4	0.0

Arsikere

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	36.3	20.5	48.4	34.5	24.0
May	36.0	21.3	64.4	51.8	54.2
June	31.9	21.7	75.6	64.4	81.9
July	28.7	21.5	82.4	77.2	30.1
August	27.7	21.2	79.9	77.9	124.1
September	28.7	20.3	77.7	75.2	162.8
October	29.0	19.6	81.0	80.9	253.9
November	29.2	18.3	78.9	75.1	68.5
December	27.6	18.9	72.0	61.2	42.2

Bhubaneswar

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	38.3	25.6	90	45	7.8
May	37.1	27.4	92	54	197.7
June	35.5	26.6	91	64	144.6
July	32.8	26	92	74	341.7
August	32.1	26	95	78	319.3
September	32.1	25.7	94	78	406.5
October	32.2	24.2	94	70	312.6
November	30.2	20	94	55	5.3
December	28.1	16.2	93	53	0

Jagdalpur

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	37.6	21.2	69.0	30.0	41.5
May	38.1	23.7	72.0	37.0	89.8
June	34.8	24.6	80.0	55.0	221.0
July	28.9	22.6	93.0	78.0	622.5
August	28.7	22.4	94.0	77.0	582.2
September	29.4	22.5	94.0	75.0	499.0
October	30.2	20.9	96.0	67.0	237.8
November	29.5	14.8	97.0	46.0	0.4
December	28.2	12.5	97.0	42.0	5.8

Kahikuchi

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	30.7	19.9	76.0	68.0	181.0
May	31.0	22.4	78.5	72.4	226.0
June	32.2	24.8	85.6	81.0	309.0
July	31.9	25.3	89.4	84.0	377.0
August	32.1	25.4	88.0	82.5	227.0
September	31.4	24.4	85.5	82.0	199.0
October	30.2	21.9	81.8	80.7	92.0
November	27.5	16.8	80.5	77.8	25.0
December	24.4	11.2	79.0	72.8	10.0

Mondouri

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	34.68	24.12	89.8	56.9	4.8
May	36.06	26.45	87.52	60.32	3.00
June	35.28	27.1	89.27	66.47	3.60
July	34.06	26.89	89.61	71.81	3.40
August	32.24	26.3	94.65	79.35	10.70
September	32.16	25.83	94.67	76.27	6.10
October	30.85	23.33	94.52	72.77	3.20
November	29.24	18.31	91.37	51.45	1.2
December	25.4	9.19	92.12	51.09	3.4

Navsari

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	36.6	21.5	85.8	51.0	0.0
May	34.7	24.3	85.0	61.9	0.0
June	33.5	25.4	91.5	77.0	262.0
July	31.4	24.2	94.4	87.1	491.0
August	29.9	23.5	96.0	87.4	535.0
September	30.9	22.9	95.9	87.9	750.0
October	33.4	21.5	87.8	68.3	95.0
November	33.2	19.1	91.0	63.8	37.0
December	31.0	15.8	85.0	62.1	0.0

Ratnagiri

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	32.8	24.0	88.2	63.4	0.0
May	33.1	25.1	81.6	63.1	0.0
June	32.7	25.7	86.5	75.6	674.1
July	30.8	24.0	90.6	84.1	1281.3
August	30.3	24.5	90.0	81.6	774.9
September	30.2	23.9	93.8	81.5	875.9
October	32.1	23.2	93.0	73.8	269.9
November	34.1	22.3	89.8	59.0	1.2
December	33.5	19.1	82.1	51.9	0.0

Sabour

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	33.5	21.4	77.9	57.4	38.0
May	38.8	24.3	75.7	50.4	61.2
June	37.9	25.5	71.6	51.1	85.0
July	34.2	25.1	83.1	65.8	380.3
August	34.7	26.6	85.2	65.3	65.6
September	32.6	26.2	86.6	75.7	371.3
October	30.8	21.7	89.4	78.5	23.4
November	28.9	16.2	87.6	76.1	0.0
December	21.2	9.3	91.4	75.9	2.5

Mulde

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	37.3	22.9	87.8	48.8	0.0
May	37.4	23.6	86.0	47.8	0.0
June	31.9	23.8	91.0	73.8	893.2
July	29.4	23.4	92.4	84.4	1702.9
August	30.2	23.3	94.5	77.5	1085.8
September	30.4	23.6	93.3	75.8	542.3
October	33.2	23.1	90.8	66.2	366.8
November	35.0	21.6	88.8	51.0	0.0
December	34.8	20.4	87.8	43.8	0.0

Vijayarai

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	36.9	23.6	98.7	52.9	2.5
May	38.7	26.9	99.2	54.9	16.5
June	35.5	26.8	99.4	68.2	60.5
July	33.5	25.2	100.0	71.5	121.8
August	32.5	25.0	100.0	78.0	205.3
September	31.1	24.8	100.0	84.4	371.8
October	31.5	23.9	99.1	82.1	199.3
November	31.8	20.9	100.0	64.7	16.8
December	29.9	19.4	100.0	63.7	0.0

Arecanut centres
Goa

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	35.0	23.4	86.7	53.3	0.0
May	35.0	23.7	83.8	55.5	0.4
June	32.5	21.6	89.1	74.2	752.2
July	29.7	23.0	92.1	85.3	1335.4
August	29.4	22.8	94.1	82.5	1266.0
September	29.9	21.7	92.7	80.2	681.8
October	32.6	18.3	89.6	69.8	430.2
November	34.3	19.7	82.1	49.8	4.6
December	34.1	20.4	76.7	42.6	0.0

Port Blair

Month	Temperature (°C)		RH (%)	Rainfall
	Max.	Min.		
April	33.1	25.4	67.0	17.9
May	32.4	25.6	79.0	336.6
June	29.9	24.2	89.0	691.0
July	30.8	25.1	84.0	165.6
August	28.8	24.0	92.0	1098.8
September	29.1	24.1	88.0	540.0
October	31.6	24.9	75.0	270.2
November	31.0	24.7	73.0	194.5
December	30.3	24.9	68.0	1.8

Shivamogga

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	37.0	21.7	72.1	39.0	27.0
May	36.7	22.6	69.5	41.2	4.4
June	32.2	22.6	82.5	70.8	55.8
July	27.9	21.3	88.9	86.4	164.6
August	27.3	21.0	89.9	87.3	446.8
September	28.8	21.2	88.4	78.4	140.8
October	29.8	20.3	88.2	80.3	336.6
November	30.7	18.8	84.3	66.2	6.1
December	30.0	17.6	91.3	67.0	10.2

Wakawali

Month	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Forenoon	Afternoon	
April	33.9	21.2	88.8	57.3	0
May	33.5	22.2	82.2	56.6	0
June	32.0	24.8	90.7	76.8	736.1
July	28.7	24.0	96.1	91.1	1711.2
August	28.4	23.4	95.9	87.7	1312.8
September	28.3	23.6	96.2	89.6	1204.8
October	30.9	21.9	91.8	72.9	154.4
November	32.5	24.4	91.9	60.5	12.2
December	31.0	25.1	92.0	59.5	0



Delegates during 28th AGM of ICAR-AICRP on Palms



Inaugural address by Dr. W. S. Dhillon, ADG (Horti. Sci. I) during 28th AGM



Presidential address by Dr. N. Kumar, Vice-Chancellor, TNAU, during 28th AGM



Best centre award to Vijayarai during 28th AGM of ICAR-AICRP on Palms



हर कदम, हर डगर
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भारतीय कृषि अनुसंधान परिषद

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