वार्षिक प्रतिवेदन
ANNUAL REPORT
2016-17

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

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

Participants of 25th AGM

Kalpa Shatabdi variety

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CONTENTS

I. प्रस्तावना

नारियल, सुपारी, तेल ताड़ और पॉमैरा जैसी मुख्य फसलों की उत्पादन क्षमता बढ़ाने में स्थानीय विशेष समस्याओं को ध्यान में रखते हुए 13 राज्यों और एक संघ राज्य क्षेत्र में स्थापित अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना 27 सुव्यवस्थित केंद्रों में अनुसंधान किया जा रहा है।

आनुवंशिक संशोधन एवं फसल सुधार, फसल उत्पादन, रोग प्रबंधन, कीट प्रबंधन, कटाई उपरांत प्रौद्योगिकी एवं प्रौद्योगिकी हस्तांतरण के अधीन हुई प्रगति सम्मिलित वार्षिक रिपोर्ट 2016-17 प्रस्तुत करने में मुझे अत्यंत खुशी हो रही है। इस वर्ष की अवधि में कल्प शताब्दी प्रजाति, जिससे उच्च खोपड़ा मात्रा प्राप्त किया गया, तमिलनाडु के लिए विमोचन के लिए सिफारिश किया गया। पॉच स्थानीय विशेष संकर संयुक्त के साथ अलियारनगर केंद्र में किए गए मूल्यांकन परीक्षण में 34 महीने की आयु में पूर्व पुष्पित एक नारियल संकर एम जी डी × ए एल आर 1 पहचान लिया गया। नारियल संकर सी ओ डी × ए एल आर (65 गुठली/ताड़/वर्ष) और ए एल आर × एम जी डी (58 गुठली /ताड़/ वर्ष) में उच्च गुठली उपज क्षमता पायी गयी। एन आर सी ओ पी के तेल ताड़ संकर संयुक्तों के बीच 11 से 20 (वर्ष 2006 की अवधि में रोपित) पट्टुकोट्टाई के बीच मूल्यांकन किया जा रहा है जिसमें एन आर सी ओ पी में वार्षिक ताजा फल गुच्छ उपज महत्वपूर्ण रुप से उच्च पायी गयी (21.8 टन/हेक्टर) और एन आर सी ओ पी 20 में समतुल्य पायी गयी (20.8 टन/हेक्टर)। अलियार नगर केंद्र में नारियल + कोको + केला + अनानास फसलन पद्धित में नाईट्रोजन, फॉसफोरस, पोटाश के सुपार्शित 75 प्रतिशत के साथ वर्मीकंपोस्ट और जैविक पुनःचक्रमण के साथ उर्वरक प्रयोग के समीकृत कीट प्रबंधन से उच्च गुठली उपज, अन्तर फसल का उपज और उच्च सकल आय (3.28 लाख/हेक्टर) प्राप्त की गयी। और नाईट्रोजन, फोसफोरस और पोटाश के सुपार्शित 50 प्रतिशत मात्रा के साथ जैविक पुनःचक्रमण से 3.07 लाख प्रति हेक्टर आय और पूर्ण जैविक उपचार से 2.96 लाख प्रति हेक्टर प्राप्त की गयी। मुल्डे केंद्र में युवा तेल ताड़ बाग में केला, जिमीकंद और अनानास के अन्तरफसलन से इकफसल की तुलना में 85,000/ रुपए प्रति हेक्टर अतिरिक्त आय और फसलन पद्धित से 2,19,510/ रुपए कुल आय प्राप्त की गयी। तमिलनाडु के अन्नामलाई ब्लॉक के कई गॉवों में सर्वेक्षण के बीच नारियल में सफेद मच्छर का सर्पिल आक्रमण का लक्षण पाया गया और कीट रुगोस स्पाइरलिंग सफेद मच्छर *अलियुरोडिकस रुगियोपेरकुलाटस* मारटिन पहचान लिया गया और पुष्टि की गई। संक्रमित बाग में प्राकृतिक शत्रु पर निरीक्षण से अफेलिनिड परजीव्याभ, *एनकार्सिया गुआडेलौपे* के साथ कोकिनेल्लिड की विविध सरणी पायी गयी। काले सिरवाली इल्ली के नियंत्रण के लिए कुल 12,89,100 *बी. हेबाटर*, 23,69,000 *बी. ब्रेविकोर्निस* और 47,45,200 *जी. निफान्टिडिस* अम्बाजिपेट, अलियार नगर, अरसिकरे और रत्नगिरी केंद्रों से 2016-17 में कृषकों को वितरण किया गया। यह उल्लेखनीय है कि अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के 4 केंद्रों द्वारा आदिवासी उप योजना कार्यक्रम का कार्यान्वयन किया गया। इसके अतिरिक्त हितधारकों को प्रमाणित प्रौद्योगिकियों के प्रभावी प्रचार के लिए सभी केंद्रों में विभिन्न प्रशिक्षण कार्यक्रम और विस्तार गतिविधियॉ आयोजित की गई।

डॉ. टी. महापात्र, सचिव, डेयर और महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली द्वारा दिए गए निरंतर प्रोत्साहन को मैं अपना सौभाग्य मानता हूँ। डॉ. ए. के. सिंह, उप महानिदेशक (बागवानी विज्ञान) और एन. के. कृष्णकुमार, पूर्व उप महानिदेशक (बागवानी विज्ञान) डॉ. वसाका सिंह ढ़िल्लन, सहायक महानिदेशक (बागवानी विज्ञान) और बागवानी विज्ञान, भारतीय कृषि अनुसंधान परिषद के स्टाफ सदस्यों द्वारा दिए गए समर्थ सहारे और आवश्यक मार्गदर्शन के लिए मैं आभारी हूँ। तकनीकी कार्यक्रमों के रुपांकन और कार्यान्वयन के लिए डॉ. पी. चौड़प्पा, निदेशक और भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान के स्टाफ सदस्य द्वारा दी गई सहायता और मार्गदर्शन के लिए मैं कृतघ्नता ज्ञापन करता हूँ। भाकृअनुप-भारतीय तेल ताड़ अनुसंधान संस्थान, पेडवेगी के निदेशक महोदय डॉ. आर. के. माथुर 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। श्रीमती जिलु वी. साजन, वैज्ञानिक, श्रीमती के. नारायणी, निजी सचिव और सुश्री धात्री एन आर, श्री एस. एस. साजु, वरिष्ठ अनुसंधान अध्येता और श्री ए. मोहना को भी साधुवाद देता हूँ जिन्होंने इस रिपोर्ट के निष्पादन में मदद और समन्वयन कार्य किया है।

जुलाई, 2017

(डॉ. एच.पी. महेश्वरप्पा)

PREFACE

The All India Coordinated Research Project on Palms (AICRPP) is being operated in 27 centres established in 13 states and one union territory, with the aim of addressing the location specific problems in improving productivity of the mandate crops *viz*., coconut, arecanut, oil palm and palmyrah.

I have immense pleasure in presenting the Annual Report 2016-17 which include the progress made under Genetic resources and crop improvement, Crop production, Disease management, Pest management, Post harvest technology & TOT. During the year, Kalpa Shatabdi variety having higher copra content was recommended for release in Tamil Nadu state. A coconut hybrid, MGD x ALR 1 was observed to be the earliest for flowering at the age of 34 months at Aliyarnagar centre in an evaluation trial carried out with five location-specific hybrid combinations. The coconut crosses COD x ALR (65 nuts/palm/year) and ALR x MGD (58 nuts/palm/year) were found to be promising with higher nut yield potential. Among the oil palm hybrid combinations of NRCOP, 11 to 20 (planted during 2006) being evaluated at Pattukkottai, the annual FFB yield was observed to be significantly higher in NRCOP 17 (21.8 t/ha) and was on par with NRCOP 20 (20.8 t/ha). In coconut + cocoa + banana + pineapple cropping system, integrated nutrient management (INM) with 75% of recommended NPK through fertilizer coupled with organic recycling with vermicompost, recorded higher nut yield and yield of intercrops, with higher net income (Rs. 3.28 lakhs per ha) followed by 50% of recommended NPK + organic recycling (Rs. 3.07 lakhs per ha) and fully organic treatment (Rs. 2.96 lakhs per ha) at Aliyarnagar centre. Intercropping of banana, elephant foot yam and pineapple in juvenile oil palm garden gave additional return of Rs. 85,000/- per ha over sole crop and total return from the cropping system was Rs. 2,19,510/-per ha at Mulde centre. Incidence of invasive spiralling whitefly in coconut was documented during surveys in several villages of Anaimalai block, Coimbatore Dt., Tamil Nadu and the pest has been identified and confirmed as Rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin. Observations on the natural enemy fauna in the infested gardens revealed the presence of a diverse array of coccinellids along with an aphelinid parasitoid, *Encarsia guadeloupae*. To manage the black headed caterpillar menace, a total of 12,89,100 numbers of *B. hebetor*, 23,69,000 numbers of *B. brevicornis* and 47,45,200 numbers of *G. nephantidis* parasitoids were distributed to farmers from Ambajipeta, Aliyarnagar, Arsikere and Ratnagiri centres. It is noteworthy that the Tribal Sub-Plan (TSP) program has been implemented through four AICRPP centres. Besides, various training programmes and extension activities have been undertaken at all the centres for effective dissemination of proven technologies to the stakeholders.

I consider it a privilege to express my sincere thanks to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR for the constant support given for the project. I am grateful to Dr. A.K. Singh, Deputy Director General (Hort. Science), Dr. N. K. Krishna Kumar, Former Deputy Director General (Hort. Science), Dr. Wasakha Singh Dhillon, ADG (Hort. Science-I) and staff of Horticulture Science Division, ICAR for their support and necessary guidance. The technical guidance and help in formulation and implementation of technical programmes by Dr. P. Chowdappa, Director and staff of ICAR-CPCRI, Kasaragod and Dr. R. K. Mathur, Director and staff of ICAR-IIOPR, Pedavegi are gratefully acknowledged. I appreciate the efforts and zeal shown by all the staff of the centres during execution of various programmes. The help rendered by Dr. Alka Gupta and Mrs. K. Sreelatha in Hindi translation is acknowledged with gratitude. The support and coordination of Mrs. Jilu V Sajan, Scientist, Smt. K. Narayani, Private Secretary, Ms. Dhathri N R, Mr. S S. Saju, SRFs and Mr. A. Mohana, of AICRP Cell for bringing out this report is appreciated.

July, 2017

(H. P. Maheswarappa)

II. कार्य सारांश

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्र जिसका मुख्यालय भाकृअनुप-कें रो फ अ सं, कासरगोड़ एक समन्वयन केंद्र के रुप में 27 केंद्रों के साथ नारियल, तेल ताड़, सुपारी और पॉमैरा फसलों की उत्पादन क्षमता बढ़ाने की स्थानीय विशेष प्रौद्योगिकियों के विकासन में सफलतापूर्वक विभिन्न सस्य जलवायु क्षेत्रों का प्रतिनिधित्व कर 13 राज्यों और एक संघ शासित प्रदेश में स्थित है। कृषकों को हस्तातंरित प्रौद्योगिकियों के साथ आनुवंशिक संसाधन, फसल सुधार, फसल उत्पादन, रोग प्रबंधन, कृमि कीट प्रबंधन और कटाई उपरांत प्रौद्योगिकियों के अधीन मुख्य फसलों में वर्ष 2016-17 की अवधि में हुई अनुसंधान कार्य की प्रगति इस रिपोर्ट में प्रस्तुत की गई है।

वर्ष 2016-17 में हुई अनुसंधान उपलब्धियाँ

नारियल

आनुवंशिक संसाधन और फसल सुधार

अलियारनगर केंद्र में पाँच स्थानीय विशेष संकर संयुक्त मूल्यांकनाधीन है। चार वर्ष के परीक्षण के बाद संकर संयुक्तों के बीच एम जी डी ए एल आर 1 पहले पुष्पित (34 महीने) पाया गया। सी ओ डी ए एल आर (65 गुठली/ताड़/वर्ष) और ए एल आर × एम जी डी (58 गुठली/ताड़/वर्ष) संकर उचित पाया गया। एच आर एस, अम्बाजिपेटा में विमोचित नारियल प्रजातियों/संकरों के मूल्यांकन में संकर, वी एच सी 1 और गोदावरी गंगा से उच्च गुठली उपज 139 और 136 गुठली/ताड़/वर्ष क्रमशः प्राप्त की गयी। यद्यिप उच्च खोपड़ा मात्रा/गुठली चन्द्र संकरा 168.7 ग्रा अंकित किया गया। और फिलीपाइन्स आर्डिनरी 166.6 ग्रा और वी एच सी-2 166.8 ग्रा समान उच्च खोपड़ा मात्रा रिकार्ड किया गया।

फसल उत्पादन

अलियारनगर केंद्र में नारियल + कोको + केला + अनानास समीकृत पोषण प्रबंधन की सस्यन पद्धित में अनुमोदित नाईट्रोजन, फोसफोरस, पोटाश मात्रा के 75 प्रतिशत उर्वरक प्रयोग से और अनुमोदित नाईट्रोजन, फोसफोरस, पोटाश मात्रा के वर्मीकंपोस्ट प्रयोग के साथ जैविक पुनःचक्रमण से उच्च गुठली उपज और अन्तर फसल उपज अंकित की गयी और उच्च सकल आय 3.28 लाख प्रति हेक्टर और अनुमोदित नाईट्रोजन, फोसफोरस, पोटाश मात्रा के 50 प्रतिशत और जैविक प्रयोग से 3.07 लाख/हेक्टर और पूर्ण जैविक उपचार से 2.96 लाख प्रति हेक्टर प्राप्त किया गया। अम्बाजिपेटा में पोषण प्रबंधन विधियों के बीच पूर्ण रुप से जैविक उपचार में उच्च सकल आय (2.34 लाख प्रति हेक्टर और लाभ मूल्य अनुपात 3.36 और अनुमोदित नाईट्रोजन, फोसफोरस, पोटाश मात्रा के 50 प्रतिशत उर्वरक प्रयोग के साथ जैविक पुनःचक्रमण और वर्मीकंपोस्ट वर्मीवाश प्रयोग जैव उर्वरक प्रयोग स्वस्थाने हरी खाद प्रयोग से (2.16 लाख प्रति हेक्टर और लाभ मूल्य अनुपात 3.36) प्राप्त किया गया। लेकिन केवल नारियल के इकफसल से 0.76 लाख सकल आय और लाभ मूल्य अनुपात 3.16 पाया गया। अरसिकरे केंद्र में नारियल इकफसल की तुलना में (सकल आय 0.60 लाख हेक्टर और लाभ मूल्य अनुपात 1.64) समीकृत कृषि पद्धित के साथ नारियल हरा चारा पशु से उच्च सकल आय 1.29 लाख और लाभ मूल्यअनुपात 2.06 पाया गया।

फसल संरक्षण

नारियल रोगों का सर्वेक्षण एवं निगरानी

तीन राज्यों जैसे आन्ध्र प्रदेश, तमिलनाडु और कर्नाटक में आयोजित रोविंग सर्वेक्षण से आधार तना सड़न रोग, तना स्त्रवण, पत्ता चित्ती, पत्ता शीर्णता और कली सड़न के लक्षण पाए गए। आन्ध्र प्रदेश में आधार तना सड़न लक्षण उच्च 9.35 प्रतिशत पाया गया और कर्नाटक में 3.13 प्रतिशत और तमिलनाडु में 1.46 प्रतिशत। आन्ध्रप्रदेश में तना स्त्रवण रोग भी तीक्ष्ण 2.43 प्रतिशत पायी गयी और कर्नाटक में 1.95 प्रतिशत और तमिलनाडु में 0.05 प्रतिशत। तीन राज्यों में विभिन्न स्थानों में नियत प्लोट सर्वेक्षण आयोजित किया गया, से एक वर्ष की अवधि में आधार तना सड़न रोग और तना स्त्रवण रोग की तीक्ष्णता और फैलाव पहचाना गया। पर्णिल रोग जैसे पत्ता शीर्णता और पत्ता चित्ती एक वर्ष की अवधि में कम पायी गयी।

आधार तना सड़न रोग

गैनोडेरमा के 13 एकलन का संग्रहण कर्नाटक, तमिलनाडु और आन्ध्रप्रदेश से किया गया। और उनकी विभिन्नताओं को इंगित की गयी। कृत्रिम संरोपण परिस्थिति के अधीन नारियल पौध को

मारने के लिए गैनोडेरमा एकलन लगभग 15 महीने लेता है। आधार तना सड़न रोग सूचकांक के साथ अधिकतम तापमान का संहसंबद्ध अनुकूल पाया गया। विभिन्न अन्तर मिश्रित बागों के बीच आन्ध्रप्रदेश और कर्नाटक के केला अंतर रोपित बाग में कम आधार तना सड़न रोग लक्षण देखा गया।

नारियल में आधार तना सड़न रोग का प्रबंधन

वार्षिक अंतराल में प्रति ताड़ प्रत्येक रुप से 125 ग्रा. *ट्राईकोडेरमा रीसेइ* और *स्यूडोमोनस फ्लूरोसेंस* 5 कि.ग्रा नीम केक का प्रयोग, और 125 ग्रा *टी. रीसेई* और *पी. फ्लूरेसेन्स* का टाल्क आधारित फोरमुलेशन का मृदा प्रयोग वार्षिक अंतराल में 5 कि. ग्रा नीम केक वर्ष में तीन बार 100 मि. ली पानी में 1 मि. ली हेक्साकोनसोल का मूल वेधन1 कि.ग्रा/ताड़/वर्ष के दर में सूक्ष्म पोषकों के प्रयोग से रोग लक्षण कम पाया गया।

तना स्त्रवण रोग प्रबंधन

तिमाही अंतराल में 2 मि. ली प्रोपिकोनसोल 100 मि. ली पानी के दर में मूल वेधन से निम्नतम रोग सूचकांक देखा गया।

कीट विज्ञान

राईनोसेरस भृंग

अलियारनगर केंद्र में राईनोसेरस भृंग के कारण पत्ता क्षति में महत्वपूर्ण कमी पायी गयी। जैसे क्लोरान्ट्रानिलिप्रोल के साथ (16.6 पत्ता क्षति) और केंरोफअसं वनस्पतिक केक लेप से (17.1) और नाफ्थलिन बाल्स (18.5) लेकिन नियंत्रणाधीन 27.3 पायी गयी। इसी प्रकार रत्नगिरी में भी पायी गयी। अम्बाजिपेट और अरसिकरे में केंरोफअसं वनस्पतिक केक पेस्ट और बाद में क्लोरान्ट्रानिलिप्रोल से राईनोसेरस भृंग के कारण हुई पत्ता क्षति में महत्वपूर्ण कमी पायी गयी।

रुगोस स्पाइरलिंग सफेद मच्छर

तमिलनाडु के कोयम्बत्तूर जिले में अन्नामलाई ब्लॉक के कई गॉवों में अगस्त 2016 में किए गए सर्वेक्षण में नारियल में स्पाइरल्लिंग सफेद मच्छर का फैलाव लक्षण देखा गया। वह जाति को पहचाना और पुष्टि की गई कि वह रुगोस स्पाईरिल्लिंग सफेद मच्छर, *अलियुरोडिकस रुगियोपेरकुलाटस* मारटिन है। संक्रमित बाग में प्राकृतिक शत्रु पर निरीक्षण से अफेलिनिड परजीव्याभ, *एनकार्सिया गुआडेलौपे* के साथ कोकिनेल्लिड की विविध सरणी पायी गयी। कोयम्बत्तूर जिला, कालियपुरम गॉव में अनाईमलाई ब्लॉक में 78.2 प्रतिशत तक *ई गुआडेलौपे* परजीव्याभकरण देखा गया और बाद में रुगोस स्पाइरलिंग सफेद मच्छर का जैव दमन हो जाता है।

काला सिरवाली इल्ली

2016-17 में काला सिरवाली इल्ली, *ओपिसिना एरिनोसेल्ला* का लक्षण आन्ध्रप्रदेश, तमिलनाडु, कर्नाटक और महाराष्ट्र में देखा गया जिसके लिए परजीव्याभ जैसे *ब्राकोन ब्रेविकोर्निस*, *बी. हेबाटर* और *गोनियोसस निफान्टिडिस* सफलतापूर्वक व्यापक रुप से पालन पोषण किया और, अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के विभिन्न केंद्र द्वारा वितरण किया गया। कुल 12,89,100 *बी. हेबाटर*, 23,69,000 *बी. ब्रेविकोर्निस* और 47,45,200 *जी. निफान्टिडिस* अम्बाजिपेट, अलियार नगर, अरसिकरे और रत्नगिरी केंद्रों से 2016-17 में कृषकों को वितरण किया गया।

तेल ताड़

फसल सुधार

एन आर सी ओ पी संकर संयुक्त में 11 से 20 (2006 की अवधि में रोपित) पाटुकोटाई में मूल्यांकनाधीन है। वर्ष 2016-17 की अवधि में एन आर सी ओ पी 17 का ताज़ा फल गुच्छ उपज (21.8 टन/हेक्टर) उच्च पायी गयी और एन आर सी ओ पी 20 के समान (20.8 टन/हेक्टर) पायी गयी। मुल्डे केंद्र में 2007 में रोपित संकर संयुक्त एन आर सी ओ पी-1 से 10 की ताजा फल गुच्छ उपज आंकड़े से यह देखा गया कि संकर एन आर सी ओ पी-2 से महत्वपूर्णता से उच्च उपज (22.2 टन/हेक्टर) और इसी प्रकार गंगावती केंद्र में एन आर सी ओ पी 4 से 16.4 टन/हेक्टर उपज पायी गयी। विजयराय केंद्र में एन आर सी ओ पी 9 उच्च उपज (25.1 टन/हेक्टर) अंकित किया गया। वर्ष 2009-10 में रोपित संतती मूल्यांकन परीक्षण के अधीन संकर एन आर सी ओ पी 31 अन्य संकरों की तुलना में मुल्डे केंद्र में ताजा फल उपज (13.5 टन/हेक्टर) के अनुसरण में उत्तम निष्पादन दिखाया है जबकि विजयराय केंद्र में एन आर सी ओ पी 39 से उच्च उपज (23.7 टन/हेक्टर) पायी गयी।

तरुण तेल ताड़ बाग में केला, रतालू और अनानास के अंतर फसलन से इक फसलन की अपेक्षा 85,000/- रुपए का अतिरिक्त आय प्राप्त किया गया। और फसलन पद्धित से 2,19,510/- रुपए कुल आय प्राप्त किया गया।

पॉमैरा

फसल सुधार

पान्डिरिमामिडी केंद्र में 1991 में रोपित जननद्रव्य प्रजातियों में उच्चतम नीरा उपज जाति सं 11/91 (48.71) अंकित किया गया। प्रजाति से 12/91 में उच्चतम औसत संख्या के फल अंकित

किया गया। और गुच्छों की उच्चतम औसत संख्या (6.8) प्रजाति सं 12/91 में अंकित किया गया। वर्ष 1993 में रोपित जननद्रव्य प्रजातियों के बीच उच्चतम नीरा उपज 37.55 लीटर और प्रजाति सं 3/93 और 7/93 उच्च संख्या के फल गुच्छ (7.0) प्राप्त किया गया। और प्रजाति से 4/93 में अधिकतम संख्या के फल प्रति गुच्छ 11.0 अंकित किया गया।

कटाई उपरांत प्रौद्योगिकी

उच्च ताप लघु समय द्वारा ताज़ा फूल रस (केरोफअसं विधि द्वारा संग्रहित) का रोगाणुनाशन, 10 दिनों तक कोई महत्वपूर्ण गुण परिवर्तन नहीं देखा गया और प्रशीतित परिस्थिति के अधीन 15 दिनों तक भण्डार किया जा सकता है। प्रशीतित परिस्थिति के अधीन कारबणीकृत/सल्फाईटड नीरा का शेल्फ जीवन 14 दिनों तक हैं और पाश्चरीकरण करने से 30 दिनों तक लंबित किया जा सकता है। केंरोफअसं विधि (68° ब्रिक्स तक) द्वारा संग्रहित फूल रस सांद्रण कर पॉमैरा रस तैयार किया जाता है। परंपरागत विधि की तुलना में इसका गुण उच्चतम है। और प्रशीतित अवस्था के अधीन 63-68° ब्रिक्स का टी एस एस में पॉमैरा रस का जीवन काल 3 महीने तक है और परिवेशी स्थिति में 30 दिनों तक है।

आयोजित बैठक

पच्चीसवीं वार्षिक समूह बैठक

भाकृअनुप अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की पच्चीसवीं वार्षिक समूह बैठक भाकृअनुप केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़ में 19 से 21 मई 2016 तक आयोजित की गई। डॉ. के. रामस्वामी, कुलपति, तमिलनाडु कृषि विश्वविद्यालय, कोयम्बत्तूर डॉ. पी. चौड़प्पा, निदेशक, भाकृअनुप-केंरोफअसं, कासरगोड़, डॉ आर के माथुर, भाकृअनुप-भारतीय तेल ताड़ अनुसंधान संस्थान, पेडवेगी, डॉ. पी एल सरोज, निदेशक, काजू अनुसंधान निदेशालय, पुत्तूर, परियोजना के विभिन्न केंद्रों में कार्यरत वैज्ञानिक और भाकृअनुप-केंरोफअसं, कासरगोड़ के विभिन्न अनुसंधान स्टेशन से वैज्ञानिकों की उपस्थिति में उद्घाटन समारोह संपन्न हुआ। डॉ. एच पी महेश्वरप्पा, परियोजना समन्वयक ने परियोजना के विभिन्न केंद्रों में पिछले वर्ष में की गई गतिविधियों पर संक्षिप्त रिपोर्ट प्रस्तुत की।

वर्ष 2015-16 में एक लंबी × लंबी नारियल संकर विमोचन के लिए सिफारिश किया गया और उचित उच्च उपज प्रदाय तेल ताड़ संकर का मूल्यांकन किया गया जो आगामी वर्षों में देश में पहले संकर विमोचन के लिए सहायक होगा। फसल उत्पादन में जैविक पोषण प्रबंधन के साथ नारियल आधारित फसलन पद्धित विभिन्न केंद्रों में सफलतापूर्वक प्रदर्शन किया जाता है। और विभिन्न केंद्रों में अंतर फसल के रुप में फूल फसल लाभदायक पाया गया। तमिलनाडु और कर्नाटक में काले सिरवाली इल्ली एक बढ़ती चिंता के रुप में पाया गया है। और विभिन्न केंद्रों में जैव नियंत्रण एजेंट के विमोचन से कीटों का सफलता पूर्वक प्रबंधन प्रदर्शित किया गया। आन्ध्र प्रदेश और कर्नाटक में स्लग इल्ली लक्षण रिपोर्ट किया गया है और लाईट ट्राप उपयोग कर सफल प्रबंधन प्रदर्शित की गयी। हितधारकों के लाभ के लिए अनेक संख्या में गतिविधियाँ जैसे प्रदर्शनियाँ, प्रशिक्षण और नैदानिक प्रक्षेत्र संदर्शन आयोजित की गई थी।

उद्घाटन समारोह के अवसर पर अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के केंद्रों से चार प्रकाशनों का विमोचन किया गया। प्रति वर्ष अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्रों का निष्पादन का मूल्यांकन किया जा रहा है। और वर्ष 2015-16 अलियार केंद्र उत्तम निष्पादन केंद्र के रुप में निर्णय लिया गया।

डॉ.एन.के.कृष्णकुमार,उपमहानिदेशक(बागवानी),भाकृअनुप, नईदिल्ली की अध्यक्षता में अंतिमसत्रदिनांक 21 मई 2016 को आयोजित किया गया। डॉ. पी. चौड़प्पा, निदेशक, भाकृअनुप-केंरोफअसं और डॉ. आर. के. माथुर, निदेशक भाकृअनुप-भारतीय तेल ताड़ अनुसंधान संस्थन, पेडवेगी भी उपस्थित थे। डॉ. एच. पी. महेश्वरप्पा, परियोजना समन्वयक (ताड़) ने दो दिन के लिए आयोजित समूह बैठक का और सिफारिशों का संक्षिप्त विवरण दिया। उप महानिदेशक (बागवानी) ने उत्तम निष्पादन केंद्र के वैज्ञानिकों को प्रमाणपत्र वितरण किया। विभिन्न सत्रों की सिफारिशों का प्रस्तुतीकरण अनुमोदन हेतु किया गया। अध्यक्ष की अभ्युक्ति के रुप में उप महानिदेशक महोदय ने सुझाव दिया गया कि अखिल भारतीय समन्वि ताड़ अनुसंधान परियोजना के अधीन कोको फसल की समस्याओं को पता लगाने के लिए कोको को एक मुख्य फसल के रुप में सम्मिलित किया जाए और परियोजना का पुनः नामकरण अखिल भारतीय समन्वित परियोजना रोपण फसल किया जाए। कार्यक्रम की अवधि पर हितधारकों के हित के लिए 10 प्रकाशनों का विमोचन किया गया।

सिफारिशें

- नारियल बाग में एरियोफिड़ कीट के प्रबंधन पर किए गए अध्ययन में यह देखा गया कि बिना उपचारित ताड़ और उपचारित बाग जहाँ समीकृत कीट प्रबंधन और समीकृत

सूत्रकृमि प्रबंधन के साथ बिना एज़ाडिराक्टिन के मूल वेधन की तुलना में 1 एज़ाडिराक्टिन (100 मि.ली 10 मि.ली पानी) का मूल वेधन के साथ समीकृत कीट प्रबंधन और समीकृत सूत्रकृमि प्रबंधन से उपचारित ताड़ों में औसत क्षति ग्रेड सूचकांक पर आधारित एरियोफिड कीट क्षति निम्नतम पायी गयी (0.1 से 2.0 क्षति ग्रेड़ सूचकांक)।

- स्लग इल्ली *डारना नरारिया* के विरुद्ध लाइट ट्राप के साथ किए गए अध्ययन से यह देखा गया कि 200 वाट्स इनकान्डेसेंट बल्ब 1½ ऊपर जल पैन के साथ तीन ट्राप/हेक्टर की संस्थापना से उच्चतम संख्या में प्रौढ़ शलभ पकड़ा गया। प्रकाश स्रोत की ओर स्लग इल्ली *डारना नरारिया* शलभ का आकर्षण का उच्चतम समय पर किए गए अध्ययन से यह देखा गया कि शलभ का आकर्षण 19.00 घंटे से 21.00 से 01.00 घंटे तक उच्चतम और घटकर 03.00 घंटे में शून्य हो जाता है।
- लाल ताड़ घुन *रिंकोफोरस फेरुजनियस* के विरुद्धा विभिन्न कीटनाशिनियों के मूल्यांकन पर किए गए परीक्षण में इमिडाक्लोप्रिड उपचारित ताड़ों में घुन संक्रमण से सौ प्रतिशत स्वास्थ्य लाभ पाया गया।
- नारियल के आधार तना सड़न रोग के प्रबंधन के लिए नीम केक के साथ 125 ग्रा. *टी. विरिडे* +125 ग्रा *पी.फ्लूरोसंस* प्रति ताड़ प्रति वर्ष का मृदा प्रयोग उचित पाया गया।
- तेल ताड़ के साथ सब्जी भिंडी के अंतर फसलन से उच्च फल उपज और सकल आय प्राप्त की गयी और बाद में कर्नाटक के तुंगभद्रा कमांड क्षेत्र के अधीन तरुण तेल ताड़ों के साथ टमाटर और फ्रेंगन की खेती से उच्च उपज प्राप्त की गयी।

EXECUTIVE SUMMARY

The All India Coordinated Research Project on Palms with its headquarters at ICAR-CPCRI, Kasaragod, coordinates research in 27centres located in thirteen states and one union territory representing different agro climatic regions have been successful in developing location specific technologies to improve the productivity of coconut, oil palm, arecanut and palmyrah. Progress of research work in the mandate crops under genetic resources and crop improvement, crop production, disease management, pest management and post harvest technology along with the transfer of technologies to the farmers during the year 2016-17 is presented in this report.

Research achievements during 2016-17

Coconut

Genetic Resources and Crop Improvement

At Aliyarnagar centre, Kalpa Shatabdi variety having higher copra content was recomended for release in Tamil Nadu state. location-specific hybrid combinations are under evaluation. The trial is four years old and among the combinations, MGD x ALR 1 was observed to be the earliest to start flowering (34 months). The crosses COD x ALR (65 nuts/palm/year) and ALR x MGD (58 nuts/palm/year) were found to be promising. Evaluation of released varieties/hybrids in coconut at HRS, Ambajipeta revealed that the hybrids, VHC-1 and Godavari Ganga performed better with higher nut yield of 139 and 136 nuts/palm/year, respectively. However, significantly higher copra content/ nut was recorded in Chandra Sankara (168.7 g) and was on par with Philippines ordinary (166.6 g) and VHC-2 (166.8 g).

Crop Production

In coconut + cocoa + banana + pineapple cropping system, integrated nutrient management (INM) with 75% of recommended NPK through fertilizer coupled with 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 organic recycling (Rs. 3.07 lakhs per ha) and fully organic treatment (Rs. 2.96 lakhs per ha) at Aliyarnagar centre. At Ambajipeta, among the nutrient management practices, the net returns were higher in fully organic treatment (Rs. 2.34 lakhs per ha and BC ratio = 3.58) followed by 50% of Rec. NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring (Rs. 2.16 lakhs per ha and BC ratio= 3.36) compared to monocrop of coconut with net returns of Rs. 0.76 lakhs and B: C ratio of 3.16. At Arsikere centre, integrated farming system with coconut + green fodder + cows recorded higher net returns (Rs. 1.29 lakhs) and B: C ratio (2.06) compared to monocrop of coconut (net return = Rs. 0.60 lakhs ha and B:C ratio = 1.64).

Crop Protection

Disease Management

Survey and surveillance of coconut diseases

Roving survey conducted in three states viz., Andhra Pradesh, Tamil Nadu and Karnataka for the major diseases of coconut revealed occurrence of basal stem rot, stem bleeding, leafspot, leaf blight and bud rot. The incidence of basal stem rot was the highest in Andhra Pradesh with PDI of 9.35%, followed by Karnataka (3.13%) and Tamil Nadu (1.46%). Stem bleeding disease was also more severe in Andhra Pradesh with PDI of 2.43%, followed by Karnataka (1.95%) and Tamil Nadu (0.05%). Fixed plot survey conducted at different locations in three states revealed a general increase in severity and spread of basal stem rot and stem bleeding disease over a period of one year. Foliar diseases like leaf blight and leaf spot were reduced over a period of one year.

Basal stem rot disease

Thirteen isolates of *Ganoderma* were collected from Karnataka, Tamil Nadu and Andhra Pradesh and their variations have been characterized. *Ganoderma* isolates took around 15 months to kill coconut seedling under artificial inoculation conditions. There was a

positive correlation of basal stem rot disease index with maximum temperature. Among the different intercropped gardens, banana intercropped gardens recorded lesser incidence of basal stem rot disease at Andhra Pradesh and Karnataka.

Management of basal stem rot disease in coconut

Soil application of talc based formulation of 125 g each of *Trichoderma reesei* and *Pseudomonas fluorescens* + 5 kg of neem cake per palm at yearly interval, and soil application of talc based formulation of 125 g each of *T. reesei* and *P. fluorescens* + 5 kg of neem cake per palm at yearly interval+root feeding of 1 ml of Hexaconazole in 100 ml water thrice in a year + micronutrient application @ 1 kg/palm/year recorded lesser disease incidence.

Stem bleeding disease management

Root feeding of Propiconazole @ 2 ml + 100 ml water at quarterly interval recorded the lowest disease index.

Pest Management

Rhinoceros beetle

At Aliyarnagar centre, a significant reduction in leaf damage due to rhinoceros beetle was recorded with chlorantraniliprole (16.6% leaf damage), followed by CPCRI botanical cake + paste (17.1%) and naphthalene balls (18.5%) compared to control (27.3%). A similar trend was observed in Ratnagiri. CPCRI botanical cake + paste followed by chlorantraniliprole gave significant reduction in leaf damage due to rhinoceros beetle at Ambajipeta and Arsikere.

Rugose spiralling whitefly

Incidence of a new invasive spiralling whitefly was noticed in coconut during August 2016, during surveys in several villages of Anaimalai block, Coimbatore Dt., Tamil Nadu. The species was identified and confirmed as Rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin. Observations on the natural enemy fauna in the infested gardens revealed a diverse array of coccinellids along with an aphelinid parasitoid, *Encarsia guadeloupe*. Parasitisation by *E. guadeloupe* was observed to an extent of 78.2 per cent at Kaliyapuram village, Anaimalai block, Coimbatore district, subsequently leading to biosuppression of the RSW.

Black headed caterpillar

During 2016-17, incidence of coconut black headed caterpillar, *Opisina arenosella* was noticed in Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra for which larval parasitoids *viz., Bracon brevicornis, B. hebetor* and *Goniozus nephantidis* were successfully mass reared and distributed by different AICRP (Palms) centres. A total of 12,89,100 numbers of *B. hebetor*, 23,69,000 numbers of *B. brevicornis* and 47,45,200 numbers of *G. nephantidis* were distributed to farmers from Ambajipeta, Aliyarnagar, Arsikere and Ratnagiri centres during 2016-17.

Oil palm

Crop Improvement

In the hybrid combinations of NRCOP 11 to 20 (planted during 2006), under evaluation at Pattukkottai, the FFB yield realized during 2016-17 was significantly higher with NRCOP 17 (21.8 t/ha) and was on par with NRCOP 20 (20.8 t/ha). The hybrid combinations, NRCOP 1 to 10, planted during 2007 at Mulde centre, the FFB yield data during 2016-17 indicated that, the hybrid NRCOP 2 recorded significantly higher FFB yield (22.2 t/ha). Similarly, NRCOP 4 recorded significantly higher FFB yield (16.4 t/ha) at Gangavathi centre. At Vijayarai centre, NRCOP 9 recorded significantly higher FFB yield (25.1 t/ha). Under progeny evaluation trial planted during 2009-10, the hybrid NRCOP 31 performed better as compared to other hybrids with respect to FFB yield (13.5 t/ha) at Mulde centre, whereas at Vijayarai centre, NRCOP 39 gave significantly higher FFB yield (23.7 t/ha).

Intercropping of banana, elephant foot yam and pineapple in juvenile oil palm garden gave additional return of Rs. 85,000/- over sole crop and total return from the oil palm based cropping system was Rs. 2,19,510/- per ha at Mulde centre.

Palmyrah

Crop Improvement

At Pandirimamidi centre, among the 1991 planted germplasm accessions, the highest neera yield was recorded in Acc. No. 11/91 (48.7 l). The highest average number of fruits (12.0) was recorded in Acc. No. 12/91 and the highest average number of bunches (6.8) was recorded in Acc. No. 12/91.

Among 1993 planted germplasm accessions, the highest neera yield (37.55 l) was recorded with the Acc. No.3/93 and Acc. No. 7/93 has recorded the highest number of fruit bunches (7.0). The maximum number of fruits per bunch (11.0) was recorded in Acc. No. 4/93.

Post Harvest Technology

By HTST (High Temperature Short Time) sterilisation of fresh inflorescence sap (collected through CPCRI method), there was no significant quality change up to 10 days and it can be stored for 15 days under refrigerated condition. Shelf life of carbonated/ sulphited (0.01% KMS) neera under refrigerated conditions was up to 14 days and it can be extended up to 30 days by carrying out pasteurization. Palmyrah syrup prepared by concentrating inflorescence sap collected through CPCRI method (up to 68° Brix) found superior in quality compared to traditional method and shelf life of palmyrah syrup at TSS of 63-68° Brix under refrigerated condition was up to 3 months and at ambient condition it was up to 30 days.

Meetings held

XXV Annual Group Meeting

The XXV Annual Group Meeting of ICAR-All India Coordinated Research Project on Palms was held at ICAR- Central Plantation Crops Research Institute, Kasaragod from 19th to 21st May 2016. The inaugural meeting was graced by the presence of Dr. K. Ramasamy, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore, Dr. P. Chowdappa, Director, ICAR- CPCRI, Kasaragod, Dr. R. K. Mathur, Director, ICAR- Indian Institute of Oil Palm Research, Pedavegi, Dr. P. L. Saroj, Director, Directorate of Cashew Research, Puttur, scientists working in various centres of the project and scientists from various research stations of ICAR-CPCRI, Kasaragod. Dr. H. P. Maheswarappa, Project Coordinator, presented a brief report highlighting the activities carried out during last year in various centres of the project.

During 2015-16, a T×T coconut hybrid was recommended for release and promising high yielding oil palm hybrids have been evaluated, which could help in release of the first hybrid of the country in coming years. In crop production, coconut based cropping systems with organic nutrient management was successfully demonstrated at various centres and incorporation of flower crops as intercrops was found to be a profitable option at different centres. Black headed caterpillar was found to be a growing concern in the states of Tamil Nadu and Karnataka and successful management of the pest through mass release of the bio-control agents was demonstrated at various centres. Slug caterpillar incidence was reported in Andhra Pradesh and Karnataka, and its successful management was demonstrated using light traps. A number of activities including demonstrations, trainings and diagnostic field visits were carried out during the year for the benefits of the stakeholders.

Four publications were released from the AICRP centres during the inaugural session. The performance of AICRP centres is being evaluated every year and during 2015-16, AICRP centre, Aliyarnagar was judged as the best performing centre.

The plenary session was held on 21st May, 2016 under the chairmanship of Dr. N. K. Krishna Kumar, DDG (Hort. Sci.), ICAR, New Delhi and Dr. P. Chowdappa, Director, ICAR-CPCRI and Dr. R. K. Mathur, Director, ICAR- IIOPR, Pedavegi were also present at the occasion. Dr. H. P. Maheswarappa, Project Coordinator (Palms), briefed about the group meeting programme held for two days along with recommendations. DDG (Hort. Sci.) gave away the certificate and memento to Scientists of the best performing centre. Recommendations from the various sessions were presented for approval of the session. In the chairman's remarks, DDG suggested including cocoa as a mandate crop under AICRP on Palms to address the problems of cocoa crop and renaming the project as AICRP on plantation crops During the programme, 10 publications were released for the benefits of the stakeholders.

Recommendations

- In the studies conducted on the management of eriophyid mite in coconut gardens, it was observed that eriophyid mite damage based on mean damage grade index was the lowest in IPM and INM treated palms with root feeding with azadirachtin 1% (10 ml + 10 ml water) (Mild to moderate -0.1 to 2.0 damage grade index) when compared to the untreated control garden and treatment garden where IPM and INM package without root feeding of azadirachtin.

- The studies with light traps against the slug caterpillar *Darna nararia* revealed that installation of three traps/ha with 200 W incandescent bulb 1 ½′ above + water pan has trapped highest numbers of adult moths. Studies on peak time of slug caterpillar *D. nararia* moth attraction towards the light source revealed that moths got attracted from 19.00 hours onwards and attained peak in between 21.00 to 01.00 hours and gradually decreased to nil at 03.00 hours.
- In the trial on evaluation of various insecticides against the red palm weevil, *Rhynchophorus ferrugineus*, the imidaclorpid treated palms showed hundred per cent recovery from the weevil infestation.
- The vegetable okra intercropped with oil palm recorded higher fruit yield and net returns followed by tomato and brinjal in juvenile oil palm under Tungabhadra command area of Karnataka.

III. PROFILE OF AICRP ON PALMS

3.1. OBJECTIVES

Among the plantation crops, palms such as coconut (*Cocos nucifera* L.), arecanut (*Areca catechu*), oil plam (*Elaeis guineensis* Jacq.) and palmyrah (*Borassus flabellifer* 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 with the following objectives:

- To identify, conserve and utilize elite genetic resources for useful traits in palms from different agro-climatic regions and to evaluate performance of varieties/hybrids under different locations and to facilitate release of varieties/ hybrids .
- To improve input use efficiency and develop location-specific palm based integrated farming systems to enhance the productivity per unit area and organic cultivation packages for palms and palm based farming system.
- To evaluate bio-intensive pest and disease management strategies, modeling and forecasting of disease incidence and documentation of pest dynamics in changing scenario of palm ecosystem.
- Development of post-harvest technologies in palmyrah and to demonstrate and transfer of technologies to the farmers.

3.2. LIST OF THE CENTRES

The project is implemented in 27 centers with its headquarters at Kasaragod and, 15 centers are conducting research on coconut, eight on oil palm, four on arecanut and two on palmyrah. The coordinating centers are located in 13 states and one union territory covering 12 SAU's/SHU's, 2 Central Agricultural University and four ICAR institutes.

State	Center/Location	Area of Research	University/Institution
Andaman and Nicobar	Central Island Agricultural Research Institute, Port Blair - 744 101, Phone : 03192-250436	Coconut and Arecanut: Crop Improvement & Production	Indian Council of Agricultural Research
Andhra Pradesh	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
	Agricultural Research Station, Vijayarai, West Godavari Dt. - 534 475, Phone : 08812-225431	Oil Palm: Crop Improvement & Production	
	Horticultural Research Station, Pandirimamidi, Ramapachodaram, East Godavari Dt. - 533 288, Phone : 08864-246577	Palmyrah: Crop Improvement, Production & Post Harvest Technology	
	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
Arunachal Pradesh	College of Horticulture & Forestry, Pasighat - 791 102, Phone : 0368-2224887	Oil Palm: Crop Improvement & Production	Central Agricultural University, P.O. Box 23, Imphal, Manipur - 795 004
Assam	Horticultural Research Station, Kahikuchi, Guwahati Kamrup Dt. - 781 017, Phone : 0361-2840232	Coconut: Crop Improvement & Production	Assam Agricultural University, Jorhat, Assam - 785 013

Bihar	Bihar Agricultural College, Sabour, Bhagalpur Dt. - 813 210, Phone : 0641-2451001	Coconut: Crop Improvement & Production	Bihar Agricultural University, Sabour, Bhagalpur, Bihar - 813 210
	Regional Research Station, Madhopur, Majhaulia Via., West Champaran Dt. - 845 454, Phone : 06252-280542	Oil Palm: Crop Improvement & Production	Rajendra Central Agricultural University, Pusa, Samastipur, Bihar - 848 125
Chhattisgarh	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagdalpur - 494 005, Phone : 07782-229360	Coconut: Crop Improvement & Production	Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh - 492 012
Goa	Central Coastal Agricultural Research Institute, Ela, Old Goa Dt. - 403 402, Phone : 0832-2285448	Coconut: Crop Improvement & Production. Arecanut : Crop Improvement and Production	Indian Council of Agricultural Research
Gujarat	ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari - 396 450, Phone : 02637-282144	Coconut: Crop Improvement & Production	Navsari Agricultural University, Navsari, Gujarat - 396 450
Karnataka	Horticultural Research Station, Arsikere, Hassan Dt. -573 103, Phone: 08174-291565/291711	Coconut: Crop Improvement, Production & Protection	University of Horticultural Sciences, Navanagar, Bagalkot, Karnataka - 587 102
	Agricultural Research Station, Gangavathi, Koppal Dt. - 583 227, Phone: 08533-271443/271034	Oil Palm: Crop Improvement & Production	
	Arecanut Research Centre, College of Agriculture, Navile, Shivamogga Dt. – 577 225, Phone : 08181-267011	Arecanut : Crop improvement, Production and Protection	University of Agricultural & Horticultural Sciences, Navile, Shivamogga, Karnataka - 577 225
	Agricultural and Horticultural Research Station, Bavikere, Chikkamagaluru – 577 144, Phone : 08261 255122	Oil Palm: Crop Improvement & Production	
Kerala	Central Plantation Crops Research Institute, Kasaragod - 671 124, Phone : 04994-232733	Coconut: Crop Production	Indian Council of Agricultural Research
	Regional Agricultural Research Station, Pilicode P.O., Kasaragod - 670 353, Phone: 0467-2260450	Coconut: Crop Improvement	Kerala Agricultural University, KAU, Vellanikkara, Thrissur, Kerala - 680 656
Maharashtra	Regional Coconut Research Station, Bhatye, Ratnagiri Dt. - 421 612, Phone : 02352-255077	Coconut: Crop Improvement, Production & Protection	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri Dt., Maharashtra - 415 712
	College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. - 416 520, Phone: 02362-244231/244232	Oil Palm: Crop Improvement & Production	
	Central Experimental Station, Asond block, Wakavali, Dalopli Taluk., Phone : 02358-282417	Areanut : Crop Improvement & Production	
Odisha	Department of Horticulture, (OUAT), Bhubaneswar - 751 003, Phone : 0674-2397463	Coconut: Crop Improvement & Production	Orissa University of Agriculture and Technology, Bhubaneswar, Odisha - 751 003
Tamil Nadu	Coconut Research Station, Aliyarnagar, Coimbatore Dt. - 642 101, Phone: 04253-288722/288662	Coconut: Crop Improvement, Production & Protection	Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu - 641 003
	Coconut Research Station, Veppankulam, Thanjavur Dt. - 614 906, Phone: 04373-260205/202534	Coconut: Crop Improvement, Production & Protection	

	Agricultural Research Station, Pattukkottai, Thanjvur Dt. -614 602 Phone : 04373-235832	Oil Palm: Crop Improvement & Production	
	Agricultural College & Research Institute, Killikulam, Vallanad, Tuticorin Dt. - 628 252, Phone : 04630-261226	Palmyrah: Crop Improvement & Post Harvest Technology	
West Bengal	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 - 741 252

3.3. BUDGET

The budget for the year 2016-17 was ₹ 360.00 lakhs (ICAR Share)

(₹ in lakhs)

Sl. No.	Head	Expenditure as on 31.03.2017
1.	Pay and allowances	**233.99**
2.	T.A.	**15.80**
3.	RC	**102.51**
4.	HRD	**5.70**
5.	NRC	**2.00**
	Total	**360.00**

NEH: 24.74 lakhs TSP: 14.15 lakhs

Centre wise budget for 2016-17 (ICAR share)

Centre	Pay	TA	RC	HRD	NRC	Total
Aliyarnagar	23.20	0.80	7.50	0.00	0.00	**31.50**
Ambajipeta	37.79	1.60	7.00	0.85	0.00	**47.24**
Arsikere	19.50	0.50	3.00	0.00	0.00	**23.00**
Jagdalpur	0.00	0.00	0.00	0.00	0.00	**0.00**
Kahikuchi	18.34	1.50	4.50	0.40	0.00	**24.74**
Bhubaneswar	10.36	0.90	4.70	0.10	0.00	**16.06**
Mondouri	17.94	0.80	2.50	0.40	0.00	**21.64**
Ratnagiri	30.00	1.60	5.00	0.20	2.00	**38.80**
Veppankulam	8.50	1.00	6.50	0.00	0.00	**16.00**
Killikulam	19.13	1.00	3.00	0.40	0.00	**23.53**
Pandirimamidi	19.73	1.00	3.00	0.40	0.00	**24.13**
Pattukkottai	12.75	0.60	3.50	0.40	0.00	**17.25**
Gangavathi	0.00	0.00	3.00	0.00	0.00	**3.00**
Mulde	12.75	0.50	4.00	0.40	0.00	**17.65**
Vijayarai	0.00	0.00	3.00	0.00	0.00	**3.00**
Navsari	0.00	0.00	2.50	0.15	0.00	**2.65**
Sabour	4.00	0.00	2.00	0.00	0.00	**6.00**
Pasighat	0.00	0.00	0.00	0.00	0.00	**0.00**
Madhopur	0.00	0.00	0.00	0.00	0.00	**0.00**
Pilicode	0.00	0.25	2.00	0.00	0.00	**2.25**
Kasaragod	0.00	0.00	4.00	0.00	0.00	**4.00**
PC cell	0.00	1.25	4.66	0.00	0.00	**5.91**
Port Blair	0.00	2.50	9.00	0.00	0.00	**11.50**
Goa	0.00	0.00	0.00	0.00	0.00	**0.00**
Shivamogga	0.00	0.00	2.00	0.00	0.00	**2.00**
Wakawali	0.00	0.00	2.00	0.00	0.00	**2.00**
IIOPR, Pedavegi	0.00	0.00	2.00	0.00	0.00	**2.00**
Bavikere	0.00	0.00	0.00	0.00	0.00	**0.00**
Jagadalpur TSP	0.00	0.00	6.75	0.50	0.00	**7.25**
Navasari TSP	0.00	0.00	0.33	0.75	0.00	**1.08**
Bhubaneswar TSP	0.00	0.00	1.50	0.00	0.00	**1.50**
Ratnagiri TSP	0.00	0.00	3.57	0.75	0.00	**4.32**
Total	**233.99**	**15.80**	**102.51**	**5.70**	**2.00**	**360.00**

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.

3.4. STAFF STRENGTH

Category	Present strength
Scientific	35
Technical	20
Supporting	17
Total	72

Staff Position

HEAD QUARTERS

Project Coordinator's Cell, ICAR- CPCRI, Kasaragod, Kerala - 671 124

Project Coordinator : Dr. H. P. Maheswarappa
Scientist (Entomology) : Mrs. Jilu V. Sajan
Private Secretary : Mrs. K. Narayani

UDC : Mrs. A. J. Mary

Skilled supporting staff : Mr. A. Mohana

ANDAMAN & NICOBAR ISLANDS

Central Island Agricultural Research Institute, Port Blair - 744 101 (Phone: 03192 250436; Fax: 03192-251068)

Scientist (Horticulture) : Dr. Ajit Arun Waman

ANDHRA PRADESH

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

Senior Scientist (Horticulture) : Dr. G. Ramanandam

Scientist (Entomology) : Dr. L. Renjith Kumar

Scientist (Horticulture) : Mrs. E. Padma

Scientist (Pathology) : Dr. B. Neeraja

Technical Assistant : Shri. B. Koteswara Rao

: Smt. N. Maheswari

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

Scientist (Horticulture) : Dr. P. Madhavi latha

Agricultural Extension Officer : M. Tirupathi Raju

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

Scientist (Horticulture) : Sri. G. N. Murthy

Scientist (Food Sci. & Tech.) : Er. P. C. Vengaiah

Technical Assistant : A. S. R. Anjaneyulu

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. Narasimha Rao

ARUNACHAL PRADESH

College of Horticulture and Forestry, Central Agricultural University, Pasighat, East Siang Dt. - 791 102 (Phone: 0368- 2224887; Fax - 0368- 2225066)

Scientist (Horticulture) : Dr. Barun Singh

ASSAM

Horticultural Research Station, Kahikuchi, Guwahati, Kamrup Dt. -781 017 (Phone: 0361- 2840232)

Senior Scientist (Horticulture) : Dr. J. C. Nath

Scientist (Agronomy) : Dr. K. K. Deka (upto 16.11.2016)

: Dr. P. Bora (17.11.2016 onwards)

Technical Assistant : Shri. Rajaram Patowari

BIHAR

Regional Agricultural Station, Madhopur, West Champaran (Phone: 06252-280542)

Scientist (Horticulture) : Mr. S. C. Narayan

Bihar Agricultural College, Sabour, Bhagalpur-813210 (Phone: 0641- 2451001)

Scientist (Horticulture) : Dr. Ruby Rani

CHHATTISGARH

Saheed Gunadadhoor 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

Technical Assistant : Vacant

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 Station, Arsikere, Hassan Dt. – 573 103 (Phone: 08174 - 291565)

Senior Scientist (Horticulture) : Mr. R. Siddappa

Scientist (Pathology)	: Dr. Manjunath Hubballi
Scientist (Entomology)	: Dr. G. S. Chandrasekhar
Technical Assistant	: Mrs. Sunita M. Patil
	: Ms. Shweta (from 19.01.2016)
	: Mr. K. E. Dayananda

Agricultural Research Station, Gangavathi, Koppal Dt. - 584 227 (Phone: 08533 – 271034/ 08533 - 271030)

Scientist (Agronomy)	: Dr. Sanjeevaraddi G. Reddi
Research Assistant (Technical)	: Ms. Chandravathi B.

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

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

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

Scientist (Agronomy)	: Dr. Basavaraj Naik

KERALA

Central Plantation Crop 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)

Scientist (Plant Breeding)	: Dr. Vanaja T.

MAHARASHTRA

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

Senior Scientist (Plant Breeding)	: Vacant
Scientist (Agronomy)	: Dr. Shinde V. V.
Junior Entomologist	: Dr. S. S. Chavan
Junior Agricultural Assistants	: Mr. P. A. Shinde
	: Mr. H. B. Yadhav

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

Scientist (Horticulture)	: Mr. V. P. Damodhar (up to November 2016)
	: Mr. N. G. Rathod (from December 2016)
Senior Technical Assistant	: Shri N. M. Naik

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

Scientist (Horticulture)	: Dr. R. G. Khandekar

ODISHA

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

Scientist (Horticulture)	: Dr. S. C. Sahoo
Technical Assistant	: Mr. P. K. Jena

TAMIL NADU

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

Senior Scientist (Plant Breeding)	: Dr. A. Subramanian
Scientist (Entomology)	: Dr. T. Srinivasan
Scientist (Agronomy)	: Dr. S. Rani
Scientist (Plant Pathology)	: Dr. R. Ramjegathesh
Technical Assistant	: Mr. M. Pachalingam
Technical Assistant	: Vacant

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

Scientist (Horticulture)	: Dr. T. Sumathi
Senior Technical Assistant	: Shri. N. Kanagasabapathy

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

Senior Scientist (Horticulture)	: Dr. K. S. Vijai Selvaraj
Scientist (Agronomy)	: Dr. A. Selvarani
Scientist (Plant Pathology)	: Dr. S. Thangeswari
Technical Assistant	: Mr. D. Ravi
	: Mrs. B. Sundari

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

Scientist (Horticulture)	: Dr. T. Prabhu
Scientist (Agrl. Food Proc. Engin.)	: Dr. M. Balakrishnan
Technical Assistant	: Tmt. P. Anantha Bai

WEST BENGAL

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

Senior Scientist (Plant Breeding)	: Dr. D. K. Ghosh
Scientist (Agronomy)	: Dr. D. K. Ghosh (LKN)
Technical Assistant	: Mr. A. K. Dey

IV. EXPERIMENTAL RESULTS IN COCONUT

4.1. GENETIC RESOURCES AND CROP IMPROVEMENT

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

Germplasm conservation plays a prime role in crop breeding as the very objective of the activity is to preserve the genetic diversity of a particular plant or genetic stock for its use at any time in future. Research efforts were undertaken to conserve and evaluate coconut germplasms; collect, conserve and evaluate local germplasm collections and evaluate elite genotypes from germplasms in multi-location trials.

Expt. 1: Evaluation of conserved germplasms

This trial was laid out at Bhubaneswar, Navsari and Sabour centres for conservation and multi-location testing of coconut germplasm and their evaluation for yield and reaction to biotic and abiotic stresses. The experiment was laid out as un-replicated observational trial with 10 palms (Sabour) and 5 palms (Bhubaneswar and Navsari) per genotype.

List of germplasms under evaluation in Gen. 1: Expt. 1 trial

Centre	Genotypes evaluated
Bhubaneswar	COD, Sakhigopal, MYD, St. Vincent, SSG, Guam type I, BSI, Andaman Ordinary, Zanzibar Tall, San Ramon, Benaulim Tall, Gangabondam, WCT, MGD, Tiptur Tall and Java Tall.
Navsari	COD, MYD, Gangabondam, CGD, Benaulim Tall, PHOT, Kappadam, Seychelles, Borneo, FMS, LCOT, ADOT, San Ramon, Guam , New guinea tall, WCT, BRR, BGL, BYL and Spicata.
Sabour	LCOT, PHOT, ADOT, Benaulim, Tiptur Tall, Arasampatti Tall, ECT, Gonthembili Tall, Zanzibar Tall, Hazari Tall, Assam green Tall, Malayan Yellow Dwarf, Malayan Orange Dwarf, Kamrup green dwarf, COD, GBGD and Sakhigopal.

Bhubaneswar

Sixteen germplasm accessions comprising of 4 dwarfs and 12 talls were planted during 2004 as the un-replicated trial for evaluation. Among the dwarfs, Gangabondam performed better by exhibiting maximum plant girth (133.5 cm), number of functional leaves (27.7/palm), rate of production of leaves (12.7/palm), leaf length (4.8 m) and number of inflorescences (11.7/palm). Among the talls, maximum plant height (4.5 m) and the largest leaf (5.6 m) with wider leaflets (5.7 cm) was recorded in BSI. But the maximum number of functional leaves (29.2/palm) and stem girth (185.8 cm) were registered in Guam. Among the floral characters studied, the maximum number of inflorescences (11.50/palm) was recorded in Tiptur tall, whereas, the maximum number of female flowers per palm (177.8) was recorded in BSI. The highest yield (50.3 nuts/palm) was recorded in Andaman Ordinary Tall (Table 1).

Navsari

The germplasms comprised of four dwarfs and 15 talls, seedlings of which were planted during August 2014, and the trial is in establishment phase.

Sabour

The seedlings were planted during 2013 and are in establishment phase. Among the accessions under evaluation, significantly higher plant height of 453 cm was recorded in the variety Sakhigopal followed by MYD (430 cm) and COD (395 cm). Maximum collar girth of 139.4 cm was observed in COD followed by MYD and Sakhigopal.

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

This experiment was formulated with a view to collect, conserve and evaluate the local germplasm of coconut for yield and reaction to biotic and abiotic stresses. The trials are in progress in Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Pilicode, Ratnagiri, Sabour and Veppankulam centres. The evaluation materials comprise of 10-15 local germplasm collection (IC No. series). Among the collections in

Table 1. Growth and floral attributes of germplasm accessions at Bhubaneswar centre in Gen. 1: Expt. 1 (Year of planting 2004)

Germplasms	Plant height (m)	Plant girth (cm)	No. of functional leaves/ palm	Annual leaf production	Leaf length (m)	Petiole length (cm)	No. of inflore-scence/ palm/ year	No. of female flowers/ palm/ year	No. of nuts/ palm/ year
COD	1.7	77.8	25.0	12.0	4.4	120.3	10.8	157.8	36.0
MGD	2.9	120.5	26.3	12.5	4.8	134.0	9.0	133.5	36.8
MYD	2.0	82.8	26.0	12.5	4.3	120.3	8.5	133.8	34.0
Gangabondam	1.3	133.5	27.8	12.6	4.8	131.5	11.8	220.5	42.0
SSG	2.9	112.2	27.6	12.4	5.1	138.8	9.8	155.4	37.0
Guam type I	3.2	185.8	29.2	12.4	5.3	137.6	9.6	154.2	37.3
WCT	3.5	155.5	27.0	12.8	5.6	154.5	10.0	171.5	39.0
Tiptur tall	3.3	139.0	27.3	12.3	5.4	150.3	11.5	166.0	34.5
St. Vincent	3.9	146.3	27.3	12.3	5.4	159.7	10.7	163.0	33.3
Java tall	2.5	111.0	24.3	12.0	4.6	135.3	9.5	146.5	27.5
British Solomon Island	4.5	178.4	28.8	12.8	5.6	152.6	10.8	177.8	41.2
Andaman Ordinary Tall	4.2	176.0	28.0	12.3	5.4	168.0	11.0	158.3	50.3
Zanzibar tall	4.2	179.7	25.3	12.3	5.0	158.0	10.0	140.3	37.0
Benaulim Tall	2.8	115.0	22.8	12.0	4.8	136.5	10.0	148.0	36.5
San Ramon	2.5	143.6	25.0	12.0	5.0	140.6	8.3	135.3	35.5
Sakhigopal Local	4.1	176.7	27.7	12.0	5.4	147.3	9.7	166.3	33.3
Mean	3.1	139.6	26.6	12.3	5.0	142.8	10.0	158.0	36.9
SD	0.9	34.5	1.7	0.3	0.4	13.7	1.0	21.5	4.9
CV (%)	0.3	0.2	0.1	0.02	0.1	0.1	0.1	0.1	0.1

each centre, some were evaluated in replicated trials and some in observational trials.

Aliyarnagar

A total of 11 germplasms were collected during 2007. Five are maintained as a replicated trial and the rest have been planted as the observational trial.

Replicated trial

Since the replicated trial was under planting, felling of adult palms during 2012 resulted in mortality of some seedlings and the genotypes IC No. 735 and IC No. 736 did not establish well. During the 2012 workshop, it was recommended to include germplasms from Etamozhi region in the replicated trial. Hence these genotypes were replaced with IC No. 742 from Nagerkoil district and IC No. 745 from Theni district during 2013. Since this trial comprises of palms planted in different duration, there is variation in the growth status of already established seedlings and newly gap filled seedlings.

Mean palm height of palm was observed to be 157.7 cm and mean girth was observed to be 130.1 cm. Morphological observations for vegetative growth attributes revealed that among the germplasms, IC No. 743 exhibited good overall vigour. Because of the unevenness in the age of the palms, few palms in each ecotype have started bearing. Among the germplasms under evaluation, IC No. 737 recorded the yield of 67 nuts per palm per year.

Observational trial

Six genotypes are being maintained under observational trial. Palms are seven to eight years old. The mean boll height ranged from 382.0 cm (IC No. 738) to 254.1 cm (IC No. 746) and the overall mean boll height was 324.1 cm. The average girth was 104.3 cm at the base. The maximum leaf length of 590.8 cm was observed in the genotype IC No. 741. A few palms in each genotype have reached flowering phase. Among the genotypes, IC No. 738 recorded the highest yield of 52 nuts/ palm/year.

Ambajipeta

Thirteen elite local germplasm accessions were collected from traditional coconut growing districts *viz.,* Srikakulam, East and West Godavari districts of Andhra Pradesh and seedlings were planted during 2013. Five accessions were planted in replicated trial and eight accessions were planted as observational trial and the seedlings are in establishment stage. Analysis of observations on growth attributing characters revealed non-significant difference among different accessions.

Field view of local germplasm evaluation (Ambajipeta)

Arsikere

Replicated trial

In Arsikere centre, five local germplasms *viz.,* IC No. 811, IC No. 817, IC No. 818, IC No. 820 and IC No. 821 were planted in replicated trial during July 2013 and the palms are in establishment phase. Analysis of observations on growth parameters showed significant difference among all the traits except plant height, boll girth, number of leaves and leaflet length. Maximum plant height (233.4 cm), girth (62.4cm), number of leaves (12.1), leaflet bearing portion (153.7 cm) and petiole length (91.0 cm) was recorded in the germplasm IC No. 820.

Observational trial

A total of eight local germplasms *viz.,* IC No. 823, IC No. 816, IC No. 812, IC No. 815, IC No. 818, IC No. 822, KVK 1 and IC No. 813 were planted during 2013. The accession IC No. 815 recorded the highest palm girth (31.00 cm), number of leaves (10.6) and leaflet breadth (5.4 cm), whereas the highest plant height (185.5 cm), petiole length (82.0 cm) and leaflet length (63.1 cm) was recorded in KRN-2.

Bhubaneswar

Eleven local germplasms were planted in December 2003 as observational trial with 10 palms per germplasm. Among the growth parameters studied, maximum plant height (4.9 m), plant girth at the base (187.8 cm), number of functional leaves (28.4/palm) and annual leaf production rate (12.6/palm/year) were recorded in IC No. 790. The local germplasm IC No. 900 also showed its superiority over others (Table 2) with respect to floral attributes and yield by producing the maximum number of inflorescences (11.1/palm), female flowers (177.6/palm) and yield (51.1 nuts/palm).

Table 2. Growth attributes of local germplasms in Bhubaneswar centre (Year of Planting 2013)

Germplasm/ IC. No.	Plant height (m)	Plant girth (cm)	No. offunctional leaves/ palm	Annual leaf production (No.)	Leaf length (m)	No. of inflorescence/ palm/ year	No. of female flowers/ palm/ year	Nut yield (No. of nuts/ palm/ year)
612457	4.9	187.7	28.4	12.6	5.4	11.1	177.6	51.1
612458	4.5	166.0	28.4	12.6	5.11	11.0	170.7	44.1
612459	3.8	154.2	27.4	12.6	5.5	10.2	158.3	38.9
612460	4.0	162.6	28.2	12.3	5.5	10.1	147.4	35.3
612461	3.3	149.7	26.4	12.4	5.3	10.7	154.4	37.1
612462	3.2	154.8	27.1	12.6	5.4	10.7	109.3	37.1
612463	3.2	156.2	26.9	12.3	5.3	9.3	145.1	34.0
612464	3.6	173.0	27.3	12.3	5.5	11.2	159.2	40.1
612465	3.5	146.2	26.0	12.4	5.2	10.4	156.3	40.0
612466	3.5	160.8	27.8	12.3	5.2	10.8	173.2	41.2
612467	3.2	154.2	25.7	12.2	5.2	10.3	173.7	38.0
Mean	3.7	160.5	27.2	12.2	5.3	10.5	156.9	39.7
SD	0.57	11.76	0.91	0.14	0.11	0.53	19.17	4.70
CV(%)	0.15	0.07	0.03	0.01	0.02	0.05	0.12	0.11

Kahikuchi

In Kahikuchi centre, replicated trial was initiated during 2005 with 10 local accessions of coconut collected from four districts of Assam *viz.*, Kamrup, Darrang, Nalbari and Barpeta, along with two check varieties *viz.*, Kamrupa and WCT. Five new coconut germplasms were collected from Nowgaon and Marigaon districts and planted during April 2009 for evaluation in the observational trial.

Replicated trial

Analysis of data on morphological parameters revealed that the maximum plant height (8.10 m), collar girth (188.6 cm), number of functional leaves (30.0) and annual leaf production (11.9) were recorded in Kamrupa. Early flowering was recorded in accessions IC No. 701, IC No. 703, IC No. 707 and Kamrupa which were aged 67 months from planting. No overlapping of male and female phases was observed in all the germplasms studied. With regard to nut characteristics, the genotype IC No. 702 recorded the highest nut weight (1476.5 g/nut) and tender coconut water content of 375.6 ml/nut. Significantly the highest nut yield of 68.5 nuts/palm/year was observed in Kamrupa compared to other germplasms (Table 3).

Observational trial

Observations on morphological parameters revealed that the maximum plant height was observed in IC No. 711 (5.6 m), whereas collar girth (151.3 cm), leaf production (11.8) and functional leaves (25.6) were the maximum in IC No. 715. The germplasms with IC No. 711, IC No. 713 and IC No. 715 were observed to be early in flowering (72 months after planting).

Mondouri

Ten local germplasms were collected from different districts of West Bengal. Among them, five were planted in replicated trial during 2007 and rest in the observational trial during 2009.

Replicated trial

Significant variation was observed for the vegetative characters studied. Palm height (2.9 m) was observed to be the maximum in IC No. 783 while girth was the highest in IC No. 782 (1.1 m). The maximum nut yield per palm was observed in the collection IC No. 783.

Observational trial

In the observational trial, the highest plant height was recorded in IC No. 788 (3.0 m) and maximum girth was recorded in the collection IC No. 786 (1.3 m). The ecotype IC No. 787 recorded the maximum nut yield (40 nuts/palm/year).

Navsari

Four germplasms were planted in Randomized Block Design (RBD) with five replications during 2013 and the seedlings are in establishment phase. Significantly maximum plant height (601.7 cm), total numbers of functional leaves on the crown (15.7) and total leaf length (428.7 cm)

Table 3. Morphological characters of local germplasm of coconut in replicated trial at Kahikuchi (Year of planting: 2005)

Germplasm/ IC No.	Plant height (m)	Plant girth (cm)	Functional leaf/ palm	First flowering (months)	Nut Yield (nuts/ palm/ year)	Weight of nut (g)
610353	7.1	161.2	26.9	67	52.6	1269.0
610354	7.8	183.8	27.4	68	56.0	1476.5
610355	7.8	180.0	29.3	67	46.5	1265.5
610356	7.7	178.0	27.9	78	55.7	1350.6
610357	7.2	171.7	25.7	70	57.9	1240.5
610358	7.2	156.9	26.9	70	45.6	1320.7
610359	7.6	152.4	27.0	67	55.0	1380.8
610360	7.1	158.3	26.4	70	47.0	1300.7
610361	7.2	156.7	25.8	72	52.0	1385.6
610362	6.9	148.3	25.0	73	56.5	1375.4
WCT	8.0	183.2	27.1	73	49.6	1360.8
Kamrupa	8.1	188.6	30.0	67	68.5	1375.7
CD (5%)	0.3	11.2	1.14	0.88	3.42	43.5

were recorded in IC No. 729. In the case of collar girth (159.7 cm) and petiole length (134.7 cm), IC No. 730 performed better.

Jagdalpur

A total of six local germplasms were planted during 2011 in RBD with four replications. Among the germplasms, maximum palm height (338.7 cm) and girth (98.7 cm) were recorded by the ecotype IC No. 723.

Pilicode

Six dwarf local germplasms collected from different parts of Kerala have been planted in replicated trial, during February 2017, along with a local check, COD. To enhance the collection, a state wide collection drive was initiated during 2014-15 and this resulted in the identification of local germplasms for good mother palms from 14 districts of Kerala.

Ratnagiri

A total of six germplasms collected from Konkan region were planted in replicated and observational trial for evaluation in 2007 and 2010, respectively. Analysis of data recorded in replicated trial showed that the difference among the local germplasms was non-significant for the morphological traits. In the observational trial, the mean palm height was 172.8 cm and girth was 116.4 cm. Maximum boll girth was observed in the accession IC No. 828 (135.0 cm), height in accession IC No. 826 (191.8 cm), number of leaves in accession IC No. 827 (59.2) and functional leaves in accession IC No. 827 (23.0).

To evaluate sweet coconut (*Mohacha Naral*) type found in Guhagar Tahasil of Ratnagiri district (Maharashtra), fourteen seedlings and one set of embryo culture plantlets were planted in the field at Regional Coconut Research Station, Bhatye, Ratnagiri.

Sabour

In Sabour, four local germplasms have been collected. Out of the four, two were collected during the year 2012-13 and seedlings of the same were planted in the main field. During 2016, two germplasms were identified in Munger and Purnea districts and seed nuts were collected.

Veppankulam

Five germplasms were collected and planted during 2005 in RBD as under planting in coconut garden. Subsequently, during 2012, the old palms were removed, retaining the newly planted trial palms. Observations were recorded on nut yield/palm and nut parameters. IC No. 717 was found to be dwarf statured (400 cm) and IC No. 716 recorded the higher annual nut yield (56 nuts/palm/year). Regarding fruit quality characters, IC No. 718 recorded the maximum whole nut weight, de-husked nut weight, kernel weight and copra content (1310 g/nut, 590 g/nut, 280 g/nut and 166 g/nut, respectively) (Table 4).

Table 4. Nut yield and nut parameters of local germplasm in replicated trial at Veppankulam (Year of planting: 2005)

Genotypes/ IC numbers	Nut yield/ palm	Nut weight (g)	Dehusked nut weight (g)	Kernel thickness (cm)	Copra content (g)
599263	56	1200	410	1.3	152
599264	52	1020	470	1.5	140
599265	48	1310	590	1.4	166
599266	51	1030	510	1.4	105
599267	41	1050	505	1.5	110
WCT	46	990	380	1.2	115
Arasampatti Tall	49	785	335	1.0	105
SEd ±	11.8	88.2	42.6	1.3	14.1
CD (5%)	NS	NS	89.1	2.4	NS

Expt. 3: Evaluation of elite germplasms

The experiment was formulated to evaluate few elite exotic coconut genotypes in multiple locations in replicated trials for their yield performance and for reaction to biotic and abiotic stresses. As per the technical program *inter se* crossed seed nuts of different sets of materials were supplied to centres as tabulated below 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.

In all the centres, seedlings were planted during 2015-16, and the trial is in establishment stage. In Aliyarnagar and Arsikere centres, Markham Tall was observed to be more vigorous with a better establishment. At Ratnagiri, all the test entries were observed to be more vigorous as compared to the check (Pratap), for the seedling characters studied. In Bhubaneswar centre, Laguna Tall was observed to have good early seedling vigour.

Participating centres and genotypes under evaluation in Gen. 1: Exp. 3 trial

Elite genotypes	Ambajipeta	Aliyarnagar	Arsikere	Bhubaneswar	Ratnagiri	Veppankulam
Verikkobari tall	*	*	*	*	*	*
St. Vincent tall	*		*		*	
Guam-II tall	*		*			*
Guam-III tall		*		*	*	
Zanzibar tall	*				*	
Straits settlement green	*	*	*		*	
Markham tall		*	*			*
Laguna tall				*		*
Nigerian green		*	*	*	*	*
Palawan tall		*		*		*
Kenya tall	*			*		
Local check	*	*	*	*	*	*

Field view of evaluation of elite germplasms (Bhubaneswar)

Expt. 4: Performance evaluation of INGR 13065 (*Niu Lekha*) dwarf

This trial was initiated at Aliyarnagar and Ratnagiri centres for evaluation of the dwarf genotype INGR 13065 (*Niu Lekha*). The seedlings supplied by ICAR-CPCRI, Kasaragod, were planted in un-replicated trials along with the local check, during July 2015 and they are in establishment phase.

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

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

This was initiated in 2005 at Bhubaneswar centre with an objective of evaluating new hybrids for yield, quality and tolerance to biotic and abiotic stresses. Eight cross combinations were planted in RBD with a check (ECT) with four replications. Analysis of data pertaining to growth, floral attributes and yield revealed no significant differences among the hybrids and check except for girth of the palm at base level (Table 5). The maximum girth (171.9 cm) was recorded in GBGD x PHOT hybrid. Among the hybrids, maximum yield was recorded by ECT x GBGD (49.0 nuts/palm).

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

This trial was laid out to assess the performance of newly developed location specific coconut hybrids, listed below, at nine centres in RBD with four replications.

Aliyarnagar

Analysis of observations recorded during 2015-16 revealed that the mean boll height of palms was 64.8 cm. The maximum height was recorded in the cross KTD x ALR (85.4 cm) and the least height was recorded in the check Kalpatharu (30 cm). Based on all the parameters, KTD x ALR was observed to be more vigorous as compared to other crosses. Among the five hybrid combinations, the combination MGD x ALR 1 was observed to be the earliest to start flowering (34 months). For most of the traits studied, the difference between the

Table 5. Growth attributes of different hybrids of coconut in Bhubaneswar centre

Genotypes	Plant height (m)	Plant girth (cm)	No. of functional leaves/ palm	No. of leaves/ palm/ year	No. of inflorescences/ palm/year	No. of female flowers/ palm/ year	No. of nuts/ palm/ year
Chandra Laksha (LO x COD)	2.5	138.2	27.3	12.4	10.9	173.5	41.8
VHC-1 (ECT x MGD)	2.9	150.0	27.7	12.5	11.2	179.6	44.8
Konkan Bhatye Coconut Hybrid (GBGD x ECT)	3.3	152.9	28.5	12.5	11.4	173.4	45.5
GBGD x PHOT	3.0	171.9	27.6	12.5	10.9	178.2	43.7
ECT	3.3	161.1	28.1	12.5	11.3	172.6	47.7
VHC-2 (ECT x MYD)	3.6	167.9	28.3	12.6	11.6	177.8	48.0
Laksha Ganga (LO x GBGD)	2.7	149.5	27.5	12.5	11.0	170.0	45.6
Kera Sree (WCT x MYD)	2.9	147.6	27.3	12.5	11.3	174.0	47.3
Godavari Ganga (ECT x GBGD)	2.8	160.7	27.5	12.6	11.9	182.7	49.0
C.D. (P=0.05)	NS	12.9	NS	NS	NS	NS	NS

Location specific combinations under evaluation in Gen. 2: Expt. 2

Sl. No.	Centres	Location specific combinations evaluated
1.	Aliyarnagar	Set I: Arasampatti Tall x MGD, MGD x Arasampatti Tall, Kenthali x Arasampatti Tall, CODxArasampatti Tall, COD x Keera Keralam. Set II : WCT x Kenthali , COD x Etamozhi Tall, Kenthali x Etamozhi Tall
2.	Ambajipeta	ECT x Cochin China, GBGD x Cochin China, ECT x PHOT, GBGD x PHOT, PHOT x GBGD, ECT x GBGD
3.	Arsikere	TPT x PHOT, TPT x LCOT, LCOT x MYD, LCOT x MOD, TPT x MYD, TPT x MOD
4.	Bhubaneswar	SKL x COD, MGD x SKL, SKL x GBGD, GBGD x BANA, COD x BANA
5.	Kahikuchi	Assam Green Tall x Cochin China, Assam Green Tall x IND 058, Assam Green Tall x PHOT, IC NO. 502 x Assam Green Tall, IC NO. 501 x PHOT
6.	Mondouri	LCOT x PHOT, ECT x Hazari, PHOT x LCOT, ECT x Jamaica Tall, ECT x Java
7	Ratnagiri	COD x IC NO. 513, COD x BGR, COD x IC NO. 514, IC NO. 513 x COD, BGR x COD, IC NO. 514 x COD
8.	Veppankulam	WCT x Kenthali, WCT x MOD, MOD x WCT, ADOT x COD, WCT x MGD

crosses was non-significant. Few palms in all the hybrids have started bearing. The maximum yield was recorded the hybrid COD x ALR (65 nuts/palm/ year) (Table 6).

Table 6. Growth characters of location specific hybrids planted in Aliyarnagar (Year of planting: 2012)

Hybrids	Palm height (cm)	Plant girth (cm)	Petiole length (cm)	Leaf length (cm)	Months for first spathe emergence	Nut yield (No./palm/year)
COD x ALR	84.8	131.1	145.2	439.8	37	65
ALR x MGD	66.2	165.2	143.5	450.8	38	58
MGD x ALR	65.4	153.9	138.4	457.1	34	52
COD x WCT (c)	62.3	128.9	142.4	433.7	37	38
KTD x ALR	85.4	134.4	145.9	466.9	37	45
WCT (c)	59.3	152.0	155.4	441.4	49	7
Kalpatharu (c)	30.0	182.1	137.3	433.3	—	—
Mean	64.8	149.7	143.9	446.1	—	—
S.E.±	3.7	6.3	3.5	8.2	—	—
C.D. (P=0.05)	10.6	17.9	10.1	23.2	—	—
CV (%)	11.5	8.4	4.9	3.7	—	—

Early performance of hybrids (Aliyarnagar)

Apart from the five location specific hybrids in Set I, three new hybrids, WCT x KTD, COD x Etamozhi Tall and KTD x Etamozhi Tall were planted on 16.07.14 in RBD with four replications, with six palms per replication, along with check WCT. The mean plant height was observed to be 306.4 cm and girth was 89.0 cm. The trial is in establishment phase.

Ambajipeta

The seedlings of six cross combinations were planted during 2011in RBD with three replications. However due to Helen and Phailin cyclones during October and November 2013, some of the seedlings were damaged and subsequently died. Gap filling was done in the month of February, 2014 and the seedlings are in the vegetative stage. The cross combinations showed non-significant differences for growth characters. The combination ECT x GBGD was the first among the crosses to start flowering.

Arsikere

The seedlings were planted during 2012 and the trial is in establishment stage. Analysis of data on morphological parameters revealed significant difference among the hybrids for all traits except the number of functional leaves. Among the hybrids, maximum plant height (316.5 cm), girth (73.3 cm), leaf production (11.3), petiole length (124.9 cm) and the number of leaflets (85.7) was recorded in the cross combination TPT x MYD.

Field view of hybrids (Arsikere)

Bhubaneswar

The data on vegetative and yield attributing characters revealed that there was no significant difference among the palms in different cross combinations. The nut yield ranged from 16.4 nuts/palm/year (GBGD x GUAM) to 30.6 nuts/palm/year (SKL x COD).

Kahikuchi

Among the hybrids under evaluation at Kahikuchi, maximum plant height (614 cm) and girth (137 cm) was recorded in IC No. 501 x PHOT. On the other hand, cross combination Assam Green Tall x Cochin China recorded the highest leaf length (472.3 cm), petiole length (112.6 cm) and breadth of the leaflet (5.7 cm). Highest fruit yield (35 nuts/palm/year) was recorded in Assam Green Tall x PHOT, closely followed by Assam Green Tall x IND 058 (34 nuts/palm/year) (Table 7).

Veppankulam

Analysis of data recorded in the trial revealed that the cross MOD x WCT yielded higher number of nuts (72 nuts/palm/year) which was followed by WCT x Kenthali Dwarf (67 nuts/palm/year). Among the five cross combinations, ADOT x COD registered maximum whole nut weight and de-husked nut weight (950 g/nut and 415 g/nut), respectively whereas VHC1 (check) recorded higher kernel weight and copra content (185 g/nut and 105 g/nut respectively).

Table 7. Growth characters of location specific hybrids planted at Kahikuchi (Year of planting: 2009)

Hybrids	Plant height (cm)	Plant girth (cm)	Annual leaf production (No.)	No. of leaves	Leaf length (cm)	Petiole length (cm)	Nut Yield (Nuts/palm/year)
Assam Green Tall x Cochin China	582	127	10.4	22.0	472.3	112.6	24.0
Assam Green Tall x PHOT	594	128	11.9	27.0	454.6	105.4	35.0
Assam Green Tall x IND 058	567	124	10.9	24.0	425.8	97.6	34.0
IC NO. 502 x Assam Green Tall	590	129	11.5	21.6	452.4	102.0	14.0
IC NO. 501 x PHOT	614	137	11.8	25.0	460.9	104.6	11.0
Kamrupa (Check)	586	128	11.6	21.9	442.4	106.0	–
CD at 5%	**15.75**	**3.67**	**NS**	**1.14**	**8.96**	**1.80**	**5.44**

Mondouri

Analysis of observations recorded showed significant variation among the five different crosses for all the traits studied. The maximum trunk height (2.2 m) was recorded in ECT x Hazari while the maximum number of leaves (19.3) was observed in ECT x Java. The maximum girth (1.3 m) was recorded in the cross LCOT x PHOT.

Ratnagiri

The trial was planted in December, 2006 and observations on morphological parameters revealed no significant differences among the different cross combinations for all growth characters under study. Flowering was observed in all the combinations. The combination COD x IC No. 513 recorded maximum nut yield (66 nuts/palm/year).

Expt. 3: Evaluation of released varieties in coconut

This trial was laid out at Ambajipeta and Bhubaneswar centres to evaluate the promising varieties of coconut arising out of experiments at ICAR-CPCRI and SAUs. The trial, involving the genotypes tabulated below, was outlaid in RBD with three replications.

Ambajipeta

Among different hybrids and varieties evaluated, VHC 1 recorded significantly the highest yield (138.8 nuts/year) and was on par with Godavari Ganga (135.8 nuts/year). Significantly the highest fruit weight was recorded in VHC 2 (1464.7 g) and was on par with Chandra Kalpa (1389.3 g) and Double Century (1356.5 g). The maximum dehusked nut weight was recorded in the Double Century (671.8 g) and was on par with Chandra Sankara (643.8 g).

Varieties/Hybrids under evaluation in Gen. 2: Expt. 3

Centres	Varieties / Hybrids to be evaluated	Year of planting
Ambajipeta	Hybrids: Chandra Sankara, Chandra Laksha, Kera Ganga, Laksha Ganga VHC 1, VHC 2, Godavari Ganga; Varieties: Chandra Kalpa and Double Century (check)	2002
Bhubaneswar	Hybrids: Kera Sankara, Kera Ganga, Kera Chandra, Chandra Sankara; Varieties: Chandra Kalpa and Sakhigopal (check)	2004

Copra content was significantly the highest in Chandra Sankara (168.7 g) and it was on par with Double Century (166.6 g) and VHC 2 (166.8 g) (Table 8).

maximum of 194.4 cm recorded in the cross ADOT x ECT and a minimum of 30.0 cm recorded by the check ALR (CN) 2. A significant difference was observed among the hybrids for palm height. Girth

Table 8. Growth characters and nut features of released varieties and hybrids at Ambajipeta (Year of planting: 2002)

Treatments	Palm height (m)	Plant girth (cm)	Number of bunches/ year	Nut Yield (Nuts/ palm/ year)	Fruit weight (g)	De-husked fruit weight with water (g)	Kernel thickness (cm)	Copra content (g/nut)
Chandra Sankara	5.4	107.0	11.1	104.6	1290.2	643.9	1.3	168.7
Chandra Laksha	5.7	94.0	11.2	112.1	912.0	432.7	1.2	122.3
VHC 1	5.9	121.0	11.2	138.8	971.8	432.3	1.1	111.6
VHC 2	5.9	112.0	11.9	131.2	1464.7	684.7	1.2	166.8
Kera Ganga	5.7	95.0	11.1	116.5	1022.4	453.4	1.2	123.6
Laksha Ganga	5.8	104.0	10.5	97.4	1056.2	475.9	1.3	106.5
Double Century	6.1	150.0	11.1	108.7	1356.5	671.8	1.3	166.9
Godavari Ganga	5.8	90.0	11.9	135.8	1033.7	489.9	1.1	145.6
Chandra Kalpa	5.9	94.0	11.6	104.6	1389.3	377.4	1.3	133.6
S.Em±	0.2	4.0	0.5	2.2	36.6	61.2	0.07	4.9
CD (P=0.05)	0.7	12.0	N.S	6.8	110.8	185.0	N.S	14.8

Bhubaneswar

Analysis of data pertaining to different growth and floral attributes revealed that there was significant variation among the cultivars with respect to plant height, girth, leaf length and rate of production of female flowers. The maximum plant height (3.2 m) was recorded in Kera Sankara (WCT x COD). The maximum girth of the palm was recorded in LCOT (139.7 cm) and maximum yield was recorded in Kera Sankara (39.9 nuts/palm).

Expt. 4: Evaluation of Tall x Tall coconut hybrids

The trial was initiated with an objective of evaluating five T x T 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 centres (Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Kahikuchi, Navsari, Ratnagiri and Veppankulam) for evaluation in RBD with three replications and six palms per genotype per replication.

Aliyarnagar

The trial was planted during 2011. The mean boll height was observed to be 130.1 cm with the

of palm measured at the base was observed to be the highest in the check variety Kalpatharu (182.1 cm).

Among all the hybrids, one palm each in the crosses WCT x TPT and ECT x LCOT were observed to be early bearing (2 yrs, 10 months)

Ambajipeta

The trial was initiated during 2011. However, due to Helen and Phailin cyclones in 2013, some of the accessions died. Gap filling was done during February 2014 and the trial is in establishment stage. During the year 2015-16, significantly the highest plant height of 714.7 cm and leaf length of 308.5 cm was recorded in WCT x TPT. The T x T hybrids exhibited non-significant differences for the number of functional leaves and petiole length.

Arsikere

The trial was initiated during 2012. Analysis of observations recorded during the year 2015-16 revealed that all the growth parameters exhibited significant variation among the entries evaluated for all the traits except leaflets breadth. The hybrid LCOT x ADOT recorded the highest plant height (300.9 cm), girth (75.9 cm), number of leaves (11.7) and petiole length (138.5 cm).

Bhubaneswar

The trial was initiated in June 2013. Analysis of observations revealed that there was no significant difference among the five T x T hybrids. The performance of LCOT x ADOT hybrid was relatively better compared to others with respect to plant height (403.5 cm) and number of functional leaves (14.9/palm).

Kahikuchi

The trial was initiated in 2013. The maximum plant height (281.0 cm), girth (47.5 cm), number of leaves (9.6), total leaf length (266.5 cm) and the number of leaflets (63.0) were observed in LCT x ADOT which indicated better early seedling vigour of the combination.

Navsari

The experiment was laid out in RBD with four replications and six different treatments during 2013. Analysis of the observations recorded revealed that significantly higher plant height (588.2 cm), collar girth (148.7 cm) and total leaf length (424.0 cm) was observed in ECT x LCOT.

Ratnagiri

The trial was initiated in the year 2011. Analysis of morphological observations recorded revealed non-significant difference among different cross combinations for growth characters under study except leaflet length (right and left) and functional leaves.

Veppankulam

Planting of the trial was done in the year 2009. Observation on morphological parameters revealed that the difference among the hybrids was non-significant for the characters studied.

Expt. 5: Evaluation of location specific Tall x Tall coconut hybrids

This trial was laid out in three centres *viz.*, Ambajipeta, Ratnagiri and Veppankulam to evaluate the performance of new T x T combinations as listed below, for yield and reaction to biotic and abiotic stresses. It was laid out in RBD with three replications and the plot size was 6 palms per genotype per replication.

Ambajipeta

The trial seedlings were planted during 2011. However due to Helen and Phailin cyclones during October and November 2013, some of the accessions died. Gap filling was done during the month of February 2014 and the experiment is in establishment stage. Analysis of observations showed non-significant difference among the hybrids for most of the characters studied.

Ratnagiri

The trial was initiated during 2009 and palms are seven years old. Analysis of observation on growth parameters recorded during the year 2015-16 revealed that all hybrids were on par with each other. Among the hybrids, the cross combination PHOT x IC No. 514 showed vigorous growth while LCOT x Banavali Green Round Tall showed dwarf characters with respect to all the vegetative characters.

Veppankulam

The trial was initiated during 2011, among the seven new T x T crosses, non-significant difference was observed for the growth parameters studied during 2015-16. The height of palm ranged from 682.0 cm (San Ramon x Zanzibar) to 860.0 cm (ECT x Zanzibar).

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

This experiment was laid out at Ambajipeta, Mondouri, Ratnagiri, Veppankulam and Pilicode centres to develop short statured hybrids for tender nut purpose, to evaluate hybrids for tender nut, yield and quality and to screen them for pest and disease resistance. The experimental material comprised of five D x D hybrids *viz.*, COD x MYD, COD x MGD, MYD x CGD, GBGD x MOD, CGD x MGD supplied by ICAR-CPCRI, Kasaragod and a local check and

Sl. No	Centres	Combinations evaluated
1.	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
2.	Ratnagiri	PHOT x Banavali Green Round Tall, Banavali Green Round Tall x PHOT, PHOT x IC NO. 513, IC NO. 513 x PHOT, IC NO. 514 x PHOT, PHOT x IC NO. 514, LCOT x Banavali Green Round Tall
3.	Veppankulam	WCT x PHOT, WCT x Cochin China, PHOT x WCT, ECT x Zanzibar, ECT x Java Giant, ECT x PHOT, San Ramon x Zanzibar

these were planted in RBD with four replications with six palms per genotype per replication.

Ambajipeta

The experiment was planted in 2011. However, due to Helen and Phailin cyclones in 2013, some of the accessions died and gap filling was carried out during 2014 and the seedlings are in establishment stage.

Mondouri

The trial was initiated during 2012 and the palms are four years old. Analysis of data on morphological parameters revealed that the height of hybrid COD x MYD was less (183.4 cm) compared to others. Number of leaves (15.0) was maximum in CGD x MGD while the maximum girth (103.3 cm) was recorded in GBGD x MOD.

Ratnagiri

Analysis of data revealed that after four years of planting, there were non-significant differences for most of the growth characters. The hybrid GBGD x MOD recorded the maximum stem girth (95.7 cm).

Pilicode

The trial was initiated in the year 2014 with a set of six D x D hybrids *viz.*, COD x MYD, COD x MGD, MYD x CGD, GBGD x MOD, CGD x MGD and GBGD x CGD and it is in establishment phase. The hybrid COD x MYD was observed to exhibit good early vigour.

Veppankulam

The trial was initiated during 2011. Based on the analysis of observations, it was observed that the cross CGD x MGD recorded the lowest height with less girth (568 cm and 78 cm, respectively) and regarding the tender nut quality parameters, COD x MGD recorded the highest volume of tender nut water (465 ml/nut). Regarding the Total Soluble Solids (TSS), maximum score was observed in the cross MYD x CGD (6.7° Brix) (Table 10).

Field view of DxD hybrids (Veppankulam)

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

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

Demonstration blocks of 10 coconut varieties/ hybrids *viz.*, Kalyani Coconut -1 hybrid, Gauthami Ganga, Konkan Bhatye hybrid, Kera Keralam, Kera Bastar, Kahikuchi hybrid, Kalpa Pratibha, Kalpa Mitra, Kalpa Raksha and Kalpa Dhenu released by different AICRP centres and ICAR-CPCRI, Kasaragod were established in Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour and Veppankulam. The main aim of the demonstration block was to showcase the performance of released cultivars in different agro-climatic conditions. The demonstration block consisted of 10 genotypes and one local check with 10 palms per genotype. The palms in all the centres are four to five years old and started flowering.

Table 10. Growth attributes of D x D crosses at Veppankulam (Year of planting: 2011)

Crosses	Plant height (cm)	Plant girth (cm)	Annual leaf production (No.)	Leaf length(cm)	Nut yield/ palm/ year	Quantity of tender nut water (ml/fruit)
COD x MYD	588	80	13.5	312.6	32	340
COD x MGD	610	80	13.2	308.6	36	465
MYD x CGD	590	90	13.4	310.1	27	330
GBGD x MOD	622	87	13.2	306.5	33	325
CGD x MGD	568	78	12.8	315.9	37	380
COD (Local) check)	620	88	12.4	278.5	31	395
S.Em±	68.95	5.81	0.58	46.87	11.2	33.25
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Expt. 2: Nucleus seed gardens for released varieties

The main aim of this activity is to establish nucleus seed gardens of important varieties for production of quality planting materials. This activity is undertaken in Aliyarnagar, Ambajipeta, Arsikere, Jagdalpur, Kahikuchi, Mondouri, Ratnagiri and Veppankulam centres.

Varieties for large scale multiplication

Sl. No.	AICRP centre	Varieties
1.	Aliyarnagar	ALR1, Kalpa Pratibha, Kera Keralam, COD, Kenthali, MYD, GBGB, MGD
2.	Arsikere	Kalpatharu
3.	Ambajipeta	Gauthami Ganga, Kalpa Pratibha, Kera Bastar
4.	Jagdalpur	Kera Bastar
5.	Kahikuchi	MYD
6.	Mondouri	Kalyani Coconut 1, Kalpa Mitra, Kera Keralam
7.	Ratnagiri	Gauthami Ganga, East Coast Tall, Kera Bastar
8.	Veppankulam	Kera Keralam, Kalpa Pratibha

Aliyarnagar

Seed nuts from Kera Keralam mother palms were sown in nursery periodically and seedlings produced were distributed to farmers. Kalpa Pratibha seed garden comprising of 30 seedling are in establishment phase. The *inter se* crossing is also in progress to produce true to type seed nuts of Kalpa Pratibha. Apart from the above, dwarf gardens of MGD, MYD and CGD, planted in 2015 are in establishment stage. During the year 2016, 40 selfed seedlings of the dwarf variety GBGD were planted for the establishment of mother palm block and the seedlings are in establishment phase. With a view of establishing mother palm block of Kalpatharu, 75 *inter se* mated seedlings of the variety were procured from ICAR-CPCRI, Kasaragod. The same will be planted in Aliyarnagar farm during July 2017. *Interse* mating is also being undertaken to produce Kalpa Shatabdi seedlings for the establishment of nucleus block.

During 2016-17, 5846 seedlings of WCT, 3358 seedlings of ALR 1, 2469 seedlings of Kalpatharu, 749 seedlings of COD, 864 seedlings of Kenthali dwarf and 2321 seedlings of Chandra Sankara hybrid were distributed to farmers, from the mother palms and crossing blocks maintained at CRS, Aliyarnagar.

Arsikere

A mother block of 40 seedlings of Kalpatharu, 50 seedlings of COD, 50 seedlings of GBGD, 25 seedlings of MYD, 25 seedlings of MOD, 10 seedlings of Fiji Tall, 25 seedlings of Kulashekaran Green, 15 seedlings of MGD, 15 seedlings of ECT varieties/ hybrids were planted in the nucleus seed garden.

Ambajipeta

Under this project, multiplication of Gauthami Ganga, Kera Bastar and Kalpa Pratibha was allotted for Ambajipeta centre. During 2013-14, the *inter se* crossed seedlings of Gauthami Ganga (300 Nos.) and Kalpa Pratibha (150 Nos.) were planted at Horticultural Research Station, Ambajipeta for further production of quality planting material. The growth of the seed garden is satisfactory. Further, the mother block of Double Century (PHOT) (120 Nos.) is also being maintained, as it is one of the parents in the production of new hybrid (GBGD x PHOT) which was proposed for release from Horticultural Research Station, Ambajipeta.

Kahikuchi

As the female parent for the hybrid MYD x WCT is limited at the centre, a mother block of MYD with 25 palms was planted in the field. Simultaneous hybridization programme of the above cross was also carried out to produce planting materials. *Inter se* crossed seedlings of Kamrupa (150 Nos.) were planted at the centre (HRS, Kahikuchi) during 2011 for the establishment of nucleus seed garden.

Mondouri

A total of 50 palms each of three varieties *viz*., Kalyani Coconut – 1, Kera Keralam and

Kalpa Mitra were planted in the year 2009 and the mother palm blocks are in establishment phase.

Ratnagiri

For large scale multiplication of newly released varieties, seedlings were planted on large scale in the orchard. About 175 seedlings each of ECT and GBGD and 290 seedlings of Kera Bastar have been planted.

Veppankulam

Seed garden of Kera Keralam variety was established in an area of 2 ha and production of planting materials for Kalpa Pratibha variety is in progress with the available mother palms.

Field view of mother block of GBGD (Ratnagiri)

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

Sabour

Treatments

T_1 : Control (No fertilizer)

T_2 : 25% of Rec. NPK through drip system

T_3 : 50% of Rec. NPK through drip system

T_4 : 75% of Rec. NPK through drip system

T_5 : 100% of Rec. NPK through drip system

T_6 : 100% of Rec. NPK as soil application (as per recommended schedule)

Design : RBD with 4 replications

Sabour

The experiment was initiated during October 2012 in four years old Sakhigopal Tall variety of coconut. The different fertigation levels were found highly significant with respect to plant growth parameters like maximum plant height (435.5 cm), collar girth (172.5 cm), number of functional leaves (24.0/plant) and annual leaf production (10.4 per plant) recorded in T_5 (100% RDF fertigation) followed by T_4 (75% RDF through fertigation). Similarly, leaf growth parameters like leaf length, number of inflorescence per plant, initial number of female flower and initial fruit set were recorded the highest in T_5 (100% RDF fertigation) followed by T_4 (75% RDF through fertigation), whereas in palms under T_1 (no fertilizer application) growth parameters were significantly poor. Palms under T_5 (100% RDF fertigation) were earliest to flower (62.5 months after planting) and was on par with T_6 (100% RDF though basin application), whereas palms under T_1 treatment took the maximum time for flowering (78.5 months).

Agron. 10: Development of coconut based integrated cropping system models for different agro-climatic regions

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour and Veppankulam)

The development of location specific cropping system model was started during 2008-09 at different centres, covering an area of 0.40 ha. The crops were planted as per the combinations suggested for different agro–climatic regions. During 2012-13, three integrated nutrient management treatments were imposed in the cropping system along with monocrop.

Treatments:

T_1 : 75% of Rec. NPK + organic recycling with vermicompost.

T_2 : 50% of Rec. NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring.

T_3 : Fully organic: organic recycling with vermicompost + vermiwash application + biofertilizer application, *in situ* green manuring and green leaf manuring (Glyricidia loppings) + composted coir pith and mulching with coconut leaves.

T_4 : Control (monocrop of coconut with recommended NPK and organic manure).

Aliyarnagar

The coconut based cropping system with cocoa (CCRP 1, CCRP 8, CCRP 9 and CCRP 10) + banana (Nendran) + pineapple (Kew) was started during 2008. Black pepper (*var.* Panniyur-1) was included in the cropping system during December 2015.

During the year 2015-16, integrated nutrient application of 75% of recommended NPK through fertilizer coupled with 25% NPK through organic recycling with vermicompost (T_1) recorded higher nut yield and intercrops yield, along with higher net income (Rs. 3,28,150/ha) followed by 50% of recommended NPK + 50% through organic (Rs.3,07,200/ha) and fully organic treatment (Rs. 2,96,500/ha). Nut yield recorded under monocrop of coconut (T_4) was the lowest and the same trend was seen in net returns also (Rs. 1,06,500/ha) (Table 11).

Ambajipeta

The coconut based cropping system with cocoa + banana + pineapple + elephant foot yam (*Kharif*) - tomato (Rabi) + heliconia was started during 2008 in 20 years old Godavari Ganga plot. During

Table 11. Yield and economics of coconut and intercrops in the cropping system (Aliyarnagar)

Treatments	Coconut (nuts/ha)	Yield of intercrops			Net income (Rs./ha)	B:C ratio
		Cocoa (kg/ha)	Banana (kg/ha)	Pineapple (kg/ha)		
T_1	18798	310	15550	2410	328150	2.40
T_2	17065	296	15215	2360	307200	2.44
T_3	16688	281	15000	2280	296500	2.49
T_4	13712	-	-	-	106500	1.77

Cocoa @ Rs. 200/kg; Banana @ Rs. 10/kg; Pineapple @ Rs. 10/kg

Coconut based HDMSCS (Aliyarnagar)

Coconut based HDMSCS (Ambajipeta)

2015 -16, the nut yield was higher in T_1 (178.5 nuts/palm) followed by T_2 (172.6 nuts/palm), T_3 (168.5 nuts/palm) and the lowest in T_4 (142.5 nuts/palm). The yield of intercrops was also higher in T_1 followed by T_2 and T_3. Integrated nutrient management of 75% of recommended NPK with organic recycling with vermicompost recorded higher net income (Rs. 1,91,063 per ha) followed by fully organic nutrient management treatment (Rs. 1,85,019/ha) and 50% of recommended NPK + recycling of organic (Rs. 1,75,368/ha). The earthworm and microbial population were higher in the cropping system compared to monocrop of coconut (Table 12).

Arsikere

The intercrops like cocoa, lime and drumstick were planted in the coconut based cropping system during October 2008. Banana was added to the cropping system during October 2012. During 2015 -16, the number of leaves on the crown, annual leaf production and the number of bunches and buttons per palm were similar in all the treatments. However, the nut yield and copra yield per palm were higher in T_2 and T_3 compared to T_1 and T_4 (monocrop). The productivity of the cropping system was higher than the monocrop of coconut due to additional yield from the intercrops. The dry beans yield of cocoa, fruit yield of lime, pod yield

Table 12. Yield of coconut, intercrops and economics in CBCS (Ambajipeta)

Treatments	Coconut (No. of nuts/ha)	Cocoa dry beans (kg/ha)	Pineapple (kg/ha)	Tomato (kg/ha)	Elephant foot yam (kg/ha)	Heliconia (No. of cut flowers/ha)	Net income (Rs./ha)	B : C Ratio
T_1	31594	504	1725	2835	2025	9720	1,91,063	2.68
T_2	30550	468	1692	2635	1620	9720	1,75,368	2.30
T_3	29824	468	1675	2430	1540	8100	1,85,019	2.10
T_4	25222	—	—	—	—	—	55,579	1.52

Table 13. Yield and economics of coconut based cropping system (Arsikere)

Treatments	Coconut (nuts/ha)	Yield of intercrops (kg/ha)				Net return (Rs./ha)	BC ratio
		Cocoa dry bean	Lime fruit	Drumstick pod	Banana fruit		
T_1	**108000**	257	1100	838	6404	205030	3.49
T_2	**115320**	282	1178	912	6802	216290	3.36
T_3	**9480**	314	1260	946	7610	234600	3.58
T_4	**9220**	-	-	-	-	75640	3.16

Selling price: Coconut: Rs. 12/nut; Cocoa: Rs. 130/kg; Lime fruits: Rs. 30/kg; Drumstick: Rs. 20/kg; Banana: Rs. 15/kg

of drumstick and fruit yield of banana were higher in T_2 and T_3 compared to T_1. Among the nutrient management practices, the net returns were higher in T_3 (Rs. 2,34,600) followed by T_2 (Rs. 2,16,290) and T_1 (Rs. 2,05,030). The B: C ratio was also higher in T_3 (3.58) followed by T_1 (3.49) and T_2 (3.36). Monocrop of coconut recorded the lowest net returns (Rs. 75640) and B: C ratio (3.16). The earthworm and microbial population were higher in cropping system compared to monocrop of coconut both in the coconut basin and in the inter-space. Among the cropping systems, the earthworm and microbial population were higher in T_3 (Fully organic) followed by T_2 and T_1, both in the coconut basin and in the inter-space (Table 13).

Coconut based HDMSCS (Bhubaneswar)

Bhubaneswar

The crop combination of coconut + guava + banana + pineapple was restructured during 2012-13 and three treatments of integrated nutrient management were imposed in the cropping system. Colocasia was added to the coconut based cropping system during 2015. The performance of the intercrops like banana and guava was better in T_2 followed by T_1 and T_3. Pineapple and colocasia performed relatively better in T_1 followed by T_2 and T_3 treatments. The yield of coconut as well as the intercrops was higher in integrated nutrient management treatments (T_1 and T_2) compared to fully organic treatment (T_3). The maximum net return (Rs. 1,83,345/ha) was recorded in T_1 followed by T_2 (Rs. 1,74,452/ha) and T_3 (Rs. 1,33,042/ha) treatments (Table 14).

Jagdalpur

The crop combinations of banana: 24 plants (G-9), cinnamon: 24 plants (local var.), guava: 36 plants (VNR Bihi-1), black pepper (Panniyur) + mango ginger/Amahaldi (local var.), colocasia (White Gouraiya), elephant foot yam (Gajendra), bottle guard (Varad) and cowpea (Gomti) were planted in the coconut based cropping system in T_1 to

Table 14. Yield and economics of coconut based cropping system (Bhubaneswar)

Treatments	Coconut (nuts/ha)	Yield of intercrops (kg/ha)				Net return (Rs./ha)
		Guava	Banana	Pineapple	Colocasia	
T_1	7724	1502	3287	4898	1337	183345
T_2	8363	1637	3656	4663	1126	174452
T_3	7397	1383	3112	4137	985	133042
T_4	6885	-	-	-	-	34666

Selling price: Guava @Rs.18/kg; Banana @ Rs. 12/kg; Pineapple @ Rs. 30/kg; Colocasia @ Rs.15/kg and Coconut @ Rs 7/nut

Table 15. Yield of coconut and intercrops in coconut based cropping system (Jagdalpur)

Treatments	Coconut (nuts/ ha)	Yield of intercrops (kg/ ha)							Cost of cultivation (Rs./ha)	Net income (Rs./ha)
		Banana	Guava	Elephant foot yam	Mango ginger	Colocasia	Cowpea	Bottle gourd		
T_1	**11600**	2548	77	1459	986	556	795	1187	75860	196460
T_2	**12100**	3213	135	2356	1373	780	996	1498	88540	251980
T_3	**9625**	2123	68	979	763	498	635	956	68150	149600
T_4	**9465**	-	-	-	-	-	-	-	32470	62180

Rates of Intercrops: Elephant foot yam Rs. 30/- per kg; Amahaldi Rs. 30/- per kg; Colocasia Rs. 15/- per kg; Cowpea Rs. 10/- per kg; Bottle gourd Rs.10/- per kg; Banana Rs. 20/- per kg; Coconut Rs. 10/- per nut; Guava Rs.50/-kg

T_3. Maximum yield of intercrop as well as the net return (Rs. 2,51,980/ha) and B:C ratio (3.8) was found under 50% NPK + vermicompost + vermiwash + biofertilisers + *in situ* green manuring followed by 75% NPK + vermicompost (Rs. 1,96,460/ha and 3.5) and fully organic nutrient management (Rs.1,49,600/ ha and 3.2) (Table 15).

Kahikuchi

The coconut based cropping system comprising of turmeric, pineapple, Assam lemon, banana and black pepper with coconut was started during 2008. Three treatments of integrated nutrient management were imposed from March 2013 and the performance of coconut based cropping system was compared with the control plot of monocropping of coconut. Microbial population (bacteria, fungi and actinomycetes) and earthworm population of soil were recorded higher in T_3 followed by T_2 and the lowest was recorded in T_4. The highest net return (Rs. 4,79,810) with benefit cost ratio (1.61) was recorded in T_2 followed by T_1 and the lowest net return (Rs. 3,95,150/ha and B:C ratio of 1.24) was recorded in the treatment by fully organic nutrient management. Control plot (coconut monocropping) was recorded a net return of Rs. 64,150/ha and benefit cost ratio of 1.18 (Table 16).

Mondouri

The performance of component crops in the cropping system comprised of coconut + black pepper + banana + elephant foot yam were evaluated (Table 17).

Table 16. Yield and economics of coconut based integrated cropping system (Kahikuchi)

Treatments	Coconut (Nuts / ha)	Yield of intercrops (kg/ha)					Net return (Rs./ha)	B:C ratio
		Pine apple	Banana	Assam lemon	Turmeric	Black pepper		
T_1	13225	16720	13500	5400	13025	176	425610	1.43
T_2	14000	17750	15745	6250	14450	185	479810	1.61
T_3	12750	16250	12750	4890	12250	160	395150	1.24
T_4	11700	-	-	-	-	-	64150	1.18

Table 17. Yield and economics of coconut based cropping system (Mondouri)

Treatments	Coconut (nuts/ ha)	Yield of intercrops (ha)				Cost of production (Rs/ha)	Net return (Rs/ha)	B:C ratio
		Banana (kg)	Lemon (No.)	EF yam (kg)	Dry black pepper (kg)			
T_1	18320	17953	16376	8876	326	259547	347975	2.34
T_2	17612	15287	14774	7110	265	250622	274830	2.10
T_3	17435	13616	13528	4800	167	254219	174230	1.69
T_4	18320	Nil	Nil	Nil	Nil	90490	92705	2.0

T_1 = 75% RDF + organic; T_2 = 50% RDF + organic; T_3 = 100% organic; T_4 = Full RDF + organic.
Market price: Coconut @ Rs10/piece; onion @ Rs10/kg; potato @ Rs.10/kg; Black pepper @ Rs500/kg and Banana @ Rs 6/kg.

Coconut based HDMSCS (Mondouri)

Treatment T_1 recorded the highest net returns (Rs. 3,47,975/ha), with a B:C ratio of 2.3 followed by T_2 with a B:C ratio of 2.1 and net return of Rs. 2,74,830 ha. The monocrop of coconut recorded the lowest net return (Rs. 92,705/ha) with a B: C ratio of 2.0.

Navsari

The crop combination of coconut + banana + turmeric + tannia + elephant foot yam was followed in the centre. The nut yield of coconut, fruit yield of banana, tuber yield of elephant foot yam and leaf yield of tannia were maximum in 50% RDF + organic Recycling (T_2) treatment. But the rhizome yield of turmeric crop was maximum in T_3 followed by T_2 and T_1. Moreover, the highest net return with B:C ratio (3.18) was recorded in T_2 followed by T_3 (2.83) and T_1 (2.26) (Table 18).

Ratnagiri

The cropping system comprised of coconut + nutmeg (Konkan Swad) + cinnamon (Konkan Tej) + banana (Konkan Safed Velchi) + pineapple (Kew) was started during June 2008 and integrated nutrient management treatments were imposed during 2012-13. The number of functional leaves and number of buttons per palm was significantly higher in T_2 (50% of RDF + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring) followed by T_1 and T_3 treatments (Table 19). The highest net income of Rs. 6,43,885/ha and B:C ratio of 3.87 were recorded in application of 50% of recommended NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring followed by fully organic nutrient management (net income of Rs. 6,29,357/ha and

Table 18. Yield of coconut and component crops in the CBCS at Navsari centre

Treatments	Yield of coconut (nuts/ha)	Yield of component crops (kg/ha)				Net return (Rs./ha)	B:C ratio
		Banana	Elephant foot yam	Tannia (No. of leaves/ha)	Turmeric		
T_1	21120	9990	17860	90029	18770	556744	2.26
T_2	24728	11470	23670	103680	19760	719356	3.18
T_3	23320	9250	16700	69984	21530	611723	2.83
T_4	19888	–	–	–	–	85716	1.60

Selling price: Coconut = Rs.7/nut; Banana = Rs. 6/kg; Turmeric = Rs.15/kg; EFY = Rs. 15/kg and Tannia = Rs. 0.50/leaf

Table 19. Yield of component crops in coconut based integrated cropping system (Ratnagiri)

Treatments	Coconut (nuts/ palm)	Yield of intercrops (kg/ha)				Cost of production (Rs./ha)	Net return (Rs./ha)	B:C ratio
		Pineapple (kg)	Banana (kg)	Cinnamon bark (kg)	Cinnamon leaves (kg)			
T_1	123.5	498.7	3500.0	83.1	367.5	377873	584590	3.13
T_2	129.5	568.7	4112.5	166.2	568.7	407456	643885	3.87
T_3	124.8	665.0	4812.5	74.4	393.7	382126	629357	3.33
T_4	110.5	-	-	-	-	118564	151300	1.73

Selling price: Coconut Rs.12/- nuts; Pineapple fruits Rs.30/kg; Banana fruits 20/kg; Cinnamon leaves Rs.100/kg and Bark Rs. 500/kg

Coconut based HDMSCS (Ratnagiri)

B:C ratio of 3.33) and 75% of recommended NPK + organic recycling with vermicompost (Rs. 5,84,590/ ha and B: C ratio of 3.13).

Sabour

The cropping system of coconut + banana + turmeric + guava + pea was initiated during 2014-15. The Shakhigopal tall variety of coconut, Grand naine variety of banana, Rajendra sonia variety of turmeric, Allahabad safeda variety of guava and Azad pea- 3 variety of pea were grown in the cropping system. Plant growth characters likes plant height, plant girth, number of functional leaves, annual leaf production, leaf length and number of inflorescence per plant were highest in T_2 (50% inorganic + organic) followed by T_1 (75% inorganic + organic) and T_3 (100% organic).

Veppankulam

The cropping system model of coconut (ECT) + black pepper (Panniyur 1) + banana (G9) + cocoa (F1 hybrid) was initiated during July 2009 and nutrient management treatments were imposed during 2012-13. The number of functional leaves (29 per palm per year), number of bunches (11 per palm per year) and number of nuts (119 per palm per year) were the highest in T_2 treatment followed by T_3 and T_1 treatments. 50% of recommended NPK + organic recycling with vermicompost+vermiwash application + biofertilizer application and *in situ* green manuring (T_2) was recorded higher net income and B:C ratio (Rs. 3,67,110/ha and 2.90, respectively) followed by fully organic nutrient management (Rs. 3,48,288/ha) and 75% of recommended NPK + organic recycling with vermicompost (Rs. 2,96,490/ha). T_4 registered comparatively low net income (Rs. 1,11,640/ha) with low B:C ratio (1.93). The average earthworm population (23 nos.) and soil microbial population counts (fungi, 14.26 10^{-3} cfu/g of soil and bacteria 16.22 x 10^{-5} cfu/g of soil) were more in T_2 (Table 20).

Agron. 10 A: Development of coconut - livestock integrated farming system models

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

Arsikere

Treatment details

T_1 : Coconut + fodder crops - cows

T_2 : Monocrop of coconut

Area for each treatment: 0.40 ha; Cows: 5

Design : Coconut + fodder crops – cows system is compared with the monocrop of coconut.

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

Fodder legumes : *Stylosanthes hamata* in intraspace of coconut

Fodder trees : Drumstick and agase (*Sesbania grandiflora*) (in the border of the plot).

The experiment was laid out during September 2013. The rooted slips of napier grass (Co-3) were planted in the inter-space of coconut at a spacing of 90 cm x 60 cm on 14.09.2013. The fodder legume - *S. hamata* was sown in the inter-space of coconut on 16.09.2013. The fodder trees - Drumstick and *S. grandiflora*

Table 20. Yield of coconut and intercrops in the cropping system (Veppankulam)

Treatments	Coconut (No. of nuts/ha)	Intercrops			Net income (Rs./ha)	B:C ratio
		Cocoa (kg/ha)	Banana (kg/ha)	Pepper (kg/ha)		
T_1	19250	210	21300	34	296490	2.29
T_2	20825	225	22150	37	367110	2.90
T_3	20125	220	21600	35	348288	2.78
T_4	17850	-	-	-	111640	1.93

[Cocoa @ Rs.205/kg; Banana @ Rs.10/kg; Pepper @ Rs.600/kg; Coconut @ Rs.13/nut]

Model details and centres:

Treatments	Arsikere	Aliyarnagar	Veppankulam
Expt. 1	Coconut + fodder crops-cows; Fodder grass : Hybrid Napier (CO3) in the interspace of coconut; Fodder legumes: *S. hamata* in intraspace of coconut; Fodder trees: drumstick and agase (*S. grandiflora*); Cows – 5 Nos	Coconut + fodder trees + pasture crops-goat Fodder grass: *Cenchrus ciliaris* Fodder legumes *S. hamata* Fodder trees: *S. grandiflora* + *Leucaena leucocephala* + *Glyricidia*	Coconut + fodder trees + pasture crops-goat; Fodder grass: *Cumbu Napier (CO (BN5) + Desmanthus sp.* Fodder trees: *S. grandiflora* + *L. leucocephala* + *Glyricidia*
Expt. 2	Coconut + pasture crops-sheep; Pasture crops: anjan grass + *S. hamata* (3:1) Sheep:20 Nos.	Goat : Tellicherry breed (6+1)	
T_2	Monocrop of coconut		

were planted in the border of the plot. The outputs from coconut and dairy have been quantified and economics of the system has been worked out. The integrated farming system with coconut + green fodder + cows recorded higher net returns (Rs. 1,29,173) and B:C ratio (2.06), whereas the lowest net return (Rs. 60,000/ha) and B:C ratio (1.64) was recorded in monocrop of coconut (Table 21).

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

Treatment details

T_1: Coconut + pasture crops – sheep

T_2: Monocrop of coconut

Area for each treatment: 0.40 ha; Sheep: 20

Fodder crops: Pasture crops: anjan grass + *S. hamata* (3:1)

The experiment was laid out during May 2014. The pasture crops like, anjan grass (*C. ciliaris*) and stylo (*S. hamata*) were sown in the inter-space of coconut on 30.05.2014. The establishment and growth of pasture were satisfactory. The sheep were allowed to graze the pasture from 20.11.2014 and the production of pasture, sheep and sheep manure have been quantified (Table 22).

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

Aliyarnagar

Treatment details

T_1: Coconut + fodder trees + pasture crops – goat

T_2: Monocrop of coconut

Area for each treatment: 0.40 ha. Year of start: 2015-16

Goat: Tellicherry breed

Table 21. Economics of coconut based IFS with cows (Arsikere)

Farming system	Item	Output (2015-16)	Cost of production (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	B:C Ratio
IFS	Coconut	6664 No.'s	16400	79968		
	Fodder	44100 kg	9400			
	Concentrates		21000			
	Cow dung	33088 kg				
	Urine	6180 litres				
	Cows (Maintenance)		74500			
	Milk	6315 litres		170505		
	Total		**121300**	**250473**	**129173**	**2.06**
Monocrop	**Coconut**	6895 No.'s	**22700**	**82740**	**60040**	**3.64**

Note: Area - 0.40 ha; Coconut palms: 70; No. of cows: 5; Coconut: Rs. 12/-per nut (2014-15); Milk: Rs. 27/- per litre

Table 22. Economics of coconut based IFS with sheep (Arsikere)

Farming system	Item	2015-16	Cost of production (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	B:C ratio
IFS	Coconut	3452 No.s	11200	41424	-	-
	Pasture	4200 kg	3800	-	-	-
	Sheep	6000 kg	38500	56200	-	-
	Lamb production	14 No.s	-	-	-	-
	Total		53500	97624	44124	1.82
Monocrop	Coconut	3288 No.s	14600	39456	24856	2.70

Note: Area- 0.40 ha; Coconut palms: 40; Coconut: Rs. 12/- per nut; Sheep: Rs. 250/- per kg live weight

Coconut + grass + sheep integration (Arsikere)

Coconut + grass + goat integrated system (Aliyarnagar)

Fodder crops

Pasture crops: *C. ciliaris* + *S. hamata* (3:1)

Fodder trees: *S. grandiflora* + *L. leucocephala* + *Glyricidia* (in the border of the plot)

Pasture crops like *C. ciliaris* + *S. hamata* (3:1) were sown in the interspaces of coconut. Fodder trees like *S. grandiflora* + *L. leucocephala* + *Glyricidia* were planted all along the border bunds. Recommended package of practices for coconut and fodder crops are being followed. Tellicherry goats (6 female + 1 male) were purchased on 03.03.2016 and included in the coconut based cropping system.

Veppankulam

Treatment details

T_1: Coconut + fodder trees + pasture crops – goat

T_2: Monocrop of coconut

Design: Coconut + fodder trees + pasture crops – goat system compared with the monocrop of coconut

Area for each treatment: 0.40 ha; Year of start: 2015-16

Goat: Tellicherry breed

Fodder crops

Pasture crops: Cumbu Napier (CO(BN)5) + *Desmanthus sp*.

Fodder trees: *S. grandiflora* + *L. leucocephala* + *Glyricidia*

The experiment was started in the year 2015–16 and Tellicherry breed goats were purchased in the ratio of 6 (female) : 1 (male) for the integrated system. The fodder crops were raised under irrigated condition. The goat manure used as a partly supplement of the nutrient requirement of coconut palms and grasses (Table 23).

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

Expt. 2: Performance of cocoa varieties/ hybrids as intercrop in coconut gardens

(Ambajipeta, Kasaragod, Navsari and Veppankulam)

Ambajipeta

Cocoa clones: 6: VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4 and VTLC-1 (control)

Table 23. Output from the system (Veppankulam)

Sl. No.	Output (0.40 ha)		Remarks	Gross Income (Rs./0.40 ha)
IFS				
1	Coconut (Nos)	8100	Sold at Rs. 13/-	1,05,300
2	Pasture production (kg)	3125	Grazed by goats	–
3	Goat manure (kg)	2125	Used for coconut and pasture	–
4	Lamb production (Nos)	9	–	–
Monocrop (0.4 ha)				
5	Coconut (Nos)	7125	Sold at Rs. 13/-	92,625

Design: RBD; Replications: 4; No. of plants/plot: 6

Spacing: Coconut: 7.5 m x 7.5 m and cocoa: 3.0 m x 7.5 m; Year of start: 2008

Six cocoa clones *viz.*, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4 and VTLC-1 (control) were planted during November 2008 in RBD with four replications. The plant height, height at first branching, canopy spread and the number of branches did not differ significantly among cocoa clones. The dry bean yield was significantly higher in VTLCH-1 (2.2 kg/tree) followed by VTLCH-4 (2.1 kg/tree) (Table 24).

Kasaragod

Seedling and graft of thirteen cocoa clones were planted during 2008. The yield ranged from 34.5 to 95.0 pods/tree in the plants raised from grafts and from 42.0 to 94.0 pods/tree in the plants from seedlings.

Navsari

Five cocoa clones *viz.*, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3 and VTLCH-4 were planted during 2009-10 in RBD with four replications. Significantly maximum number of pods/tree/year (46.2) and total dry bean yield/tree/year (1.7 kg) were recorded in

Table 24. Growth and yield of cocoa clones as intercrop in coconut garden (Ambajipeta)

Treatments	Plant height (cm)	Girth (cm)	No. of beans per pod	Dry bean yield/ tree/ year
VTLC -1	209.2	30.7	34.2	1.9
VTLCC –1	234.7	31.0	37.1	1.8
VTLCH –1	217.3	33.5	41.3	2.2
VTLCH –2	216.2	31.7	33.4	2.0
VTLCH –3	224.8	28.64	38.4	2.1
VTLCH –4	214.8	27.6	34.0	1.9
S Em ±	8.5	1.17	1.3	0.06
CD at 5%	N.S	3.58	4.0	0.18

Coconut + cocoa intercropping system (Ambajipeta)

VTLCC-1 cocoa clone, however, weight of pod (45.7 g) and weight of single dry bean (1.2 g) were recorded in VTLCH-3 whereas, the maximum number of beans/pod (20.8) was recorded in VTLCH-4 and was at par with VTLCC-1 and VTLCH-1. Moreover, the initial yield of coconut (WCT) was 60 nuts/palm and it increased to 78 nuts/palm in the year 2015-16 *ie*. 30 per cent increase over pretreatment yield (Table 25).

Veppankulam

Six cocoa verities/ hybrids *viz*., VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4 and VTLC-1 (control)

were planted in RBD with four replications under coconut garden on 14.08.2008. VTLCH-1 performed well in terms of stem girth (35.0 cm), pod weight (141.5 g/pod), number of beans (32.2 beans/pod) and dry beans yield (2.3 kg/tree) followed by VTLCC-1 (2.00 kg/tree) and VTLCH- 2 (1.95 kg/tree) (Table 25).

Table 25. Pod yield of different clones of cocoa as mixed crop in coconut garden

Clones	Navsari		Veppankulam	
	No. of beans/ pod	Dry bean yield/tree/ year (kg)	Dry bean yield/tree/ year (kg)	No. of beans/ pod
VTLCC – 1	20.70	1.66	2.00	26.52
VTLCH – 1	19.60	1.26	2.32	32.25
VTLCH – 2	16.85	1.33	1.95	26.36
VTLCH – 3	15.10	1.32	1.75	25.24
VTLCH – 4	20.83	1.43	1.60	24.65
CD (P=0.05)	1.90	0.22	2.12	5.01

Expt. 3: Multi location trial (MLT) of cocoa clones under palms

(Aliyarnagar, Arsikere, Kahikuchi, Ratnagiri and Vijayarai)

Objective: To assess the performance of different cocoa clones under coconut in different agro climatic regions

Aliyarnagar

Treatments: 14 (14 cocoa clones)

VTLCP-1, VTLCP-3, VTLCP-5, VTLCP-6, VTLCP-8, VTLCP-9, VTLCP-10, VTLCP-11, VTLCP-12, VTLCP-13, VTLCP-14, VTLCP-15, VTLC-16 and VTLC-9 (control).

Design: RBD; Replication: 2; No. of plants/Replication: 6; Date of planting: 26.08.2013

Spacing: Coconut: 7.5 m x 7.5 m and cocoa: 3.75 m x 7.5 m.

Total of 14 clones were planted on 26.08.2013 with 14 treatments, 2 replications and 6 plants in each treatment. The plant height, girth and canopy spread at third year were not differed significantly between cocoa clones and the height ranged from 1.34 m to 1.99 m.

Arsikere

Treatments: 15 (Cocoa clones-13 and hybrids-2): VTLC-1, VTLC-9, VTLC-13, VTLC-15, VTLC-17, VTLC-18, VTLC-25, VTLC-36, VTLC-37, VTLC-57, VTLC-65, VTLC-128 and VTLCC-1. Cocoa hybrids 2: VTLCH-3 and VTLCH-4.

Design: RBD; Replication: 2; No. of plants/replication: 6; Date of planting: 03.09.2012

Spacing: Coconut: 7.5 m x 7.5 m (175 palms/ha) and cocoa: 3 m x 7.5 m (444 trees/ha).

Age of palms: 35 years; Soil type: Red sandy loam

The cocoa clones were planted in the experiment plot on 03.09.2012 in RBD with two replications. The plant height, number of branches, canopy height, girth, height at first branching, canopy spread and canopy volume were differed significantly between cocoa clones. The girth was significantly higher in VTLCC-1 (13.8 cm) followed by VTLC-18, VTLC-128, VTLC-13 and VTLC-17. The height at first branching was significantly more in VTLCH-57 (1.49 m) followed by VTLC-128 and VTLCH-3. The canopy spread was significantly higher in VTLC-17 (1.5 m^2) and VTLC-18 compared to other clones.

Kahikuchi

Treatments: 16 (15 cocoa clones and 1 hybrid)

Cocoa clones: 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)

Design: RBD; Replication: 2; No. of plants/ Replication: 6

Spacing: Coconut: 7.5 m x 7.5 m; cocoa: 3 m x 7.5 m (444 plants/ha);

Age of Palms: 45 years; Year of start: October 2015.

The cocoa clones and hybrid procured from ICAR-CPCRI, Regional Station, Vittal were planted in coconut garden on 02-10-2015 in RBD design with 2 replications. The establishment and growth of all the clones and hybrid were found satisfactory.

Ratnagiri

Cocoa clones were planted during November 2012, in RBD with two replications. Due to water logging, there was mortality and gap filling was carried out during February 2014 and September 2016.

Treatments: 21 cocoa clones

Cocoa clones - VTLC-1, VTLCP-8, VTLCP-5, VTLCP-3, VTLC-37, VTLCP-16, VTLC-13, VTLCP-6, VTLCP-14, VTLC-15, VTLCP-10, VTLCP-11, VTLC-17, VTLC-128, VTLCP-12, VTLC-18, VTLCP-9, VTLCP-15, VTLC-25, VTLCP-1, VTLCP-13.

Vijayarai

Treatments (No. of varieties): 14 varieties (VTLC-1, VTLC-9, VTLC-13, VTLC-17, VTLC-18, VTLC-20, VTLC-25, VTLC-36, VTLC-37, VTLC-57, VTLC-65, VTLC-128, VTLCH-3, VTLCH-4), Replications: 2; Design: RBD; Year of planting: December 2012.

During the period, plant height varied among the grafts and VTLCH-3 recorded significantly higher plant height (320 cm) followed by VTLCH-4 and VTLC-17. VTLC-36 recorded the highest plant spread (363 cm) in N-S direction followed by VTLCH-3 and VTLCH-4.

Oil palm + cocoa intercropping system (Vijayarai)

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

(Kahikuchi and Mondouri)

Objective: To find out the best pepper variety/ varieties intercrop in coconut garden

Kahikuchi

Five pepper varieties *viz*., IISR Thevam, IISR Shakthi, IISR Malabar Excel, Sreekara and Panniyur-1 were planted in coconut garden during September 2009. The experiment was laid out in RBD with four replications. Each variety of pepper was planted under six palms in each replication. Among the varieties/hybrids, Panniyur-1 recorded significantly the higher number of spikes (103.4 in one meter column height), spike length (14.4 cm), number of berries per spike (62.6) and yield (1.05 kg/vine) compared to other varieties/hybrid.

Mondouri

Five pepper varieties were planted during 2010-11 under coconut. The performance of the variety Panniyur-l was excellent as compared to other four varieties namely IISR-Thevam, IISR-Shakti, Malabar Excel and Sreekara. Maximum spike length of 13.05 cm was recorded in Panniyur-1 followed by IISR Thevam (8.3 cm). Fresh yield of berries/plant (2.4 kg/ plant) and dry yield (0.84 kg/plant) was recorded higher in Panniyur-1 followed by Sreekara (Table 26).

Table 26. Growth and yield of pepper varieties under coconut

Pepper variety	Spike length (cm)		Dry yield (kg/plant)	
	Kahikuchi	Mondouri	Kahikuchi	Mondouri
IISR Thevam	10.9	8.3	0.86	0.34
IISR Shakti	11.6	6.3	0.72	0.27
IISR Malabar excel	11.5	7.7	0.80	0.36
Sreekara	8.7	7.6	0.78	0.47
Panniyur-1	14.4	13.0	1.05	0.84
CD (P=0.05)	1.34	0.245	0.08	0.042

Expt. 5: Evaluation of coconut based cropping system models

Port Blair

Coconut based cropping system models with different crop combinations viz. coconut alone (T_1), coconut + black pepper + ginger + banana (T_2), coconut + black pepper + ginger + pineapple (T_3) and coconut + black pepper + ginger + elephant foot yam (T_4) were established for evaluating their performance under island condition. All the crops *i.e.* coconut and intercrops are being maintained under organic condition. Black pepper is in juvenile stage, where as flowering has been initiated in pineapple and banana. Yield of ginger under organic condition was found to be 1545 kg/ha, 1738 kg/ha and 1198 kg/ ha in T_2,T_3 and T_4 respectively. Further 4264 kg/ha yield of elephant foot yam was also obtained in T_4.

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

(Mondouri)

Experiment details

Treatments: 7

T_1: Coconut + black pepper + onion + sweet potato

T_2: Coconut + black pepper + turmeric + elephant foot yam

T_3: Coconut + black pepper + ginger + colocasia

T_4: Coconut + black pepper + coriander + sweet potato

T_5: Coconut + black pepper + chilli + sweet potato

T_6: Coconut + black pepper + onion + potato

T_7: Coconut Monocrop

Design: RBD; Replication : 4; No. of palms per treatment: 4; Year of start: 2015-16

The experiment was laid out during 2015-16 in RBD with four replications in COD x WCT experimental plot of 36 years age. Out of the 7 treatments under the cropping system model, maximum nut yield of 106.5 nuts/ha was recorded in the treatment T_2 and T_3. The treatment T_3, coconut + black pepper + ginger + colocasia model recorded maximum B:C ratio of 1:2.27 with a maximum net return of Rs. 3,37,388/ ha. T_5 treatment, coconut + black pepper + chilli + sweet potato model recorded a lowest B:C ratio of 1:1.56 though lowest net return of Rs 93,590/ha was recorded by monocrop (T_7) coconut only (Table 27).

Table 27. Yield and economics of coconut based cropping system with tuber crops and spices

Treatment	Gross return (Rs./ha)	Cost of production (Rs./ha)	Net return (Rs./ha)	B:C ratio
T_1	330940	187137	143803	1.77
T_2	567255	275961	291294	2.05
T_3	603851	266463	337388	2.27
T_4	297880	166346	131534	1.79
T_5	317560	203384	114176	1.56
T_6	314936	185142	129794	1.70
T_7	184080	90490	93590	2.03

T_1: coconut + black pepper + onion + sweet potato; T_2: coconut + black pepper + turmeric + elephant foot yam; T_3: coconut + black pepper + zinger + colocasia; T_4: coconut + black pepper + coriander + sweet potato; T_5: coconut + black pepper + chili + sweet potato; T_6: coconut + black pepper + onion + potato; T_7: coconut monocrop.

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

(Bhubaneswar, Kasaragod and Ratnagiri)

Experiment details

Treatments

Main plot - 3: Cropping systems

Bhubaneswar & Kasaragod	Ratnagiri
C_1: Coconut + sapota + vegetable (rainy season)	C_1: Coconut + *Garcinia indica* + vegetable crops (rainy season)
C_2: Coconut + sapota + pineapple	C_2: Coconut + *G. indica* + pineapple
C_3: Monocrop of coconut	C_3: Monocrop of coconut

Sub plot – 3: Nutrient management practices

N_1: Green manuring + biofertilizers + organic recycling + FYM (as per POP)

N_2: Green manuring + biofertilizers + organic recycling + soil test based nutrient (chemical fertilizers) application

N_3: Green manuring + biofertilizers + organic recycling + 100 % RDF

Husk incorporation was common to all the sub plot treatments. Husk was placed in one layer in the trenches of planting zone.

Bio fertilizers: Azospirillum and Phosphobacteria

Green manuring: Cowpea in the basin as well as in the available interspaces of coconut

FYM: Recommended dose to coconut as well as component crops

Treatment combinations: 3 x 3 = 9; No. of palms per treatment: 6

Design: Split plot design; Replications: 3; Year of start: 2015-16

Bhubaneswar

The experiment was initiated in the littoral sandy soil during 2016. The cropping system was developed by planting intercrops like pineapple, sapota and cowpea during rainy season in 2016.

Kasaragod

This experiment was started with the objective to develop coconut based multispecies cropping system model in coastal 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 subplots, nutrient management (N-1: green manuring + biofertilizer + organic matter recycled + FYM @ 10 t/ha + 50%

RDF, N-2: green manuring + biofertilizer + organic matter recycled + 100% recommended dose of fertilizers + FYM @ 10 t/ha and husk incorporation, coir pith/dried coconut leaves incorporation and control) was studied. Tomato variety Anegha and ashgourd variety Indu were grown during post monsoon season and heliconia was planted. Fodder yield of hedge lucerne *D. virgatus* (fodder crops) was recorded and the data showed that the treatment N-3 (51 t/ha) and N-2 (40 t/ha) (organic recycling + 100% recommended chemical fertilizer) recorded higher fodder yield, which significantly differed from 100% organic treatment N-1 (28 t/ha). The coconut yield recorded during the period 2015-16 reveled that among the system tried coconut+sapota+flower and coconut+sapota+vegetable intercropping recorded higher coconut yield of 131 and 127 nuts/palm respectively and is significantly higher to control (96 nuts/palm).

Ratnagiri

G. indica (Kokum) has been planted as per the treatments. Initial soil nutrient status has been analyzed and observations on pre treatment coconut growth and yield were recorded.

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)

Treatments: 3

T_1- Recommended practice (500:320:1200 g NPK/ palm + FYM- 50 kg/palm + TNAU micronutrient mixture -1 kg/palm+neem cake @ 5 kg/palm)

T_2- Biomanures 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 sunhemp twice a year.

T_3 - T_2 + soil test based nutrient application

Coconut variety: Chowghat Orange Dwarf (COD); Age of palms: 25 years;

No. of palms per treatment – 6; Soil type- Sandy loam

Design – RBD; Replications – 7; Year of start: 2014-15

The experiment was started during 2014-15 in a 10 year old coconut garden of COD variety at Avalchinnampalayam village with 3 treatments *viz.*, T_1: Recommended package of practice, T_2: Biomanures and biofertilizers and T_3: Biomanures and biofertilizers + soil test based nutrient application. The experiment was laid out in RBD with five replications. The growth parameters of coconut *viz.*, palm height, number of functional leaves, number of inflorescence and tender nut yield per palm were recorded. Growth and tender nut yield of dwarf coconut were not significantly influenced by nutrient management treatments (Table 28).

Table 28. Growth parameters and yield of tender nuts in dwarf coconut (2015-16) (Aliyarnagar)

Treatments	Plant height (cm)	No.of functional leaves	No. of inflore-scence	Tender nut yield (nuts / palm / year)
T_1	312.0	24.6	9.6	199
T_2	312.6	25.2	9.6	210
T_3	314.0	26.8	10.0	222
Mean	**312.9**	**25.5**	**9.7**	**210**
SEd ±	**2.93**	**0.28**	**0.02**	**0.42**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**

Expt. 3: Network project on "Organic farming in coconut based farming system"

(Aliyarnagar, Ambajipeta, Arsikere and Kasaragod)

Experimental details

Treatments- 5

T_1: *In situ* organic matter recycling + PGPR consortia+*in situ* green manuring + husk burial

T_2: *In situ* organic matter recycling + PGPR consortia + *in situ* green manuring + husk burial + 25 kg FYM

T_3: T_1 + 50 % recommended K_2 O through the application of sulphate of potash

T_4: T_2 + 50 % recommended K_2 O through the application of sulphate of potash

T_5: Conventional method (chemical fertilizer application)

Design: RBD; Replications: 4; No. of palms per treatment: 6; Year of start: 2014-15

Cropping system to be followed at different centres:

Aliyarnagar: coconut + cocoa

Ambajipeta: coconut + cocoa + banana

Arsikere: coconut + cocoa + lime + drumstick

Kasaragod: coconut + cocoa + pepper trailed on coconut trunk + banana + vegetable + glyricidia along the border

Aliyarnagar

A field experiment was initiated as per the treatments during 2014-15 in 26 years old VHC 2 hybrid coconut garden. 15 m length and 1.3m (4 feet) width trench was formed in-between the coconut trees (T_1 – T_4). Cocoa variety (VTLCS) was planted inside the trenches (6 pits per trench). PGPR consortia and organic manures were applied as per the treatments. The growth parameters (plant height, girth and total number of leaves) were not significantly differed among the treatments. The highest nut yield was recorded in T_4 treatment (168 nuts/palm/year), whereas the lowest was observed in T_5 treatment (150 nuts/palm/year).

Ambajipeta

The trial was initiated during 2015 in a 30 years old East Coast Tall coconut field in four replications. Cocoa and banana were planted as intercrops. Chemical fertilizer application (T_5) recorded the highest total number of leaves on crown (33.0) and number of bunches per year (11.8) followed by T_4 (*in situ* organic matter recycling + PGPR consortia + *in situ* green manuring + 25 kg cow dung + 50% recommended K_2O through application of sulphate of potash).

Arsikere

Year of start: 2015-16; Date of planting of intercrops: 30.09.2015

Nut yield per palm recorded among the treatments was non-significant and ranged from 62.7 to 67.4 nuts/palm/year.

Kasaragod

Nut yield of palms and copra content

The analysis of yield data revealed that there was no significant difference observed for the yield parameters *viz.*, nut yield and copra weight. The organic cultivation treatment, *in situ* organic matter (frond, leaf, inflorescence waste and husk) recycling in trenches made in the interspace of 6 coconut palms (15 m length, 1.2 m width and 60 cm depth) + *in situ* green manuring in the basin + PGPR consortia in the basin + cowdung (50% of Recommended dose of all crops and 50% recommended K_2O using sulphate of potash) (T_4) recorded higher nut yield of 109 nuts/palm/year and followed by T_3 (102 nuts/palm), T_1 (99 nuts/palm), T_2 (97 nuts/palm) and T_5 (85 nuts/palm).

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

(Aliyarnagar)

Objective: Validation of root (wilt) disease management technology

Year of start: 2015-16

Package practices proposed based on the soil test results:

- Addition of organic manure @ 25 kg per palm.
- Application of *Trichoderma sp.* @ 50 g/ palm.
- Sowing daincha seeds in coconut basin @ 100 g/ palm and incorporation before flowering.
- Application of recommended dose of fertilizers.
- Addition of 50 g zinc sulphate per palm

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 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.

In the trial (demonstration) plot incidence of root (wilt) at Coimbatore district was ranged from 4 to 40 and the average root (wilt) disease index was 15.53. The average nut yield per palm per year was 79/palm/year. The root wilt disease intensity in Kanakkapillaivalasai village, Tirunelvelli district ranged from 0-42 in demonstration plot and

the average root (wilt) disease index was 15.28. The average nut yield/palm/year was 96/palm/year. The root (wilt) disease intensity in the trial (demonstration) plot of Melagudalur village, Theni district was ranged from 0 to 50 and the average root (wilt) disease index was 24.10. The average nut yield was 79/palm/year (Table 29).

Among the three districts (Tirunelveli, Theni and Coimbatore), the maximum intensity of root wilt disease (24.1) was observed in Theni district followed by Coimbatore (15.5) and Tirunelveli districts (15.3). Compared to demonstration plot, high disease index and minimum nut yield per palm were recorded in control plot.

Table 29. Incidence of root (wilt) disease in demonstration and control plot at three districts

Particulars	Manakkadavu village Coimbatore District		Kanakkapillaivalasai village, Tirunelveli District		Maelagudalur village, Theni District	
	Demonstration plot	Control plot (Farmers practice)	Demonstration plot	Control plot (Farmers practice)	Demonstration plot	Control plot (Farmers practice)
Ranges of disease index	4 to 40	2 to 48	0 to 42	2 to 46	0 to 50	6 to 56
Average disease index	15.53	16.30	15.28	19.62	24.10	26.02
Nut yield/ palm/ year	79	68	96	86	79	66

4.3. DISEASE MANAGEMENT

Path. 1: Survey and surveillance of coconut diseases

Roving survey

Arsikere

Survey on the occurrence of coconut diseases *viz.*, basal stem rot (BSR), stem bleeding, leaf blight and bud rot was conducted in major coconut growing districts of Karnataka namely Hassan, Shivamogga and Tumkur. The results showed that basal stem rot was predominant in all the above districts and the disease incidence ranged from 1.50 to 5.18 per cent. The maximum incidence of 5.18 per cent was recorded in Tumkur taluk. The incidence of stem bleeding varied across different areas surveyed. Disease incidence ranged from 0.98 to 3.91 per cent. Maximum incidence of stem bleeding was recorded at Bhadravathi taluk and the least incidence was in Soraba taluk of Shivamogga district. Bud rot disease was concentrated more in high rainfall areas than the dry belt. The incidence ranged from 0 to 4.34 per cent. Maximum disease incidence of 4.34 per cent was noticed in Shivamogga taluk. The foliar diseases of coconut namely leaf blight and leaf spot were separately recorded and the intensity of leaf blight ranged from 0 to 19.93 per cent, whereas that of leaf spot ranged from 10.13 to 18.10 per cent. The maximum incidence of 18.10 and 19.93 per cent of leaf spot and leaf blight were recorded at Sagar (Shivamogga Dt.) and Arakalagodu (Hassan Dt.) taluk, respectively.

Aliyarnagar

The roving survey was conducted in different villages of Coimbatore, Tirunelveli, Tirupur, Kanyakumari and Theni districts for the occurrence of coconut diseases. The maximum incidence of basal stem rot was in Theni block of Theni district recording 0.85 per cent followed by Cumbum (0.64%) in Theni district. Further, the maximum incidence of stem bleeding was at Pongalur block in Tirupur district documenting 0.45% followed by Thovalai block (0.34%) in Kanyakumari district. The maximum incidence of bud rot was recorded at Pongalur block (0.35%) and that of leaf spot was at Gudimangalam block (8.49%) in Tirupur district. In addition to this, incidence of leaf blight was also documented in all the surveyed areas and maximum incidence was recorded at Gudimangalam block (13.68%) in Tirupur district.

Ambajipeta

Surveys were conducted of East Godavari, West Godavari, Srikakulam, Vijayanagaram and Visakhapatnam districts of Andhra Pradesh. Major diseases observed in coconut gardens were basal stem rot, stem bleeding and bud rot along with the minor incidence of grey leaf spot. Mean per cent incidence of basal stem rot, stem bleeding and bud rot diseases were 8.56, 2.27 and 0.70 per cent, respectively in the surveyed villages.

Veppankulam

The survey was conducted at three major coconut growing districts in east coast regions of Tamil Nadu, *viz.*, Thanjavur, Thiruvarur and Pudukkottai for the occurrence of coconut diseases during 2016-17. Major diseases observed in coconut gardens were basal stem rot, bud rot and a new disease with unknown etiology, causing button and nut shedding with yellowing and drying of fronds from bottom to top whorl. Stem bleeding disease incidence was not noticed in any of the places where the survey was undertaken. Mean per cent incidence of basal stem rot and bud rot diseases were 2.8 and 0.2%, respectively in the surveyed villages. Maximum incidence of new disease with unknown etiology was recorded at Mannargudi taluk of Thiruvarur district and disease incidence ranged from 0.6 to 2.1 per cent. Further, the bud rot incidence ranged from 0.1 to 0.3 per cent (Table 30).

Fixed plot survey

Arsikere

Fixed plot survey was conducted at Haranahalli and Arsikere taluk. The initial disease incidences were 28.69 per cent in BSR, 18.66 per cent in stem bleeding and 38.60 per cent in leaf blight. At the end of the January 2017, the incidence of BSR and stem bleeding diseases were increased to 45.68 and 24.61 per cent, respectively. However, the incidence of leaf blight disease was decreased to 15.20 per cent.

Table 30. Distribution of coconut diseases in major growing areas of Karnataka, Tamil Nadu and Andhra Pradesh

State	District	BSR (%)	Stem bleeding (%)	Bud rot (%)	Leaf blight (%)	Leaf spot (%)	Unknown etiology
Karnataka	Hassan	2.97	2.33	0.82	11.33	12.43	-
	Shivamogga	3.50	2.24	2.11	10.44	13.35	-
	Tumkur	2.93	1.29	0.55	9.66	13.08	-
Tamil Nadu	Coimbatore	0.54	0.00	0.02	6.54	8.13	-
	Kanyakumari	0.17	0.17	0.00	2.60	4.21	-
	Tirunelveli	0.23	0.04	0.04	2.13	2.09	-
	Tirupur	0.99	0.16	0.21	6.18	10.19	-
	Theni	0.30	0.06	0.00	2.10	3.19	-
	Thanjavur	1.40	-	0.30	-	-	0.60
	Pudukkottai	6.60	-	0.20	-	-	1.00
	Thiruvarur	0.30	-	0.10	-	-	2.10
Andhra Pradesh	East Godavari	17.14	1.61	0.70	-	-	-
	West Godavari	7.91	1.47	0.58	-	-	-
	Srikakulam	12.58	2.50	0.63	-	-	-
	Vijayanagaram	2.00	3.25	0.75	-	-	-
	Visakhapatnam	5.92	1.34	0.60	-	-	-
	S. Rayavaram	2.83	1.50	0.66	-	-	-

Values represent average of each district.

Ambajipeta

Fixed plot survey for stem bleeding and bud rot diseases were taken up at Horticultural Research Station, Ambajipeta and for basal stem rot disease, a survey was conducted in farmer's field at P. Gannavaram village in East Godavari District. Per cent disease incidence (PDI) of basal stem rot during April 2016 was 34.13 per cent, which was increased to 37.62 per cent by the end of March 2017. Per cent incidence of stem bleeding disease varied between 2.08 to 2.68 per cent during the year. Bud rot disease incidence was observed from September 2016 to December 2016 and a range of 1.50 to 2.65 per cent disease incidence was recorded.

Aliyarnagar

Timed plot survey was conducted at Puliyankandi and Karianchettipalayam villages of Anaimalai block in Coimbatore district. The incidence of leaf blight disease ranged from 25.74 per cent to 24.26 per cent and *Pestalotia* leaf spot disease increased from 8.28 to 8.65 per cent during June 2016 to March 2017 at Puliyankandi village. On the other hand, at Karianchettipalayam, the incidence of leaf blight and leaf spot decreased from 20.62 to 19.89 per cent and 6.56 to 5.88 per cent, respectively.

Veppankulam

Fixed plot survey was initiated at Mangadu village in Alangudy taluk of Pudukottai district during December 2012. The survey was conducted in coconut garden having 85 palms. The initial disease incidence of basal stem rot recorded was 28.00 per cent. The observations were recorded at quarterly intervals and it was found that the per cent incidence of basal stem rot was increased to 58.82 per cent during February 2017 (Table 31).

Table 31. Fixed plot survey of coconut diseases at Arsikere, Ambajipeta, Veppankulam and Puliyankandi

Month	Disease Incidence									
	Basal stem rot (%)			Stem bleeding (%)		Leaf blight (%)		Leaf spot (%)		Bud rot (%)
	A	Am	V	A	Am	A	Al	A	Al	Am
July 16	39.28	36.13	52.94	23.15	2.15	14.60	25.74	-	8.28	0.00
October16	40.91	37.45	52.94	25.73	2.50	14.60	23.76	-	7.82	1.50
January 17	45.68	37.58	54.11	24.61	2.57	15.20	21.58	-	5.32	0.00
March 17	45.68	37.62	58.82	25.15	2.68	14.85	24.26	-	8.65	0.00

A - Arsikere; Am - Ambajipeta; V - Veppankulam; Al - Aliyarnagar.

Path. 2: Basal stem rot disease

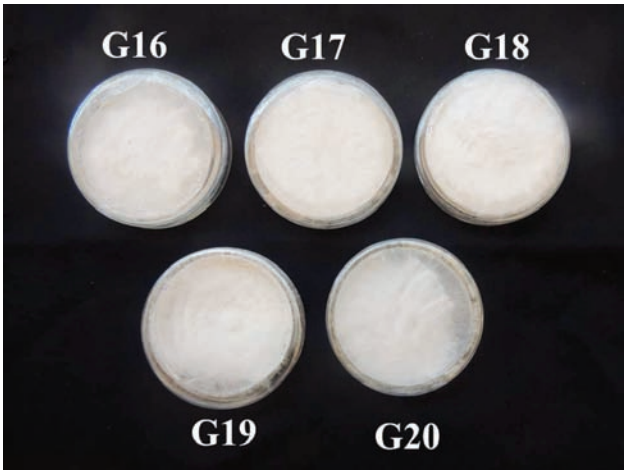
Expt. 1: Characterization and management of basal stem rot disease of coconut

Activity I: Collection of *Ganoderma* isolates from various locations to analyze diversity

Morphological and cultural variations of *Ganoderma* isolates

Arsikere

Five isolates of *Ganoderma* spp. representing various geographical locations were collected and their morphological and cultural characters were documented. The radial growth of isolates was around 90.0 mm in 9 days in almost all isolates and there was no significant difference among the isolates with respect to growth. The colonies of all isolates were white in colour and most of them were leathery and few produced cottony growth. In addition, few isolates also had foldings in their growth.



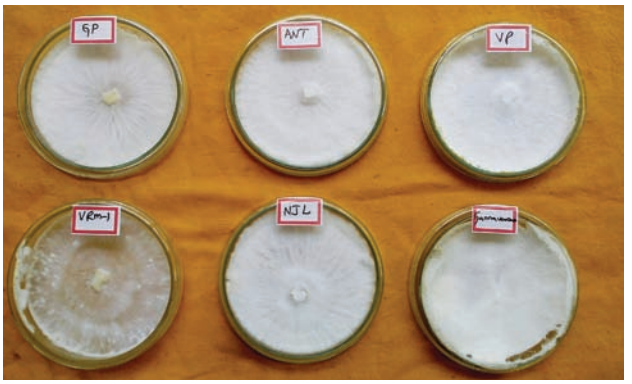
Isolates of Ganoderma collected at HREC, Arsikere

Veppankulam

Two isolates of *Ganoderma* were collected from the Veppankulam village as sporophore, in the year 2016. The isolates were having white colony and took around 9 days for completing their growth (Table 32).

Ambajipeta

Six isolates of *Ganoderma* spp. from different growing areas were collected and the variations pertaining to morphological and cultural characters were recorded. The isolates took 8 days for completing



Isolates of Ganoderma collected at Ambajipeta

Table 32. Morphological and cultural variations of *Ganoderma* isolates

State	Place	Isolate Code	Radial growth* (mm)	Colony characters
Karnataka	Hassan	G16	90.0	White leathery
	Alur	G17	90.0	White cottony
	Sakaleshpura	G18	89.5	White powdery growth
	Arakalgodu	G19	85.0	White cottony with folding
	Belur	G20	90.0	White cottony with folding
Andhra Pradesh	Gannavaram	Ga	90.0	White cottony
	Gopalapuram	Gp	90.0	White cottony
	Antervedi	AHT	90.0	White cottony
	Nallajarla	NJL	90.0	Leathery
	Vanapalli	VP	90.0	Leathery
	Veeravaram	VRM	90.0	Sparse cottony
Tamil Nadu	Veppankulam	$VPMCG_1$	90.0	White cottony
	Mangadu	MCG_2	90.0	White cottony

*Mean of five replications

their growth and there was no significant difference in growth among all isolates. The colonies were little leathery and sparse cottony in appearance.

Activity II: Virulence of *Ganoderma* isolates

Arsikere

The virulence of ten *Ganoderma* isolates was studied under sterile soil conditions. All the isolates were able to infect seedlings, indicating the pathogenic nature of the same. The isolates took varied time scale for infection right from one month to 10 months. It took almost 15 months for the complete death of all seedlings (Table 33).

Activity III: Epidemiology and disease forecasting

Arsikere

Influence of weather parameters on disease incidence of BSR

The plot having 227 palms was selected to record the disease incidence at monthly interval. The weather parameters such as relative humidity, atmospheric temperature, rainfall and rainy days were recorded to correlate the vertical and horizontal spread of disease. The results revealed that the vertical spread of the disease ranged from 180 to 262 cm and horizontal spread from 21 to 32 palms (9.25 to 14.10 %). The monthly average of weather parameters such as relative humidity, temperature and rainfall were correlated with the vertical and horizontal spread of basal stem rot disease. The result implied that there was a positive correlation between temperature and spread of disease whereas, rest all parameters under study had a negative correlation (Table 34).

Impact of intercropping on BSR disease in coconut

The disease incidence in different coconut gardens with cocoa, banana and arecanut as intercrops was recorded to assess the impact of intercrops on disease incidence. The results revealed that the disease index

Table 33. Virulence of *Ganoderma* isolates to coconut under sterile soil at Arsikere

Sl. No.	Isolates	Number of plants wilted at different days after treatment															
		30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480
1.	G1	0	0	0	0	0	0	0	0	0	1	2	2	2	3	3	3
2.	G2	0	0	0	0	0	0	0	0	0	1	1	1	1	2	3	3
3.	G3	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	3
4.	G4	0	0	0	0	0	0	0	0	0	1	1	1	2	3	3	3
5.	G5	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	3
6.	G6	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	3
7.	G7	1	0	0	0	0	0	0	0	0	1	1	1	2	3	3	3
8.	G8	0	0	0	0	0	0	0	0	0	1	1	1	2	3	3	3
9.	G9	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	3
10.	G10	0	0	0	0	0	0	0	0	0	1	1	1	2	3	3	3
Total		**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**12**	**14**	**14**	**19**	**29**	**30**	**30**

Table 34. Influence of weather parameters on BSR disease incidence at Arsikere

Sl. No.	Months	RH (%)		Temp. (^{O}C)		Rainfall (mm)	Rainy days (Nos)	Rate of VS** (cm)	HS*	Rate of HS**
		Morning	Evening	Max.	Min.					
1.	May16	65.8	37.0	34.1	20.5	86.0	6	238	28 (227)	12.3
2.	June 16	81.1	71.5	28.7	19.7	105.1	8	238	28 (227)	12.3
3.	July 16	81.1	72.5	27.9	19.0	79.2	9	239	29 (227)	12.8
4.	August 16	76.1	66.7	28.6	18.7	1.6	-	242	29 (227)	12.8
5.	September16	76.4	68.0	28.3	18.2	47.4	2	249	30 (227)	13.2
6.	October 16	72.8	61.0	30.0	16.4	-	-	251	30 (227)	13.2
7.	November16	63.7	45.5	30.8	12.7	-	-	252	32 (227)	14.1
8.	December16	73.2	65.3	73.2	65.3	-	-	252	32 (227)	14.1
9.	January 17	66.1	38.5	29.4	10.2	2.6	1	261	32 (227)	14.1
10.	February 17	63.3	37.5	31.2	10.0	-	-	262	32 (227)	14.1

RH - Relative Humidity; VS - Vertical Spread; HS - Horizontal Spread; *Values in parenthesis are total number of palms whereas values outside parenthesis are number of infected palms; **Mean of ten palms.

Table 35. Impact of intercropping on BSR disease in coconut at Arsikere

Sl. No	Month	Intercrop/sole	Disease index**	VS** (cm)	Disease incidence (%)	HS*	Rate of HS (%)
1.	April 16	Sole crop	57.22	2.25	10.62	24 (226)	10.62
		Cocoa	44.27	1.62	15.46	15 (97)	15.46
		Banana	53.26	2.06	17.01	114 (670)	17.01
		Arecanut	62.81	2.29	32.50	26 (80)	32.50
2.	July16	Sole crop	58.39	2.35	10.62	24 (226)	10.62
		Cocoa	46.84	1.70	16.49	16 (97)	16.49
		Banana	55.98	2.22	16.77	112 (668)	16.77
		Arecanut	66.48	2.54	32.50	26 (80)	32.50
3.	Oct16	Sole crop	60.91	2.55	10.62	24 (226)	10.62
		Cocoa	48.94	1.82	16.49	16 (97)	16.49
		Banana	49.30	1.86	16.47	110 (670)	16.42
		Arecanut	70.23	2.73	32.50	26 (80)	32.50
4.	January 17	Sole crop	59.85	2.51	10.62	24 (226)	10.62
		Cocoa	53.05	2.05	16.49	15 (97)	15.46
		Banana	48.50	1.92	16.47	114 (670)	17.01
		Arecanut	76.81	3.13	32.50	26 (80)	32.50

*Figures within parenthesis indicates total number of palms and figures outside indicates number ofinfected palms; ** Mean of ten palms; VS- Vertical spread in cm; HS- Horizontal spread in number of palms infected.

was less in cocoa intercropped garden compared to other intercrops under study (Table 35).

Ambajipeta

The study was initiated in November 2010 to assess the impact of other palms and intercrops on the occurrence and spread of basal stem rot disease in coconut. Fifty palms from the field with sole coconut and coconut + banana were selected in Gannavaram village of East Godavari district. The horizontal and vertical spread of the disease in sole coconut as well as coconut intercropped with the banana during the time period was recorded. In sole coconut plot, the PDI of 34.13 per cent during April 2016 was increased to 37.62 per cent by the end of March 2017. Mean vertical spread in sole coconut crop was recorded as 108.18 cm in April 2016 and as 114.69 cm in March 2017. In the new plot selected for coconut and banana, the PDI of 18.25 per cent during April 2016 was increased to 23.55 per cent by the end of March 2017. Mean vertical spread of the disease in coconut + banana plot was recorded as 123.24 cm in April 2016 and 119.48 cm in March 2017.

Veppankulam

The study was initiated during April 2016 to understand the impact of intercrops and weather parameters in coconut on the occurrence and to correlate the vertical and horizontal spread of basal stem rot disease. The result reveled that the vertical spread of the disease in sole coconut and coconut + pepper + banana + cocoa ranged from 104 to 113 cm and 103 to 118 cm respectively. The PDI of 8.33 and 1.80 per cent during April 2016 was increased to 13.33 and 2.52 per cent by the end of March 2017 in sole coconut and coconut + pepper + banana + cocoa, respectively.

Expt. 2: Studies on minimum inoculum load required for successful infection of basal stem rot disease

Arsikere

The pot culture experiment was conducted to understand the minimum inoculum load required for successful infection of basal stem rot disease. Two set of treatments were designed namely moisture stress conditions and normal conditions. In both cases, the fungal spore load, according to the treatment was imposed and the observation on mortality of seedlings after inoculation was documented. The result revealed that there was an early infection in sterile soil under moisture stress condition compared to normal condition (Table 36).

Table 36. Inoculum load of *Ganoderma* on disease incidence of BSR

Treatment	Mortality at different months after inoculation								
	1	2	3	4	5	6	7	8	9
Moisture stress condition									
T_1 – 1.5 x 10^3 cfu/ml	0	0	0	0	0	0	0	0	0
T_2 – 1.5 x 10^5 cfu/ml	0	0	0	0	0	0	0	0	0
T_3 – 1.5 x 10^7 cfu/ml	0	0	0	0	0	0	1	2	2
T_4 – control	0	0	0	0	0	0	0	1	1
Normal condition									
T_1 – 1.5 x 10^3 cfu/ml	0	0	0	0	0	0	0	0	0
T_2 – 1.5 x 10^5 cfu/ml	0	0	0	0	0	0	0	0	0
T_3 – 1.5 x 10^7 cfu/ml	0	0	0	0	0	0	0	0	1
T_4 – control	0	0	0	0	0	0	0	0	1

Expt. 3: Management of basal stem rot disease in coconut

Activity II: Integrated management of BSR – involving fungicides, bio agents and INM

Arsikere

The experiments like standardization of dosage frequency and method of application of *T. reesei* and *P. fluorescens* along with neem cake @ 5 kg/palm/year, root feeding with Hexaconazole @ 3 ml/100ml of water/palm at quarterly interval and micronutrient application @ 1 kg/palm/year were initiated during the second fortnight of June 2014 in farmer's field at Gandsi, Arsikere taluk. The pre-application observations for the incidence of BSR were recorded before the imposition of treatments

Treatment	Details
T_1	Soil application of talc based formulation of 125 g of *T. reesei* + 1.25 kg of neem cake per palm at quarterly interval.
T_2	Soil application of talc based formulation of 125 g of *T. reesei* + 2.5 kg of neem cake per palm at six month interval.
T_3	Soil application of talc based formulation of 125 g of *T. reesei* + 5 kg of neem cake per palm at yearly interval.
T_4	Soil application of talc based formulation of 125 g of *P. fluorescens* + 1.25 kg of neem cake per palm at quarterly interval.
T_5	Soil application of talc based formulation of 125 g of *P. fluorescens* + 2.5 kg of neem cake per palm at six month interval.
T_6	Soil application of talc based formulation of 125 g of *P. fluorescens* + 5 kg of neem cake per palm at yearly interval.
T_7	Soil application of talc based formulation of 125 g each of *T. reesei* and *P. fluorescens* + 1.25 kg of neem cake per palm at quarterly interval.
T_8	Soil application of talc based formulation of 125 g each of *T. reesei* and *P. Fluorescens* + 2.5 kg of neem cake per palm at six month interval.
T_9	Soil application of talc based formulation of 125 g each of *T. reesei* and *P. fluorescens*+ 5 kg of neem cake per palm at yearly interval.
T_{10}	Root feeding of 1ml of Hexaconazole in 100 ml water thrice in a year
T_{11}	Soil application of talc based formulation of 125 g each of *T. reesei* and *P. fluorescens* + 5 kg of neem cake per palm at yearly interval + root feeding of 3 ml of Hexaconazole in 100 ml water thrice in a year + micro nutrient application @ 1 kg/palm/year.
T_{12}	Control (without fungicide, bioagent, micronutrient mixture)

and post application observations were recorded at different months after treatment imposition. The treatments T_6, T_8, T_9, and T_{11} yielded lesser disease when compared to others at 30 months after the study.

Ambajipeta

The experiment on field management of basal stem rot was reinitiated with the new treatments in the earlier selected garden at P. Gannavaram village of East Godavari District of Andhra Pradesh during September 2014 for the standardization of dosage frequency and method of application of *T. reesei*, *P. fluorescens* along with neem cake (5 kg/palm/year), root feeding with Hexaconazole @ 3 ml/100ml water/palm/quarter and micronutrient application @ 1 kg/palm/year. Pre and post treatment data was recorded from the treated palms at regular intervals.

All the treatments except T_6 (soil application of talc based formulation of 125 g of *P. fluorescens* + 5 kg of neem cake/palm/year) showed decreased disease index by the end of March 2017 and Treatment T_3 (soil application of talc based formulation of 125g of *T. reesei* + 5 kg of neem cake/palm/year) showed the lowest disease index up to March 2017 and was on par with T_9 and T_4 treatments. Highest disease index was observed in T_{12} (control), which was on par with T_6 (soil application of talc based formulation of 125 g of *P. fluorescens* + 5 kg of neem cake/palm/year).

Veppankulam

The field trial on the integrated management of basal stem rot disease in coconut was conducted at Sanakarai village of Peravurani taluk and Coconut Research Station, Veppankulam of Pattukottai taluk of Thanjavur district. All the IDM practices were imposed as per the treatment schedule. The results revealed that the treatment T_7 (soil application of talc based formulation of 125 g each of *T. reesei* and *P. fluorescens* +1.25 kg of neem cake per palm at quarterly interval) showed the lowest disease index of 5.90 at Sanakarai village and 7.08 at CRS, Veppankulam and was on par with the treatment T_{11} (Soil application of talc based formulation of 125 g each of *T. reesei* and *P. fluorescens* + 5 kg of neem cake per palm at yearly interval + root feeding of 3 ml of Hexaconazole in 100 ml water thrice in an year + micronutrient application @ 1 kg/palm/year) (Table 37).

Table 37. Impact of IDM practice on BSR in coconut at Arsikere, Ambajipeta and Veppankulam

Treatment	Disease index							
	Arsikere (Gandsi)		Ambajipeta (P. Gannavaram)		Veppankulam			
					(Sanakarai)		(CRS, Veppankulam)	
	Pre-treatment	30 MAT	Pre-treatment	30 MAT	Pre-treatment	31 MAT	Pre-treatment	31 MAT
T_1	42.00	48.24	16.56	12.55	20.79	15.92	16.33	11.46
T_2	50.10	45.82	17.98	11.80	16.13	13.80	15.26	12.93
T_3	43.20	48.02	9.52	2.80	17.79	12.62	19.67	14.5
T_4	38.20	46.95	8.84	5.36	23.39	15.56	17.64	13.04
T_5	37.00	41.78	36.52	22.13	20.66	16.85	16.85	17.54
T_6	15.50	35.59	38.78	36.50	19.88	31.04	17.54	27.05
T_7	63.80	63.98	31.53	29.15	16.36	11.93	15.89	12.13
T_8	24.90	36.76	14.40	12.60	19.90	14.48	17.54	10.67
T_9	38.20	29.68	12.92	4.23	15.14	5.90	16.09	7.08
T_{10}	43.20	38.71	30.14	11.97	20.10	16.75	17.16	13.71
T_{11}	53.50	34.48	18.16	11.22	26.23	7.40	16.92	9.81
T_{12}	31.40	66.27	19.28	36.65	37.38	64.17	16.75	13.4
CD(P=0.05)	NS	7.40	NS	20.06	NS	2.93	NS	2.41

Activity III: Screening of new fungicides

Arsikere

Based on the results of in vitro studies, three different chemicals *viz*., Tebuconazole, Tetraconazole and Propiconazole were used to assess their impact on BSR disease in coconut along with positive control Hexaconazole. The results at six months after treatment revealed that root feeding of Propiconazole @ 2 ml + 100 ml water at quarterly interval recorded the lowest disease index of 27.42 and was statistically on par with Tetraconazole and Tebuconazole (Table 38).

Ambajipeta

The experiment on field management of basal stem rot by root feeding technique was initiated with the new treatments in the selected garden at Komarigiripatnam village of East Godavari district, Andhra Pradesh during November 2016. Pre and post treatment data was recorded from the treated palms at regular intervals. Among all the treatments, the lowest disease index of 19.78 was observed in T_3 (root feeding of Propiconazole @ 2 ml + 100 ml water at quarterly interval) up to January 2017, which was increased to 24.15 during March 2017 and was on par with treatment T_4 (Root feeding of Hexaconazole @ 1 ml + 100 ml water at quarterly interval). The Highest disease index was observed in control treatment as 57.34 (Table 38).

Veppankulam

Based on the results of *in vitro* evaluation, a new field experiment was initiated in a farmer's field at Avanam village of pudukkottai district during January 2016 for the management of basal stem rot disease with new treatments *viz*., Tebuconazole 25.9% EC, Tetraconazole 3.8% EW and Propiconazole 25% EC along with standard check Hexaconazole 5% EC as root feeding @ 2 ml/100 ml water at quarterly interval. Observations on the incidence of BSR before imposition of treatments and post application were recorded. Statistically, there was no significant difference among the selected new fungicides with respect to disease index (Table 38).

Expt. 5: Identification of coconut types resistant to *Ganoderma* wilt disease

Ambajipeta

Forty-four coconut varieties/hybrids were screened for the identification of resistance against *Ganoderma* wilt disease from 1984 at Horticultural Research Station, Ambajipeta under AICRP on Palms. However, none of the germplasms showed resistance to the pathogen. The varieties or hybrids screened under the programme are San Ramon OP, San Ramon SP, San Ramon IC, B.S. Islands OP, B.S. Islands SP, B.S. Islands IC, Java OP, Java SP, Java IC, S. S. Green OP, S. S. Green SP, S. S. Green IC, Guam

Table 38. Influence of chemicals on incidence of basal stem rot disease at Arsikere, Ambajipeta and Veppankulam

Treatment	Details	Disease Index					
		Arsikere		Ambajipeta		Veppankulam	
		Pre-treatment	6 MAT	Pre-treatment	5 MAT	Pre-treatment	5 MAT
T_1	Root feeding of Tebuconazole @ 2 ml + 100 ml water at quarterly interval	33.46	31.46	28.72	31.05	18.63	14.12
T_2	Root feeding of Tetraconazole @ 2 ml + 100 ml water at quarterly interval	33.93	31.62	41.11	45.33	17.46	12.60
T_3	Root feeding of Propiconazole @ 2 ml + 100 ml water at quarterly interval	34.64	27.42	25.68	24.15	16.53	13.80
T_4	Root feeding of 1 ml of Hexaconazole in 100 ml water at quarterly interval	34.73	27.62	24.71	23.91	19.68	16.40
T_5	Control	34.80	44.52	52.26	57.34	16.35	21.25
	CD (P=0.05)	**NS**	**NS**	17.96	8.50	**NS**	**NS**
	SEm±			6.09	25.26		

MAT- Months after treatment.

OP, Guam SP, Guam IC, St. Vincent OP, St. Vincent SP, St. Vincent IC, L. O. OP, L. O. SP, L. O. IC, TXD (WCT x COD), DXT (COD x WCT), TXD (ECT x GBGD), West Coast Tall, East Coast Tall, GBGD x PO, GBGD x Fiji, GBGD x LO, Gangabondam, Andaman Ordinary, Chowgat Orange Dwarf, Malayan Yellow Dwarf, Philippines Ordinary, Cochin China, VHC – 1, VHC – 2, Java, Kera Ganga, Laksha Ganga, Chandra Laksha, Godavari Ganga and Chandra Shankara.

Path. 3: Management of stem bleeding disease in coconut

Activity I: Evaluation of bioagents

Evaluation of cake and paste formulations of *Trichoderma* species against stem bleeding disease of coconut

Ambajipeta

Effect of *T. virens* cake formulation as well as *T. reesei* paste formulation along with positive control (paste application of copper oxy chloride), was tested against stem bleeding disease of coconut in farmer's field at Mukkamala village. In case of cake application, the treatment was given only once during the study period. The paste application was carried out at every month and the treated palms were observed for the disease symptoms and per cent recovery. Application of *T. virens* cake formulation completely recovered the diseased palms when compared to the paste application of *T. reesei* and copper oxy chloride against stem bleeding disease of coconut (Table 39).

Activity II: Chemical management through fungicides

Arsikere

Evaluation of fungicides against stem bleeding disease under field conditions

On the basis of results of *in vitro* studies, four different chemicals *viz*., Tebuconazole, Difenconazole, Propiconazole and Hexaconazole were imposed to stem bleeding disease infected palms and assessed their impact on disease. The result revealed that the disease index was lowest in T_4 (Root feeding of 1 ml of Hexaconazole in 100 ml water at the quarterly interval) recording 18.76 and was on par with the treatments Tebuconazole, Difenconazole and Propiconazole (Table 40).

Table 39. Influence of *Trichoderma* sp. on Stem bleeding disease at Ambajipeta

Sl. No.	Treatment	Disease Index	
		Before treatment	50 DAT
1.	*T. virens* cake application	6.30	0.00
2.	*T. reesei* paste application (as swabbing)	7.07	5.14
3.	Copper oxy chloride paste application	7.33	4.24
4.	Control	7.07	23.01
	SEm±	1.12	5.37
	CD (P ≤ 0.05)	3.33	15.45

DAT- Days after treatment.

Table 40. Evaluation of fungicides against stem bleeding disease at Arsikere and Ambajipeta

Treatment	Details	Disease Index			
		Arsikere		Ambajipeta	
		Pre treatment	6 MAT	Pre treatment	5 MAT
T_1	Root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly interval	22.70	21.60	17.74	13.11
T_2	Root feeding of Difenconazole @ 2ml + 100 ml water at quarterly interval	23.63	20.00	20.06	6.17
T_3	Root feeding of Propiconazole @ 2ml + 100 ml water at quarterly interval	23.20	20.72	23.66	5.14
T_4	Root feeding of 1 ml of Hexaconazole in 100 ml water at quarterly interval	20.36	18.76	20.70	5.91
T_5	Control	23.59	28.47	20.31	24.25
	CD (P=0.05)	NS	4.94	13.33	14.60
	SEm±		1.60	4.57	5.00

MAT- Months after treatment.

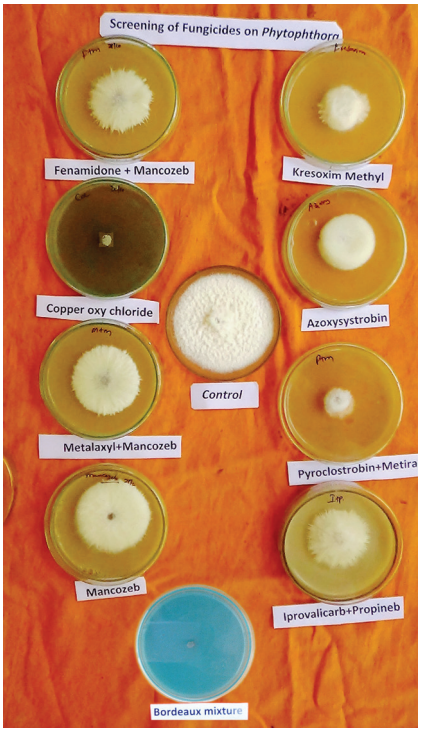
Ambajipeta

Field evaluation of identified new fungicides from *in vitro* studies against stem bleeding disease

The experiment on the management of stem bleeding with root feeding technique was initiated with the new treatments in the selected garden at Dagalavaripalem village of East Godavari district, Andhra Pradesh during November 2016. Pre and post treatment data were recorded from the treated palms at regular intervals. Among all the treatments, the lowest disease index was observed in T_3 (Table 40).

Expt. 2: Screening of latest fungicides against bud rot diseases

In vitro screening of fungicides against bud rot disease was carried out with fungicides, Azoxystrobin 23% EC, Kresoxim methyl 44.3% SC, Pyroclostrobin + Metiram 60% WG, Fenamidone + Mancozeb 60% WG, Bordeaux mixture 1%, Copper oxy chloride 50% WP, Mancozeb 75% WP, Metalaxyl + Mancozeb 68% WP and Iprovalicarb + Propineb 6675 WP (5.5% + 61.25% w/w). Among the chemicals, Bordeaux mixture 1% and Copper oxy chloride 50% WP showed complete inhibition of the mycelial growth of the pathogen under *in vitro* screening.



In vitro *screening of fungicides against Phytophthora palmivora*

Path. 4: Studies on the management of leaf blight disease in coconut

Expt. 1: Characterization and epidemiology of leaf blight disease in coconut

Activity III: Epidemiology and disease prediction

Arsikere

Influence of weather parameters on the disease incidence

The weather parameters such as relative humidity, temperature, soil temperature, rainfall and rainy days were correlated with the disease incidence and it revealed that there was a positive correlation among relative humidity in the evening and temperature with that of PDI (Table 41).

Influence of different intercrops on disease incidence at Arsikere

The incidence of disease in different intercropped gardens at various months is being recorded to analyse the impact of intercrops on the leaf blight disease incidence. The result revealed that there was no significant difference among the different intercropped gardens (Table 42).

Aliyarnagar

Monthly weather data, including maximum temperature, minimum temperature, relative humidity, rainfall, and leaf blight disease incidence were recorded regularly at weekly intervals. The results showed that the leaf blight disease intensity was increased with increase in temperature and the maximum disease intensity was observed during April. Disease intensity was found to be low during December 2016.

Expt. 2: Studies on the management of leaf blight disease in coconut

Activity I: Screening of available systemic fungicides against leaf blight pathogen

Two management field trials, each at Puliyankandi village of Anaimalai block in Coimbatore district and Gomangalampudur village of Udumalaipet block in Tirupur district, were laid out and the treatments were imposed at appropriate times. Pre and post- treatment observations (2 years after application) were recorded in both the trial plots. The maximum reduction in disease severity at 10.67 and 13.16 per cent was observed in root feeding of Tebuconazole @ 2 ml + 100 ml water at

Table 41. Influence of weather parameters on leaf blight disease in coconut at Arsikere

Sl. No.	Months	*RH (%)		*Temp.^{O}C		Rainfall (mm)	Rainy days (No.)	**PDI
		Morning	Evening	Max.	Min.			
1	June 16	81.17	71.57	28.73	19.72	105.10	8	24.15
2	July 16	81.16	72.58	27.96	19.00	79.20	9	20.85
3	August 16	76.16	66.77	28.60	18.70	1.64	-	22.56
4	September16	76.40	68.00	28.30	18.20	47.40	2	21.00
5	October 16	72.80	61.00	30.0	16.40	-	-	24.50
6	November16	63.73	45.56	30.80	12.71	-	-	23.15
7	December 16	73.22	65.38	73.22	65.38	-	-	22.00
8	January 17	66.19	38.52	29.44	10.29	2.6	1	21.00
9	February 17	63.32	37.57	31.20	10.04	-	-	25.00

*Mean of the month; **Mean of ten palms.

Table 42. Influence of different intercrops on leaf blight disease of coconut at Arsikere

Month	*PDI in Intercrop/Sole crop			
	Sole crop	Cocoa	Banana	Arecanut
October 15	18.17	18.80	19.80	19.70
January 16	20.12	20.90	20.90	19.20
April 16	21.12	22.15	19.60	21.32
July 16	19.10	20.28	18.19	22.15
October 16	20.00	23.12	21.35	23.15
January 17	25.45	24.80	23.15	22.85

*Mean of ten palms.

quarterly interval treated palms in Puliyankandi and Gomangalam pudur village trials, respectively. Treatments T_1, T_4 and T_6 were on par in both the trials (Table 43).

Table 43. Influence of chemicals on leaf blight disease at Aliyarnagar

Treatments	Treatments	PDI					
		Puliyankandi			Gomangalampudur		
		BT	PT	PROC	BT	PT	PROC
T_1	Root feeding of Tebuconazole @ 2 ml + 100 ml water at quarterly interval	25.16	14.49	10.67^{a}	27.64	14.49	13.16^{a}
T_2	Root feeding of Tebuconazole @ 2 ml + 100 ml water at half yearly interval	29.24	22.22	7.02^{bc}	25.51	17.51	8.00^{b}
T_3	Root feeding of Tebuconazole @ 2 ml + 100 ml water once in a year	26.76	22.22	4.53^{d}	28.18	22.40	5.78^{b}
T_4	Root feeding of Propiconazole @ 2 ml + 100 ml water at quarterly interval	27.56	19.20	8.89^{ab}	27.47	14.76	12.71^{a}
T_5	Root feeding of Propiconazole @ 2 ml + 100 ml water at half yearly interval	34.49	36.36	6.44^{cd}	24.80	18.04	6.76^{b}
T_6	Root feeding of Propiconazole @ 2 ml + 100 ml water once in a year	24.44	15.56	4.89^{d}	25.60	22.04	3.56^{a}
T_7	Root feeding of 2 g of Carbandazim in 100 ml water thrice at 3 months interval	34.31	27.87	8.36^{abc}	31.11	19.38	11.73^{a}
T_8	Control	20.36	15.47	-1.8	31.47	33.60	-1.33
	SED±	—	—	1.16	—	—	1.18
	CD (P=0.05)	—	—	2.48	—	—	2.53

BT- Before Treatment; PT- Post Treatment; PROC- Per cent Reduction Over Control; *Post treatment observation was taken at 2 years after application of treatments.

Activity II: Demonstration of integrated disease management on leaf blight

The demonstration on integrated management of leaf blight disease was laid out in one acre coconut garden having 73 palms at Puliyankandi village of Anaimalai block in Coimbatore district along with control plot. The following treatments were imposed at appropriate times.

- Removal and destruction of severely affected palms
- Spraying of Bordeaux mixture 0.5% or copper oxy chloride 0.3% two times at 45 days interval during summer months
- Root feeding of Carbendazim @ 2 g + 100 ml water thrice at 3 months
- Basal application of *P. fluorescens* @ 200 g along with 50 kg FYM per year.

Pre-treatment (initial) and post treatment observation (3 years after application) of leaf blight intensity were recorded in both the demonstration plots and control plots. The average intensity of leaf blight disease was reduced from 23.06 (initial year) to 8.82 per cent. However, in the case of control plot, disease intensity was slightly increased from 20.70 (initial) to 22.25 per cent.

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

A field experiment was conducted in the severe intensity of leaf blight affected farmer garden at Pongaliyur village of Anaimalai block in Coimbatore district, Tamil Nadu and to test the root feeding of different fungicides in sequence against leaf blight disease. The field experiment was laid out in RBD with four replications in each treatment. Pre-treatment (initial) and post treatment observation (9 months after application) were recorded in the trial plot. The maximum reduction in disease severity at 5.67 per cent was observed in root feeding of Tebuconazole @ 2 ml in 100 ml water followed by Propiconazole @ 2 ml in 100 ml water at three months interval treated palms. The trial is in progress.

Path. 5: Root (wilt) disease of coconut

Roving survey on the occurrence of the root (wilt) disease was conducted in different villages of Coimbatore, Kanyakumari, Tirupur, Tirunelveli and Theni districts of Tamil Nadu in the year of 2016-17. Among the districts, maximum incidence of the root (wilt) disease was recorded in Theni district (21.11 per cent) followed by Tirunelveli district (9.41 per cent) and there was no incidence in Tirupur district (Table 44).

Table 44. Root (wilt) disease of coconut in Tamil Nadu

District	Root (wilt) incidence (%)
Coimbatore	3.46
Kanyakumari	5.85
Theni	21.11
Tirunelveli	9.41
Tirupur	0.00

4.4. PEST MANAGEMENT

Ent. 1: Pest surveillance in coconut

Year of start: 2016

Fixed plot survey

Methadology

- Two plots – one plot near the Institute and another plot in pest endemic zone, six observations/year at two months interval) (June, Aug, Oct, Dec, Feb, Apr).
- If black headed caterpillar is not present in the selected area, select separate pest infested plot for *O. arenosella*. Minimum 100 palms in the garden need to be assessed.
- Observations as per standard protocol for roving survey needs to be followed.

Aliyarnagar

Roving survey

Roving survey was carried out in four districts of Tamil Nadu *viz.*, Coimbatore, Tiruppur, Tirunelveli and Kanyakumari and the extent of damage in terms of per cent incidence and intensity of damage was recorded for major pests of coconut (Table 45).

Incidence of rhinoceros beetles was noticed in young plantations in the age group of 2-10 years. The mean incidence of rhinoceros beetle was 39.0, 31.5 and 37.0 per cent in Coimbatore, Tiruppur and Tirunelveli districts, respectively and incidence of rhinoceros beetle was not observed in Kanyakumari district. The mean leaf damage was 16.7, 24.4 and 26.4 per cent and spindle damage was 18.3, 22.5 and 20.0 per cent in Coimbatore, Tiruppur and Tirunelveli districts, respectively. Juvenile palms (1.5 to 2 year old) were also attacked by rhinoceros beetles and the damage in this case was noticed in the collar region.

In Tirunelveli and Kanyakumari districts, where majority of the surveyed palms were in the age group of 20 to 40 years, the palms were found free from red palm weevil infestation. Red palm weevil incidence was not recorded in Coimbatore district also while, about 2.5 per cent incidence was noticed on 8-15 year old palms in Pongalur, Udumalpet and Sultanpet blocks of Tiruppur districts.

Mean nut damage due to eriophyid mite was the highest in Tiruppur district (65.0%) with a Mean Grade the Index (MGI) of 0.84. The MGI exceeded 1.0 (Moderate) in few villages in Senjerimaalai, Sultanpettai and Pongalur blocks while, the remaining villages recorded MGI below 1.0 (Mild). Mean nut damage was 59.3 per cent (MGI = 0.83) and 58.9 per cent (MGI = 0.75) in Tirunelveli and Kanyakumari districts, respectvely. Few villages in Pavoorchathiram and Tenkasi blocks of Tirunelveli district registered a MGI of above 1.0 (Moderate) while Kadayanallur and Alankulam blocks recorded a MGI below 1.0 (Mild). Coimbatore district registered the least nut damage (45.4 %) due to eriophyid mite and MGI was also found to be the least (0.56) among the districts. However, based on MGI, it could be observed that the mite incidence in all districts of Tamil Nadu was in the mild category (0.0 to 1.0) of CPCRI scale.

Among surveyed districts, black headed caterpillar infestation was not noticed in Tiruppur, Tirunelveli and Kanyakumari districts. Incidence of black headed caterpillar was observed in four blocks of Krishnagiri district viz., Krishnagiri, Kaveripattinam, Bargur and Hosur and a total of 1.7 lakh parasitoids were supplied for release in the affected gardens. Isolated pockets were infested with black headed

Table 45. Mean incidence of major coconut pests in four districts of Tamil Nadu

District	Rhinoceros beetle			Red palm weevil incidence (%)	Nut damage due to eriophyid mite (%)	Eriophyid mite (Grade Index)	Black headed caterpillar incidence (%)
	Mean incidence (%)	Leaf damage (%)	Spindle damage (%)				
Coimbatore	39.0 ± 13.5	16.7 ± 7.0	18.3 ± 9.2	0.0	45.4 ± 16.1	0.56 ± 0.20	30.7 ± 4.1
Tiruppur	31.5 ± 4.9	24.4 ± 8.2	22.5 ± 3.5	2.5 ± 1.3	65.0 ± 9.8	0.80 ± 0.23	-
Tirunelveli	37.0 ± 5.7	26.4 ± 3.6	20.0 ± 7.1	0.0	59.3 ± 5.8	0.83 ± 0.20	-
Kanyakumari	0.0	0.0	0.0	0.0	58.9 ± 4.8	0.75 ± 0.10	-

Values represent Mean ± S.D.

caterpillar in Coimbatore, Erode, Dharmapuri and Vellore districts for which 3.2 lakh parasitoids were supplied.

Minor pests

The incidence of an invasive spiralling whitefly was noticed in coconut during August 2016, during surveys in several villages of Anaimalai block, Coimbatore Dt., Tamil Nadu. The species was identified as Rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin. Observations on the natural enemy fauna in the infested gardens revealed a diverse array of coccinellid predators along with an aphelinid parasitoid, *Encarsia guadeloupe*. Parasitization by *E. guadeloupe* was observed to an extent of 78.2 per cent at Kaliyapuram village, Anaimalai block, Coimbatore Dt., subsequently leading to bio-suppression of the RSW.

Fixed plot survey

Fixed plot surveys were conducted in 3 locations *viz.*, Puliyankandi (Anaimalai block), Angalakurichi (Anaimalai block) and Naduppuni (Pollachi North block). The field at Puliyankandi is of ALR 1 variety, 8 years old, yielding palms. The nut damage in the field varied from 33.1 to 44.6 per cent during different months with the maximum nut damage recorded during December 2016 (44.6%). The MGI fluctuated between different months and the maximum MGI (0.49) was recorded during December 2016 and April 2017 (Table 46).

The field at Angalakurichi was having 3 years old hybrid palms (GBGD x WCT). Leaf damage fluctuated between 20.8 and 23.6 per cent, while the spindle damage ranged from 28.0 to 40.0 per cent during different months with the maximum spindle damage of 40.0 per cent during December 2016 and April 2017. Besides rhinoceros beetle damage, rugose spiralling whitefly infestation was observed during August 2016. The population of RSW increased up to December 2016 and during the 2nd week of December, parasitisation by *Encarsia* was noticed. The parasitoid tends to multiply faster causing the population of RSW to subside and by April 2017 the RSW population reached lower levels.

The field at Naduppuni was having more than 20 years old local tall variety. The incidence of coconut black headed caterpillar was 39.5 per cent during October 2016 and *Bracon brevicornis* parasitoids were released in the field. During April 2017, the leaf damage was 30.1 per cent and the number of larvae per 100 leaflets was 2.8.

Ambajipeta

Roving survey

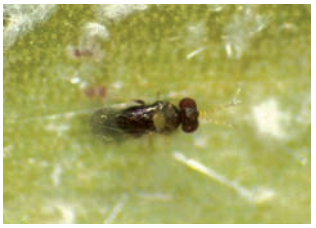
Roving survey was conducted in five districts of Andhra Pradesh viz., East Godavari, West Godavari,

Egg spirals

Nymphs of RSW

Adults of RSW

Coccinellid predator, *Menochilus sexmaculatus*



Parasitoid, *E. guadeloupe*

Emergence holes of *E. guadeloupe* on the puparia of RSW

Chrysopid larva

Rugose spiralling whitefly problem in Pollachi area, Coimbatore district, Tamil Nadu

Table 46. Extent of infestation by different pests in fixed plot survey in Aliyarnagar centre

Month	Location							
	Naduppuni (Pollachi North block)		Angalakurichi (Anaimalai block)				Puliyangandi (Anaimalai block)	
	Black headed caterpillar		Rhinoceros beetle			RSW (Scale)	Damage due to eriophyid mite	
	Leaf damage (%)	Larvae/ 100 leaflets (Nos)**	Mean incidence (%)	Leaf damage (%)**	Spindle damage (%)		Nut damage (%)	Grade index
August 2016	—	—	72.0	21.7 ± 7.8	36.0	Low	38.7	0.47
October 2016	39.5	3.1 ± 2.2	68.0	23.6 ± 10.5	28.0	High	33.1	0.42
December 2016	34.2	2.4 ± 1.4	55.0	20.8 ± 9.3	40.0	High*	44.6	0.49
February 2017	37.5	2.6 ± 1.6	50.0	21.5 ± 7.1	35.0	Medium*	42.1	0.44
April 2017	30.1	2.8 ± 1.4	44.0	23.3 ± 6.9	40.0	Low*	39.9	0.49

*Parasitisation by *Encarsia sp.* observed; ** Values represented as Mean ± S.D.

Vishakapatnam, Vizianagaram and Srikakulam districts. Rhinoceros beetle, red palm weevil, black headed caterpillar and eriophyid mite were the major pests observed in this region. Among the districts surveyed, the highest incidence (18.24%) of rhinoceros beetle was recorded in Srikakulam followed by Vizianagaram (15.27%) and the lowest incidence (11.23%) was recorded in West Godavari district. Similarly, leaf damage by the beetle was 10.28, 12.26, 14.94, 18.23 and 23.16 per cent and spindle damage was 5.80, 6.60, 8.90, 10.20 and 11.40 per cent in East Godavari, West Godavari, Vishakapatnam, Vizianagaram and Srikakulam districts, respectively (Table 47). Incidence of red palm weevil ranged from 8.42 to 18.20 per cent and incidence was high in Srikakulam and less in East Godavari. The infestation of black headed caterpillar was observed in all the districts except Vizianagaram. Infestation was 52.31, 41.64, 37.18 and 26.82 per cent in West Godavari, East Godavari, Srikakulam and Vishakapatnam districts, respectively. Infestation of eriophyid mite was recorded from all the coconut gardens in the surveyed districts and was in the range of 72.37 to 89.24 per cent. Intensity of mite damage was moderate to high in all the surveyed districts.

In roving survey, sporadic incidence of slug caterpillar, ranging from 18.60 to 22.62 per cent was recorded in West and East Godavari districts of Andhra Pradesh since February 2017.

Minor pests

During survey, incidence of rugose spiralling whitefly was observed in coconut nurseries of Kadiyapulanka village in December 2016. RSW established successfully with 2-5 live egg spirals per leaf. In some of the adult Gangabondam palms also, RSW infestation ranging from 5-12 live colonies of whiteflies/leaf were observed.

Table 47. Mean incidence of major coconut pests in important districts of Andhra Pradesh during roving survey

District	Rhinoceros beetle			Red palm weevil Mean incidence (%)	Eriophyid mite		Black headed caterpillar incidence (%)	Slug caterpillar incidence (%)
	Mean incidence (%)	Leaf damage (%)	Spindle damage (%)		Infested nuts (%)	Grade index		
E. Godavari	12.16 ± 1.09	12.26 ± 1.52	5.80 ± 0.57	8.42 ± 2.10	89.24 ± 2.68	2.74 ± 0.28	41.64 ± 2.42	22.62 ± 1.21
W. Godavari	11.23 ± 1.12	10.28 ± 1.37	6.60 ± 0.92	7.30 ± 1.52	84.48 ± 1.34	2.62 ± 0.12	52.31 ± 1.54	18.60 ± 1.42
Vishakapatnam	14.20 ± 1.71	14.94 ± 2.68	8.90 ± 1.40	14.12 ± 1.62	78.36 ± 4.26	2.10 ± 0.27	26.82 ± 1.74	Nil
Vizinagaram	15.27 ± 1.32	18.23 ± 2.21	10.20 ± 1.32	12.34 ± 1.24	75.68 ± 4.06	1.60 ± 0.18	0.00	Nil
Srikakulam	18.24 ± 1.57	23.16 ± 1.93	11.40 ± 0.90	18.20 ± 0.68	72.37 ± 2.82	1.42 ± 0.32	37.18 ± 2.38	Nil

Values are expressed as Mean ± S.E.

Fixed plot survey

Fixed plot survey was carried out from June 2016 in two villages of East Godavari Dt. *i.e.,* Samanthakuru of Allavaram mandal and Munganda of P. Gannavaram mandal (Table 48). In both the villages, only black headed caterpillar, rhinoceros beetle and eriophyid mite were prominent. Among the villages, the BHC incidence of 36.32% was observed in Samanthakuru village compared to Munganda which recorded 16.20 % in the month of October 2016. Leaf damage due to rhinoceros beetle was more (10.82%) in Samanthakuru village during August month compared to Munganda which recorded leaf damage of 9.02% during the month of October. Eriophyid damage was more in both the villages. In Samanthakuru a mean incidence of 90.21% and grade index of 1.92 was recorded and in Munganda it was 96.48% and 3.04 respectively. Red palm weevil and slug caterpillar incidence was not recorded in fixed plot survey villages.

Ratnagiri

Roving survey

The Roving survey was carried out in Palghar district in Konkan region of Maharashtra during 2016. The mean rhinoceros beetle incidence of 27.37% was recorded with maximum leaf damage of 25.14% and spindle damage of 2.22 %. The red palm weevil incidence was recorded as 9.52%. Per cent leaf damage by black headed caterpillar was 22.34%. Mean nut damage of 44.80% was noticed due to the infestation of eriophyid mite with moderate mite damage grade index of 1.20 (Table 49).

Fixed plot survey

Fixed plot survey was carried out at 2 months interval from June 2016 to April 2017 at Regional Research Station, Bhatye, Ratnagiri. Incidence of rhinoceros beetle was in the range of 17.24 to 20.22 per cent and maximum infestation was observed in the month of December. Infestation of red palm weevil was in the range of 6.32 to 9.56 per cent and maximum infestation (9.56%) was recorded in the month of December. The highest incidence of black headed caterpillar was recorded in December (7.14%) and in rainy season, it was reduced up to 5.34% in the month of August. Infestation of eriophyid mite was in the range of 28.43 to 36.15 per cent and maximum infestation (36.15%) was in the month of August. The intensity of eriophyid mite was low to moderate (Table 50).

Table 48. Mean incidence of coconut pests in fixed plot survey of Andhra Pradesh

Month	Black headed caterpillar incidence (%)		Rhinoceros beetle incidence (Leaf damage) (%)		Eriophyid mite			
	Samanthakuru	Munganda	Samanthakuru	Munganda	Samanthakuru		Munganda	
					Incidence (%)	Grade index	Incidence (%)	Grade index
June 2016	28.64 ± 2.31	10.20 ± 1.37	7.02 ± 1.52	8.14 ± 1.16	83.21 + 1.52	1.15	84.17 ± 1.48	1.87
August 2016	30.26 ± 1.17	14.31 ± 1.42	10.82 ± 1.41	8.72 ± 1.63	85.10 ± 1.12	1.32	84.62 ± 1.51	1.64
October 2016	36.32 ± 1.31	16.20 ± 1.14	10.14 ± 1.27	9.02 ± 1.21	85.17 ± 1.54	2.35	83.23 ± 2.14	1.92
December 2016	24.38 ± 1.67	8.64 ± 1.29	8.20 ± 1.07	6.32 ± 1.27	86.23 ± 1.62	1.82	88.41 ± 1.74	2.27
February 2017	14.19 ± 1.37	6.64 ± 1.52	7.23 ± 1.51	6.10 ± 1.09	88.78 ± 1.51	2.10	94.78 ± 2.10	2.54
April 2017	8.40 ± 1.32	4.31 ± 1.63	5.21 ± 1.34	4.12 ± 1.42	90.21 ± 1.14	1.92	96.48 ± 1.82	3.04

Values are expressed as Mean ± S.E.

Table 49. Mean incidence of major coconut pests in important district of Maharashtra

District	Rhinoceros beetle			Red Palm Weevil Mean incidence (%)	Eriophyid mite		Black headed caterpillar incidence (%)
	Incidence (%)	Leaf damage (%)	Spindle damage (%)		Nut damage (%)	Grade Index	
Palghar	27.37 ± 5.48	25.14 ± 5.69	2.22 ± 0.53	9.52 ± 0.00	44.80 ± 2.54	1.20 ± 0.15	22.34 ± 3.55

Values are expressed as Mean ± S.E.

Table 50. Extent of infestation by different pests in fixed plot survey in Maharashtra

Month	Rhinoceros beetle incidence (%)	Red palm weevil incidence (%)	Black headed caterpillar incidence (%)	Eriophyid mite incidence (%)
June 2016	18.14	7.78	6.51	34.12
August 2016	20.22	6.32	5.34	36.15
October 2016	19.62	7.14	6.20	28.43
December 2016	17.24	9.56	7.14	34.14
April 2017	18.97	7.29	6.25	35.00

Arsikere

Roving Survey

Roving survey was carried out in Chikkamagaluru, Tumkur, Mysore and Mandya districts and the extent of damage in terms of per cent incidence and intensity were recorded for major pests of coconut during these surveys. The infestation of rhinoceros beetle was noticed in all the age groups (4 to 42 years). The highest incidence of 45.60 per cent was noticed in Chikkamagaluru district and mean incidence of 34.80 per cent was recorded in Tumkur district (Table 51). Incidence of red palm weevil was maximum (up to 4.21%) in Tumkur district followed by Mysore district (2.95%). Incidence of red palm weevil was noticed in Mandya (2.33%) and Chikkamagaluru (1.29%) districts also.

Infestation by coconut black headed caterpillar was noticed in all the 4 major coconut growing districts of Karnataka. Severe (92.99%) incidence was noticed in Chikkamagaluru district throughout the year. The other districts where the caterpillar infestation observed include Mysore (88.86%), Mandya (77.09%) and Tumkur (75.26%). The infestation of eriophyid mite was also noticed in all major districts of Karnataka and in most cases, incidence was as high as 100 per cent in the harvested nut samples. The highest mite incidence was recorded in Tumkur district (96.72%) followed by Mysore (88.30%), Mandya (72.17%) and Chikkamagaluru (62.14%) districts.

Minor pests

In addition to the major pests, minor pests like mealy bugs and scales were noticed during the surveys. In Chikkamagaluru district mealy bugs (7%), termites (3.05%) and scales (2%) were noticed as spot occurrence (Table 52). Rat damage was noticed in palms of all age groups (4 to 42 years). The highest rat damage of 17.53 per cent was noticed in Chikkamagaluru district followed by 4.37 per cent in Mandya, 2.13 per cent in Mysore and 1.77 per cent in Tumkur. Termite incidence was maximum (up to 8.02%)

Table 51. Mean Incidence of major coconut pests in important districts of Karnataka

District	Rhinoceros beetle Mean incidence (%)	Red palm weevil Mean incidence (%)	Black headed caterpillar Mean incidence (%)	Eriophyid mite Mean incidence (%)
Chikkamagaluru	45.60 ± 5.74	1.29 ± 0.43	92.99 ± 0.47	62.14 ± 3.46
Tumkur	34.80 ± 2.72	4.21 ± 0.77	75.26 ± 2.51	96.72 ± 5.12
Mysore	16.56 ± 2.50	2.95 ± 0.63	88.86 ± 3.34	88.30 ± 6.85
Mandya	27.84 ± 2.02	2.33 ± 0.84	77.09 ± 4.68	72.17 ± 0.38

Values are expressed as Mean ± S.E.

Table 52. Occurrence of minor pests in coconut gardens of Karnataka

District	Pest incidence (%)	Rat damaged nuts (%)	Termite infested palms (%)
Chikkamagaluru	Mealybug (7%), scale (2%)	17.53 ± 0.39	3.05 ± 0.07
Tumkur	Mealybug (4%), scale (6%)	01.77 ± 0.03	4.60 ± 0.11
Mysore	Scale (10%)	02.13 ± 0.06	8.02 ± 0.30
Mandya	Scale (5%)	04.37 ± 0.08	3.35 ± 0.07

Values are expressed as Mean ± S.E.

in Mysore district followed by Tumkur district (4.60%). Termite incidence was noticed in Mandya (3.35%) and Chikkamagaluru (3.05%) districts also.

Fixed plot survey

Fixed plot survey was carried out to record the incidence and intensity of infestation by different pests of coconut at two months interval from August 2016 to April 2017 in farmer's field at Habbanghatta and J. C. Pura villages of Hassan district. The palms were in the age group of 17 to 32 years. Throughout the year leaf damage by rhinoceros beetle fluctuated between 44.85 and 33.30 per cent while spindle damage ranged from 24.33 to 31.77 per cent during different months with the maximum spindle damage of 31.77 per cent during August month at Habbanghatta village. Eriophyid mite infestation was also noticed in both Habbanghatta and J. C. Pura villages. Nut damage by mite infestation ranged from 22.89 to 29.86 per cent and mean grade index ranged from 0.95 to 2.56% during different months with the highest nut damage (29.86%) during August month at Habbanghatta village. Highest MGI of 2.56 was observed at J. C. Pura village during February month (Table 53).

Coconut black headed caterpillar incidence ranged between 34.75 to 42.21 per cent during different months with the highest per cent leaf damage (41.11%) and number of larvae per 100 leaflets (4.08) during April month at Habbanghatta (Table 54).

Ent. 2: Evaluation of botanical cake and paste for the management of rhinoceros beetle infesting juvenile palms

Year of start: 2016

Methodology

- Juvenile palms of 2-3 years age should be selected for the experiment. Cakes and paste will be supplied by ICAR-CPCRI, RS, Kayamkulam. Cakes @ 2-3 per palm and paste @ 15 g/palm are to be placed in the 2-3 innermost leaf axils.
- Five treatments to be replicated four times (5 palms per replication) in a completely randomised block design (total 100 palms for the experiment).

Table 53. Extent of infestation by different pests in fixed plot surveys in Karnataka

Period	Rhinoceros beetle				Eriophyid mite			
	Leaf damage (%)		Spindle damage (%)		Nut damage (%)		Grade index	
	Habbanghatta	J. C. Pura	Habbanghatta	J. C. Pura	Habbanghatta	J. C. Pura	Habbanghatta	J. C. Pura
August 2016	44.85 ± 3.56	42.94 ± 3.41	31.77 ± 3.54	30.48 + 3.75	29.86 ± 8.74	26.50 ± 0.80	1.41 ± 0.12	1.57 ± 0.11
October 2016	42.69 ± 2.69	39.44 ± 3.28	27.26 ± 2.37	24.41 + 2.44	25.15 ± 1.92	26.04 ± 1.01	1.54 ± 0.11	1.85 ± 0.11
December 2016	38.31 ± 3.15	34.02 ± 2.86	24.33 ± 2.81	26.39 + 3.46	22.89 ± 1.49	26.40 ± 0.91	0.95 ± 0.08	2.03 ± 0.08
February 2017	35.91 ± 2.73	36.66 ± 2.53	30.78 ± 2.68	30.44 + 3.91	25.66 ± 1.96	25.11 ± 0.82	1.74 ± 0.14	2.56 ± 0.10
April 2017	33.30 ± 2.22	35.55 ± 2.80	28.16 ± 3.21	29.45 + 2.63	24.21 ± 1.51	25.24 ± 0.83	2.43 ± 0.11	1.80 ± 0.15

Values are expressed as Mean ± S.E.

Table 54. Extent of infestation by black headed caterpillar in fixed plot surveys in Karnataka

Period	Leaf damage (%)		Active larvae/leaflet (Nos.)	
	Habbanghatta	J. C. Pura	Habbanghatta	J. C. Pura
August 2016	37.81 ± 2.24	36.23 ± 2.29	1.07 ± 0.08	1.50 ± 0.10
October 2016	39.40 ± 2.72	42.21 ± 2.44	1.48 ± 0.11	2.01 ± 0.08
December 2016	39.64 ± 2.53	40.36 ± 2.87	1.65 ± 0.11	1.09 ± 0.09
February 2017	34.75 ± 2.10	40.82 ± 3.26	2.76 ± 0.13	3.62 ± 0.14
April 2017	41.11 ± 3.17	44.11 ± 3.55	4.08 ± 0.15	2.87 ± 0.13

Values are expressed as Mean ± S.E.

Treatment details

T_1	Botanical cake (June, Oct & Feb) + paste (Aug, Dec & April)
T_2	Neem cake + sand (150 g each) to be filled in the innermost leaf axils – once in 4 months (June, Oct, Feb)
T_3	Placement of naphthalene balls in the innermost leaf axils @ 12 g/palm – once in 2 months (June, Aug, Oct, Dec, Feb, April)
T_4	Placement of chlorantraniliprole 0.4% GR (in perforated sachets) in the innermost leaf axils @ 6 g per palm once in 4 months (June, Oct, Feb)
T_5	Control

Observations to be recorded

- Spear leaf damage at quarterly intervals and express as per cent damage (Sept, Dec, March and June).
- Variety and other health management measures followed by farmer.

Application of botanical cake

Aliyarnagar

A farmer's field at Angalakurichi was selected for the experiment. The experimental field was having 3 years old juvenile palms of a hybrid (GBGD x WCT) and not yet started bearing. The pre-treatment leaf damage in different treatments ranged between 20.3 and 25.4 per cent (Table 55). At 3 months after treatment (MAT), there was no significant difference among different treatments. At 6 MAT, all the treatments registered a significant reduction in leaf damage when compared to control (27.3%), with chlorantraniliprole registering the least leaf damage (16.6%), followed by CPCRI botanical cake + paste (17.1%) and naphthalene balls (18.5%). With regard to spindle damage, the pre-treatment damage ranged from 70.0 to 85.0 per cent among different treatments. At both 3 and 6 MAT, there was no significant difference among the treatments. However, at 6 MAT, chlorantraniliprole and naphthalene balls registered the least spindle damage of 50.0 and 55.0 per cent, respectively as against 75.0 per cent spindle damage in control.

Ambajipeta

The trial was conducted at Horticultural Research Station, Ambajipeta, East Godavari Dt., Andhra Pradesh. The results revealed that, three months after treatment (MAT), the leaf damage ranged from 3.39 to 7.99 per cent per palm. The lowest damage of 3.39 per cent was recorded in botanical paste and cake followed by chlorantraniliprole (5.13%), neem cake + sand (5.32%) and naphthalene balls (5.87%). The highest leaf damage of 7.99 per cent was recorded in control. A similar trend was followed in

Table 55. Effect of botanical cake and paste for the management of rhinoceros beetles in Aliyarnagar centre

Treatment	Leaf damage (%)			Spindle damage (%)		
	Pre-treatment	3 MAT	6 MAT	Pre-treatment	3 MAT	6 MAT
T_1 - Botanical cake + paste@ 15g each/palm	21.5 (27.6)	19.5 (26.2)	17.1 a (24.1)	85.0 (67.2)	75.0 (60.0)	70.0 (56.8)
T_2 – Neem cake+ sand @150 g each/ palm	20.3 (26.8)	19.6 (26.3)	18.7 a (25.6)	85.0 (67.2)	75.0 (60.0)	75.0 (60.0)
T_3 – Naphthalene balls @12g/palm	23.6 (29.1)	20.6 (27.0)	18.5 a (25.5)	70.0 (56.8)	60.0 (50.8)	55.0 (47.9)
T_4 – Chlorantraniliprole 0.4GR @ 6g/palm	25.4 (30.3)	20.5 (26.9)	16.6 a (24.0)	75.0 (60.0)	60.0 (50.8)	50.0 (45.0)
T_5 – Control	24.9 (30.0)	26.7 (31.1)	27.3 b (31.5)	70.0 (56.8)	75.0 (60.0)	75.0 (60.0)
CD (P=0.05)	NS	NS	4.7	NS	NS	NS
CV (%)	-	-	11.7	-	-	-

Values in parentheses are arcsine transformed values; Means followed by a common letter are not significantly different by LSD (p=0.05).

2nd quarter i.e., 6 MAT, where the incidence of leaf damage (2.68%) was less in the botanical cake and paste followed by chlorantraniliprole (4.28%) which differed significantly with each other and the highest damage of 10.25% was recorded in control (Table 56).

With respect to spindle damage, all the treatments were found to be non-significant in pre treatment observation. The spindle damage ranged from 25.0 to 35.0 per cent. Whereas, in the 1st quarter the lowest spindle damage of 25.0 per cent was recorded in botanical paste and cake which was on par with chlorantraniliprole (25.0%) and differed significantly from neem cake + sand (30.0%) and naphthalene balls (30.0%) which were on par with each other. The Highest leaf damage of 35.0 per cent was recorded in control. In 2nd quarter, the lowest spindle damage (10.0%) was observed in botanical paste and cake followed by chlorantraniliprole (15.0%), neem cake + sand (20.0%) and naphthalene balls (25.0%) which differed significantly with each other and the highest spindle damage of 50.0 per cent was recorded in control.

Ratnagiri

A total of 100 palms of the variety GBGD were selected at Regional Coconut Research Station, Bhatye which were 3 years old juvenile palms and various treatments were imposed as per the technical programme after taking pre-treatment observations during the month of December 2016. The post-treatment observations on rhinoceros beetle incidence were observed during March 2017. The pre-treatment observations on leaf damage in different treatments ranged between 10.16 and 16.23 per cent. The minimum leaf damage was observed in T_1, which recorded 5.98% followed by T4 (7.20%). The treatment with botanical cake + paste and chlorantraniliprole were the best treatments and were significantly superior to rest of the treatments. The pre-treatment observation on spindle damage ranged from 30.0 to 40.0 per cent among different treatments. The lowest spindle damage was observed with chlorantraniliprole (20.0%) followed by treatment with botanical cake + paste (25.0%) (Table 57).

Application of botanical paste

Arsikere

An experiment was carried out at Horticultural Research and Extension Centre, Arsikere in 2 year old juvenile palms. The pre-treatment leaf damage in different treatments ranged between 21.27 and 22.99 per cent (Table 58). At 3 MAT, there was no significant difference between different treatments.

Table 56. Efficacy of botanical cake and paste on leaf damage due to rhinoceros beetle in experimental plots of Ambajipeta centre

Treatments	Leaf damage (%)			Spindle damage (%)		
	Pre treatment	3 MAT	6 MAT	Pre treatment	3 MAT	6 MAT
T_1 - Botanical cake + paste@ 15g each/palm	4.23 (11.87)	3.39 (10.61)	2.68 (9.42)	30.0 (33.21)	25.0 (30.00)	10.0 (18.43)
T_2 – Neem cake+ sand @150 g each/ palm	5.93 (14.09)	5.32 (13.34)	4.41 (12.12)	40.0 (39.23)	30.0 (33.21)	20.0 (26.57)
T_3 – Naphthalene balls @12g/ palm	5.87 (14.02)	5.53 (13.60)	4.67 (12.48)	35.0 (36.27)	30.0 (33.21)	25.0 (30.00)
T_4 – Chlorantraniliprole 0.4GR @ 6g/palm	6.28 (14.51)	5.13 (13.09)	4.28 (11.94)	35.0 (36.27)	25.0 (30.00)	15.0 (22.79)
T_5 – Control	6.41 (14.67)	7.99 (16.42)	10.25 (18.67)	30.0 (33.21)	35.00 (36.27)	50.00 (45.00)
C.D (P=0.05)	NS	0.23	0.34	NS	3.16	4.27
C.V (%)	-	8.42	12.68	-	10.20	9.83

Values in parenthesis are arcsine transformed values.

Table 57. Effect of botanical cake and paste for the management of rhinoceros beetle infesting juvenile palms

Treatments	Rhinoceros beetle mean incidence (%)			
	Pre- treatment (Dec, 2016)		3 MAT (March, 2017)	
	Leaf damage	Spindle damage	Leaf damage	Spindle damage
T_1- Botanical cake + paste	10.16 (18.59)	35.00 (35.79)	5.98 (12.16)	25.00 (29.74)
T_2 - Neem cake + sand (150 g/palm)	12.18 (20.43)	30.00 (32.62)	11.68 (18.99)	30.00 (32.90)
T_3 - Naphthalene balls@12g/palm	16.23 (23.76)	40.00 (39.23)	10.43 (17.80)	35.00 (36.07)
T_4 - Chlorantraniliprole0.4% GR @ 6 g/palm	11.79 (20.08)	30.00 (32.90)	7.20 (13.18)	20.00 (26.57)
T_5 - Control	12.35 (20.57)	35.00 (35.79)	13.11 (20.49)	40.00 (39.23)
S.E. ±	N.S.	N.S.	2.32	2.52
CD (P=0.05)	-	-	7.57	7.76

Figures in parenthesis are arcsine transformed values.

Table 58. Evaluation of botanical cake and paste for the management of rhinoceros beetle infesting juvenile palms in Arsikere centre

Treatment	Leaf damage (%)			Spindle damage (%)		
	Pre-treatment	3 MAT	6 MAT	Pre-treatment	3 MAT	6 MAT
T_1 - Botanical cake + paste @ 15g each/palm	22.54 (28.34)	20.14 (26.67)	18.17 (25.23)	80.0(63.43)	65.0 (53.73)	60.0 (50.77)
T_2 – Neem cake + sand @150 g each/ palm	21.27 (27.46)	20.43 (26.87)	19.33 (26.08)	80.0 (63.43)	75.0(60.00)	70.0 (56.79)
T_3 – Naphthalene balls @12g/palm	22.99 (28.65)	21.54 (27.65)	20.32 (26.79)	75.0 (60.00)	75.0 (60.00)	70.0 (56.79)
T_4 – Chlorantraniliprole 0.4GR @ 6g/ palm	21.55 (27.66)	19.63 (26.30)	18.82 (25.71)	70.0 (56.79)	65.0 (53.73)	60.0 (50.77)
T_5–Control	22.37 (28.23)	24.52 (29.68)	26.87 (31.22)	75.0 (60.00)	80.0 (63.43)	85.0 (67.21)
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Figures in parenthesis are arcsine transformed values.

At 6 MAT, all the treatments registered a non-significant reduction in leaf damage when compared to control (26.87%), with CPCRI botanical cake + paste registering the least leaf damage (18.17%), followed by chlorantraniliprole (18.82%), neem cake (19.33%) and naphthalene balls (20.32%). The pre-treatment spindle damage, ranged from 70 to 80 per cent. At both 3 and 6 MAT, there was no much difference among the treatments. However, at 6 MAT, botanical cake, chlorantraniliprole, neem cake and naphthalene balls registered the least spindle damage of 60, 60, 70 and 70 per cent, respectively as against 85 per cent spindle damage in control.

Ent. 3: Integrated management of coconut eriophyid mite

Year of start: 2016

Methodology

- Experiment to be conducted inside the research station, preferably.
- 50 palms to be selected for incorporating the following package of practices and 50 palms to be maintained as the control.

Package of practices

- Integrated nutrient management (Recommended NPK for the region + 20 kg FYM + 20 kg vermicompost + 5 kg neem cake + green manuring with cowpea/ sun hemp in coconut basins + husk incorporation in inter rows + micronutrient application + Keraprobio - 100g/ palm) in a well irrigated garden + root feeding with fenpyroximate 5% EC @ 10 ml + 20 ml water during March + spraying palm oil – sulphur emulsion during December.
- The control plots should be maintained with NPK and organic manures.

Preparation of palm oil sulphur emulsion

To prepare 1 litre mixture, 200 ml palm oil, 800 ml water, 5 gram wettable sulphur (80%) and 12 g soap

powder are required. Dissolve the soap and sulphur in water and then add palm oil and mix thoroughly. This mixture is to be stirred well and should be used for spraying on the day of preparation itself.

Observations to be recorded

- Pre-experimental soil and plant nutrient status (soil pH, organic carbon, PK level and micronutrient analysis)
- Observation on mite population (per 16 mm^2), per cent nut damage, mite grade index and yield per palm to be recorded once in six months.
- Growth, yield and yield attributing characters (annual leaf production, annual inflorescence production, nut yield, copra content, oil content, etc.) to be recorded.

Aliyarnagar

The field at Puliyankandi was having 8 year old ALR 1 (Arasampatti tall) variety which started yielding. The pre-treatment population of eriophyid mite in the treatment plots was 38.0/16 mm^2 as against 31.4/ 16 mm^2 in control plots (Table 59). Recommended dose of fertilizers as per the technical programme was applied in trial plots. The mite population showed a significant reduction (29.0/16 mm^2) at 6 MAT. Similarly, the per cent nut damage, which was initially 39.5 per cent in the trial plot reduced to 33.4 per cent along with a reduction in MGI from 0.48 to 0.40.

Ambajipeta

The experiment was conducted in a plot having 100 palms (0.5 ha) at Horticultural Research Station, Ambajipeta. IPM package was implemented in the plot as per the experimental protocol. Pre-treatment data on the intensity of eriophyid mite from the 3rd bunch was recorded in the month of September. Post treatment observations were recorded at half yearly intervals. After six months interval, the mite infestation gradually decreased from 93.86 per cent to 78.87 per cent in treatment and in control, the mite infestation increased from 94.35 to 97.44 per cent (Table 60).

Regarding eriophyid mite intensity, pretreatment MGI was in the range 1.29 to 1.38 with the scale being moderate. Average mite population in IPM (35.92/16 mm^2) and control (38.40/16 mm^2) was not significantly different. After six months the grade index in IPM plot gradually declined to mild with a grade index of 0.81 which was significantly lower compared to control where the grade index was moderate (1.64). Similarly, average mite population after six months was 27.32/16 mm^2 in IPM block

Table 59. Effect of IPM treatments on the damage due to eriophyid mite in coconut in Aliyarnagar centre

Treatments	Pre-treatment (September 2016)			Post-treatment (6 MAT) (March 2017)		
	Nut damage (%)	Mean Grade Index (MGI)	Mite population/ 16 mm^2	Nut damage (%)	Mean Grade Index (MGI)	Mite population/ 16 mm^2
T_1 : IPM garden	39.5	0.48	38.0	33.4	0.40	29.0
T_2 : Control	43.9	0.51	31.4	48.8	0.60	41.4
Sig. (P=0.05)	NS	NS	NS	S	NS	S
't' value	–	–	–	3.1	–	2.8

Table 60. Effect of IPM treatments on eriophyid mite damage in coconut at Ambajipeta centre

Treatments	Pre-treatment (September 2016)			Post-treatment (6 MAT) (March 2017)		
	Nut damage (%)	Mean Grade Index (MGI)	Mite population/ 16 mm^2	Nut damage (%)	Mean Grade Index (MGI)	Mite population/ 16 mm^2
T_1 : IPM garden	93.86 (75.65)	1.38	35.92	78.87 (62.63)	0.81	27.32
T_2 : Control	94.35 (77.01)	1.29	38.40	97.44 (80.79)	1.64	45.63
Sig. (P=0.05)	NS	NS	NS	S	S	S
't' value	–	–	–	17.42	0.78	17.24

Values in parenthesis are arcsine transformed values.

which was significantly lower compared to control, which recorded mite population of 45.63/16 mm^2.

Ratnagiri

This experiment has been initiated in the month of March 2017. The trial is in progress.

Arsikere

The trial was conducted at Horticulture Research Station, Arsikere. The pre-treatment population of eriophyid mite in the treatment plots was 35.3/16 mm^2 as against 34.2/16 mm^2 in control plots (Table 61). The recommended doses of fertilizers as per the technical programme were applied in the trial plots. The mite population showed a reduction (20.3%) at 6 MAT. Similarly, the per cent nut damage reduced from 62.5 per cent in the INM plot to 51.2 per cent and MGI also reduced from 2.3 to 1.6.

Vellore. Mass multiplication of *B. brevicornis* and *G. nephantidis* is being carried out at bio-control laboratory of Coconut Research Station, Aliyarnagar and a total of 4,44,000 Nos of *B. brevicornis* and 45,000 *G. nephantidis* parasitoids were supplied for release Nos of in approximately 230 acres of black headed caterpillar infested coconut gardens (Table 62).

Ambajipeta

Mass multiplication of parasitoids of coconut black headed caterpillar is being carried at biocontrol laboratory, HRS, Ambajipeta and a total of 12,43,500 Nos of *B. hebetor* and 9,62,000 *G. nephantidis* were reared and supplied to 330 farmers in East and West Godavari districts were high incidence and widespread infestation of coconut BHC was observed (Table 63).

Table 61. Effect of IPM treatments on eriophyid mite damage in coconut at Arsikere centre

Treatments	Pre-treatment (September 2016)			Post-treatment (6 MAT) (March 2017)		
	Nut damage (%)	Mean Grade Index (MGI)	Mite population/ 16 mm^2	Nut damage (%)	Mean Grade Index (MGI)	Mite population/ 16 mm^2
T_1: IPM garden	62.5	2.3	35.3	51.2	1.6	20.3
T_2 : Control	61.8	2.6	34.2	71.3	3.1	43.7
Sig. (P=0.05)				S	NS	NS
't' value				5.2	—	—

Ent. 4: Production and supply of parasitoids

Year of start: 2016

Methodology

- Parasitoids of coconut black headed caterpillar (BHC) viz., *B. brevicornis* and *G. nephantidis* to be produced in all the AICRP (Palms) centres and distributed in areas where BHC problem is noticed.
- *Goniozus nephantidis* may be recollected from the black headed caterpillar infested gardens (with precise GPS data) and subjected to molecular analysis at ICAR-CPCRI, Kasaragod.

Aliyarnagar

Widespread incidence of coconut black headed caterpillar infestation was reported in Krishnagiri, Coimbatore and isolated pockets of Erode and

Table 62. Production and supply of parasitoids for the management of coconut black headed caterpillar in Aliyarnagar centre

Months	*Bracon brevicornis (Nos)*	*Goniozus nephantidis (Nos)*
April 2016	2,500	500
May 2016	33,100	4,000
June 2016	48,000	5,000
July 2016	56,000	6,000
August 2016	1,18,200	5,000
September 2016	79,200	6,000
October 2016	10,200	3,500
November 2016	44,000	5,000
December 2016	6,000	1,000
January 2017	7,500	3,000
February 2017	14,700	3,500
March 2017	24,600	2,500
Total	**4,44,000**	**45,000**

Table 63. Production and supply of parasitoids for the management of coconut black headed caterpillar in Ambajipeta centre

Month	*Bracon hebetor* (Nos)	*Goniozus nephantidis* (Nos)
April 2016	23,500	—
May 2016	18,000	—
June 2016	—	—
July 2016	2000	—
August 2016	15,500	—
September 2016	61000	—
October 2016	1,63000	1,20,000
November 2016	2,18,000	1,93,500
December 2016	3,10,500	2,68,000
January 2017	4,14,000	3,02,000
February 2017	14,500	49,000
March 2017	3,500	29,500
Total	**12,43,500**	**9,62,000**

Ratnagiri

The coconut black headed caterpillar parasitoids *viz., G. nephantidis* and *B. hebetor* were mass multiplied at bio-control laboratory, Bhatye and a total of 45,600 Nos of *B. brevicornis* and 38,200 Nos of *G. nephantidis* were supplied to the farmers during 2016-17 and the details are furnished in Table 64.

Table 64. Production and supply of parasitoids for the management of coconut black headed caterpillar in Ratnagiri centre

Months	*Bracon hebetor* (Nos)	*Goniozus nephantidis* (Nos)
April 2016	7,200	7,300
May 2016	-	4,000
June 2016	6,200	6,500
July 2016	5,500	1,000
August 2016	2,900	950
September 2016	5,000	2,150
October 2016	2,000	1,000
November 2016	-	1,000
December 2016	6,000	4,000
January 2017	5,500	6,300
February 2017	4,300	1,500
March 2017	1,000	2,500
Total	**45,600**	**38,200**

Arsikere

Widespread incidence of coconut black headed caterpillar infestation was recorded in Chikkamagaluru, Tumkur, Mysore, Hassan and Mandya districts. Mass multiplication of *B. brevicornis* and *G. nephantidis* was carried out at bio-control laboratory of Horticulture Research and Extension Centre, Arsikere and a total of 19,25,000 Nos of *B. brevicornis* and 37,00,000 Nos of *G. nephantidis* parasitoids were supplied for release in approximately 1060 acres of black headed caterpillar infested coconut gardens (Table 65).

Biological control laboratory Arsikere

Table 65. Production and supply of parasitoids for the management of coconut black headed caterpillar in Arsikere centre

Months	*Bracon brevicornis* (Nos)	*Goniozus nephantidis* (Nos)
April 2016	75,000	2,00,000
May 2016	75,000	2,00,000
June 2016	75,000	3,00,000
July 2016	1,50,000	3,00,000
August 2016	1,50,000	3,00,000
September 2016	2,00,000	3,50,000
October 2016	2,00,000	3,50,000
November 2016	2,00,000	3,50,000
December 2016	2,00,000	3,50,000
January 2017	2,00,000	3,00,000
February 2017	2,00,000	4,00,000
March 2017	2,00,000	3,00,000
Total	**19,25,000**	**37,00,000**

V. EXPERIMENTAL RESULTS IN OIL PALM

5.1. CROP IMPROVEMENT

Gen. 8: Studies on the comparative performance of different hybrid combinations of oil palm

Pattukkottai

Ten hybrids were planted during 2006 at Peraiyur, Mannargudi taluk, Thiruvarur District. The soil of the experimental field is red sandy loam. Randomised Block Design was adopted with three replications and six palms per treatment.

Ten 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, number of leaves produced per year was the highest in NRCOP 14 (24.0) and female inflorescence was the highest in NRCOP 17 (13.0). Data on yield attributes of oil palm revealed that the average bunches per palm was the highest in the hybrid NRCOP 11 (8.3) and the highest bunch weight (22.5 kg/palm), FFB yield (152.3/palm) and per ha yield (21.8 t) was recorded in the hybrid NRCOP 17 for the period of April 2016 to March 2017. The highest percentage of oil per bunch was recorded in the hybrid NRCOP 13 (26.0) (Table 66).

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

Gangavathi

Ten new oil palm hybrids developed from ICAR-IIOPR, Regional Station, Palode were planted during 2007 in RBD with 3 replications and 6 palms per treatment. The soil of the experimental field is black clayey in nature.

Hybrid cross combinations

1.	NRCOP 1 (78D x 435P)	6.	NRCOP 6 (173D x 435P)
2.	NRCOP 2 (90D x 577P)	7.	NRCOP 7 (183D x 577P)
3.	NRCOP 3 (158D x 116D)	8.	NRCOP 8 (70 D x 577P)
4.	NRCOP 4 (131D x 435P)	9.	NRCOP 9 (28D x 435P)
5.	NRCOP 5 (5D x 577P)	10.	NRCOP 10 (345D x 577P)

Vegetative growth parameters

During 2016-17, significantly higher annual rate of leaf production was recorded with NRCOP 4 (19.0) over NRCOP 7 (16.8 m) and NRCOP 8 (17.0 m) which were on par with other hybrid combinations. The number of male Inflorescence was significantly lower in the hybrid NRCOP 7 (3.4) over NRCOP 6, NRCOP 4 and NRCOP 2. The other hybrids NRCOP 1,

Table 66. Growth performance of oil palm hybrids

Hybrids	Annual leaf production (Nos)	Number of female inflorescence	Sex ratio	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP 11	22.5	12.3	0.67	112.5	16.1
NRCOP 12	23.0	12.0	0.70	91.6	13.1
NRCOP 13	22.6	12.1	0.64	90.8	13.0
NRCOP 14	24.0	12.2	0.69	117.6	16.8
NRCOP 15	22.0	11.7	0.65	97.0	13.9
NRCOP 16	23.5	12.0	0.67	100.8	14.4
NRCOP 17	23.0	13.0	0.73	152.3	21.8
NRCOP 18	22.0	11.6	0.65	121.4	17.3
NRCOP 19	23.5	12.7	0.69	97.2	13.9
NRCOP 20	23.0	11.0	0.64	145.6	20.8
S.Em ±	**0.50**	**0.30**	**0.31**	**3.53**	**2.06**
CD (P=0.05)	**1.22**	**0.80**	**0.63**	**7.08**	**4.12**

NRCOP 3, NRCOP 5, NRCOP 9, NRCOP 10 and NRCOP 8 were on par with NRCOP 7. Significantly higher number of female inflorescence was recorded with the hybrid NRCOP 4 (11.9) compared to NRCOP 1 (8.3), NRCOP 3 (8.6), NRCOP 5 (7.8), NRCOP 6 (8.4) and NRCOP 8 (8.8). The other hybrids were on par with NRCOP 4. Sex ratio was significantly higher in the hybrid NRCOP 9 (0.74) and lowest in NRCOP 6 (0.61).

The highest number of bunches per palm was recorded with hybrid NRCOP 4 (6.5) and it was significantly superior over all other hybrids. The hybrid NRCOP 4 (16.5 kg) recorded significantly higher mean bunch weight over NRCOP 9 (11.6 kg) which was on par with remaining hybrids. The hybrid NRCOP 4 (114.7 kg) recorded significantly superior FFB yield over all other hybrid combinations except NRCOP 1 (78.8 kg). The hybrid NRCOP 4 (16.4 t/ha) recorded significantly higher FFB yield over NRCOP 1 (11.3 t/ha) which was on par with the remaining hybrids (Table 67).

Bunch yield of NRCOP 4 (Gangavathi)

Mulde

Oil palm seedlings were planted during September, 2007 in RBD with 3 replications and 9 plants per treatment.

The ten cross combinations of oil palm did not show significant variation for palm height, palm girth and annual leaf production. The average height of palms ranged between- 2.9 to 3.7 m. The lowest height was recorded in NRCOP 5 (2.9 m). Average girth of palms ranged between 2.7 to 2.9 m and production of average number of leaves was in the range of 25.1 to 27.3. The highest number of leaves was recorded in NRCOP 2 (27.3).

The ten cross combinations of oil palm did not show significant variation in production of male flowers, total inflorescences and sex ratio. However, average number of female flowers significantly differed among different genotypes. NRCOP 6 recorded minimum male flowers (3.5) whereas, NRCOP 10 recorded maximum (4.9) number of male flowers. Sex ratio was the highest (0.73) in genotype NRCOP 6 followed by NRCOP 2 (0.71) due to more female flowers and lowering maleness, whereas sex ratio was the lowest (0.52) in NRCOP 10.

The hybrids did not show significant variation for yield characters. However, NRCOP 2 recorded the highest number of bunches, more bunch weight and yield of fresh fruit bunches (FFB). Hybrid

Table 67. Vegetative growth parameters, FFB yield and yield attributes of different oil palm hybrids

Hybrids	Annual leaf production (Nos)	Number of female inflorescence	Sex ratio	Number of bunches	Mean bunch weight (kg)	FFB yield (t/ha)
NRCOP 1	18.7	8.3	0.63	3.3	13.1	11.3
NRCOP 2	18.3	9.9	0.66	4.7	15.2	14.6
NRCOP 3	18.5	8.6	0.66	4.4	14.9	13.7
NRCOP 4	19.0	11.9	0.68	6.5	16.5	16.4
NRCOP 5	17.8	7.8	0.69	4.3	14.0	14.9
NRCOP 6	18.3	8.4	0.61	3.9	12.6	12.6
NRCOP 7	16.8	9.6	0.73	5.3	12.7	15.3
NRCOP 8	17.0	8.8	0.66	4.5	14.7	14.2
NRCOP 9	18.1	9.9	0.74	6.1	11.6	14.6
NRCOP 10	18.6	10.9	0.73	5.9	13.9	16.1
S. Em ±	**0.60**	**0.81**	**0.12**	**0.72**	**1.40**	**1.52**
CD(P=0.05)	**1.78**	**2.41**	**0.33**	**2.12**	**4.14**	**4.49**
CV%	**5.80**	**15.10**	**1.52**	**14.10**	**17.52**	**18.40**

NRCOP 2 recorded the highest yield (22.2 t/ha) and it was the lowest (10.6 t/ha) in hybrid NRCOP 10 (Table 68).

Pasighat

Secondary nursery seedlings were transplanted to the main field in August 2010. The recorded data (Table 69) shows that the growth of the palms with respect to height was the maximum in NRCOP 23 (0.90 m), which was significantly higher than NRCOP 30 and NRCOP 25 but on par with other hybrids. There was no significant difference in collar girth among all hybrids. The maximum number of leaves (21.6) was produced by the hybrid NRCOP 22 which was on par with NRCOP 26 to NRCOP 29. The least number of male flowers was produced by hybrid NRCOP 23 (2.4) and the maximum number of male flowers was produced by NRCOP 30 (4.6) followed by NRCOP 21. The maximum number of female flowers was produced by the hybrid, NRCOP 23 (11.7), which was significantly higher than other cross combinations. Minimum number of female flowers was produced by the hybrid NRCOP 30 (8.4), followed by NRCOP 25 (9.8). The number of FFB was recorded maximum in NRCOP 23 (11.3), which

Table 68. Growth parameters, FFB yield and yield attributes of different oil palm hybrids

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production (Nos)	Number of female inflorescence	Sex ratio	Number of bunches	Mean bunch weight (kg)	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP 1	3.3	2.8	26.4	6.2	0.61	5.7	15.6	89.6	12.8
NRCOP 2	3.6	2.8	27.3	9.8	0.71	8.9	17.5	155.3	22.2
NRCOP 3	3.4	2.8	26.3	7.5	0.67	7.0	13.8	103.7	14.8
NRCOP 4	3.0	2.7	25.3	7.0	0.62	6.1	14.2	87.6	12.5
NRCOP 5	2.9	2.8	25.1	7.6	0.64	6.9	14.5	102.6	14.7
NRCOP 6	3.5	2.7	25.7	9.3	0.73	8.3	15.4	126.1	18.0
NRCOP 7	3.3	2.7	26.3	9.1	0.69	8.2	15.4	120.5	17.2
NRCOP 8	3.5	2.7	25.4	7.1	0.68	6.3	15.1	99.8	14.3
NRCOP 9	3.7	2.9	26.6	8.1	0.69	7.7	15.7	119.5	17.1
NRCOP 10	3.0	2.7	26.3	5.3	0.52	4.1	15.1	73.7	10.6
CV%	**18.03**	**6.71**	**4.92**	**12.08**	**1.12**	**25.49**	**10.04**	**25.73**	**25.74**
S.Em±	**0.34**	**0.11**	**0.74**	**0.53**	**0.42**	**1.02**	**0.88**	**16.02**	**2.29**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 69. Growth and inflorescence production of oil palm hybrids

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production (Nos)	Male inflorescence (Nos)	Female inflorescence (Nos)	Number of bunches	Mean bunch weight (kg)	FFB yield (kg/ palm)	FFB yield (t/ha)
NRCOP 21	0.78	2.5	21.1	4.6	10.4	9.0	7.0	62.9	9.0
NRCOP 22	0.86	2.4	21.6	3.0	11.1	10.4	10.2	106.1	15.2
NRCOP 23	0.90	2.3	21.0	2.4	11.7	11.3	10.3	117.1	16.7
NRCOP 24	0.85	2.4	21.5	3.2	10.1	8.8	8.3	73.9	10.6
NRCOP 25	0.66	2.4	21.3	3.2	9.7	8.4	7.8	65.6	9.4
NRCOP 26	0.82	2.5	20.4	3.3	10.7	9.1	8.0	73.3	10.5
NRCOP 27	0.83	2.3	20.7	3.5	10.4	8.1	8.3	68.1	9.7
NRCOP 28	0.84	2.4	20.3	3.5	10.4	8.6	8.2	70.9	10.1
NRCOP 29	0.88	2.4	20.3	4.2	10.3	8.5	8.9	75.9	10.8
NRCOP 30	0.64	2.4	20.3	4.6	8.44	6.9	6.7	46.4	6.6
CD (P=0.05)	**11.65**	**NS**	**0.64**	**1.11**	**0.40**	**0.36**	**0.54**	**6.42**	**0.92**
CV (%)	**8.39**	**4.43**	**1.78**	**18.00**	**2.25**	**2.34**	**3.73**	**4.92**	**4.92**

General view of the experiment (Pasighat)

Bunch yield of NRCOP 23 (Pasighat)

was significantly higher than any other cross combinations, whereas the hybrid NRCOP 30 produced the least number of FFB 6.9 per palm. The average bunch weight was also recorded maximum (10.3 kg) in NRCOP 23 which was on par with NRCOP 22 (10.2 kg) and least in NRCOP 30 (6.7 kg) followed by NRCOP 21 (7.0 kg). The highest yield recorded was in NRCOP 23 (117.1 kg/palm and 16.7 t/ha), which was significantly higher than other cross combinations and the hybrid NRCOP 30 recorded the minimum yield (46.4 kg/palm and 6.6 t/ha).

Pattukkottai

Ten new 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. The soil of the experimental field was red sandy loam in nature.

The highest palm height (3.5 m) was recorded in the hybrid NRCOP 4 and the lowest palm height was recorded in the hybrid NRCOP 10 (2.9 m). The hybrid NRCOP 2 recorded the highest palm girth (2.7 m) and NRCOP 5 recorded the highest number of leaves produced per palm per year (25.1). Hybrid NRCOP 9 recorded significantly the lowest number of male inflorescences (6.7). The highest number of female inflorescence (12.6), average bunch weight per palm (12.8), FFB productivity (87.6 kg/palm) and FFB yield (12.5 t/ha) were recorded in the hybrid NRCOP 1. Percentage of oil per bunch was the maximum in the hybrid NRCOP 9 (26.5%) (Table 70).

Vijayarai

The hybrids were planted during September, 2007 by adopting RBD with 3 replications and 6 palms per treatment.

Palm height, girth and sex ratio were not differed significantly among various cross combinations. The hybrid NRCOP 1 recorded significantly higher annual leaf production (23.5). Yield parameters differed significantly among different hybrids and number of bunches per palm were significantly the highest in NRCOP 2 (12.3). Average bunch weight was significantly higher in NRCOP 1 (18.1 kg), which was on par with NRCOP 4. FFB yield per palm and FFB yield per hectare were significantly the highest in NRCOP 9 (176.0 kg/palm/year and 25.2 t/ha) followed by NRCOP 4 (Table 71).

Bunch yield of NRCOP 9 (Vijayarai)

Table 70. Growth and yield performance of oil palm hybrids

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	No. of male inflorescence	No. of female inflorescence	Sex ratio	Number of bunches	Mean bunch weight (kg)	FFB yield (kg/ palm)	FFB yield (t/ha)
NRCOP 1	3.3	2.5	24.1	7.5	12.6	0.63	12.8	6.8	87.6	12.5
NRCOP 2	3.4	2.8	25.0	7.1	10.8	0.60	8.5	7.1	60.1	8.6
NRCOP 3	3.3	2.5	23.5	7.7	11.7	0.61	7.0	6.9	48.6	7.0
NRCOP 4	3.5	2.7	24.8	6.9	11.2	0.62	9.2	7.3	67.2	9.6
NRCOP 5	3.4	2.6	25.1	6.8	12.5	0.65	10.1	8.2	82.5	11.8
NRCOP 6	3.2	2.6	24.0	7.2	11.7	0.62	6.8	7.5	51.2	7.3
NRCOP 7	3.2	2.7	24.2	7.0	11.3	0.62	9.9	7.1	70.2	10.0
NRCOP 8	3.3	2.5	24.1	7.1	11.6	0.62	7.8	6.8	53.6	7.7
NRCOP 9	3.1	2.4	24.0	6.7	11.2	0.63	8.9	7.6	67.4	9.6
NRCOP 10	2.9	2.6	23.8	6.9	11.6	0.63	6.8	6.3	42.6	6.1
S. Em ±	**0.10**	**0.18**	**0.56**	**0.22**	**0.46**	**0.12**	**0.84**	**1.20**	**1.98**	**1.53**
CD (P=0.05)	**0.22**	**0.36**	**1.21**	**0.50**	**0.92**	**0.30**	**1.66**	**3.00**	**3.12**	**3.62**

Table 71. Influence of different hybrids on growth and yield parameters of oil palm

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	No. of female inflorescences	Sex ratio	No. of bunches/ palm/year	FFB yield (kg/palm/ year)	Bunch weight (kg/ palm/year)	FFB Yield (t/ha)
NRCOP 1	2.6	2.9	23.5	11.6	0.53	9.0	164.1	18.1	23.5
NRCOP 2	2.0	2.9	23.2	11.9	0.53	12.3	161.4	13.5	23.1
NRCOP 3	2.1	2.9	23.2	7.4	0.43	10.8	165.9	15.8	23.7
NRCOP 4	2.6	3.0	23.3	14.6	0.52	10.7	172.1	15.9	24.6
NRCOP 5	2.4	3.1	23.1	6.5	0.50	11.3	172.0	15.3	24.6
NRCOP 6	2.2	2.9	22.8	8.3	0.42	10.4	159.4	15.7	22.8
NRCOP 7	2.5	3.0	22.8	13.1	0.41	9.7	142.0	15.1	20.3
NRCOP 8	2.3	2.9	22.7	7.3	0.47	10.0	153.9	15.3	22.0
NRCOP 9	2.2	2.8	23.2	11.4	0.47	11.7	176.0	15.4	25.2
NRCOP 10	2.2	2.9	23.3	12.6	0.40	10.8	145.5	13.7	20.8
S.Em ±	**2.31**	**2.91**	**23.13**	**3.54**	**0.51**	**10.70**	**161.22**	**15.40**	**23.05**
CD (P=0.05)	**NS**	**NS**	**0.40**	**NS**	**NS**	**1.78**	**19.89**	**2.37**	**2.69**
CV (%)	**11.70**	**3.76**	**1.02**	**41.41**	**24.22**	**9.72**	**7.19**	**8.97**	**6.81**

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

Mulde

Planting was done in the experimental field during October, 2011 by adopting RBD with 3 replications and 6 palms per treatment.

The ten new cross combinations of oil palm did not show significant variation for palm height (1.68 to 1.96 m) and palm girth (2.4 to 2.6 m). However, annual leaf production, number of female inflorescences, number of male inflorescences and sex ratio differed significantly among the different genotypes. NRCOP 39 had the highest annual leaf production (33.7). Sex ratio was maximum (0.85) in NRCOP 31 due to lowering in the production of male inflorescences (Table 72).

Pasighat

Layout and planting of this trial were done in August, 2012. Growth parameters of the plants recorded in March 2017 in the main field are presented in Table 73.

Table 72. Growth performances of different hybrid combinations

Hybrids	Palm height (m)	Annual leaf production (Nos)	Number of male inflorescences	Number of female inflorescences	Number of total inflorescences	Sex ratio
NRCOP 31	1.0	26.9	3.8	7.3	11.0	0.66
NRCOP 32	0.9	26.7	2.4	5.5	7.9	0.68
NRCOP 33	1.0	30.5	3.4	4.4	7.8	0.57
NRCOP 34	1.0	27.1	3.5	6.7	10.2	0.66
NRCOP 35	1.0	26.2	3.1	6.3	9.5	0.66
NRCOP 36	0.9	26.1	2.4	5.9	8.3	0.71
NRCOP 37	1.0	26.7	1.5	6.2	7.7	0.81
NRCOP 38	0.9	28.1	1.3	6.4	7.7	0.82
NRCOP 39	1.0	28.5	3.3	6.7	10.0	0.67
NRCOP 40	0.9	25.4	3.1	5.0	8.1	0.61
S. Em ±	**0.04**	**0.80**	**0.50**	**0.50**	**0.50**	**0.50**
CD (P=0.05)	**NS**	**2.50**	**1.30**	**1.60**	**1.60**	**1.48**
CV %	**6.60**	**5.40**	**28.20**	**15.40**	**10.60**	**1.26**

View of Gen. 8D trial (Mulde)

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 the maximum in NRCOP 37 (20.7) followed by NRCOP 26 (19.3), which was significantly higher than the leaves produced by other cross combinations. Minimum numbers of leaves (16.0) was produced in NRCOP 40. The yield and yield attributing characters such as the number of female flowers/palm, number of FFB/palm and average bunch weight were statically at par in all the cross combinations.

Pattukkottai

Nine hybrids *viz.*, NRCOP 31, 32, 33, 34, 35, 36, 37, 38 and 39 were planted on 26.02.2013 at 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 are in initial stage of bearing.

Among the replicated trial hybrids, the highest palm height (3.2 m) and leaf length (3.3 m) were recorded in hybrid NRCOP 32. Hybrid NRCOP 38 registered the

Table 73. Growth parameters of oil palm hybrids

Hybrids	Palm height (cm)	Palm girth (cm)	Annual leaf production (Nos)	Number of male inflorescences/ palm	Number of female inflorescences/ palm	Number of FFB/ palm	Average bunch weight/ palm	FFB yield (t/ha)
NRCOP 31	22.0	131.8	17.8	4.4	5.8	4.9	7.1	5.0
NRCOP 32	31.5	150.5	18.0	4.0	7.5	5.5	6.8	5.4
NRCOP 33	26.0	137.9	16.5	4.8	6.7	5.6	6.4	5.3
NRCOP 34	25.3	143.0	17.3	5.1	7.5	7.5	5.9	6.4
NRCOP 35	27.1	136.8	18.7	5.1	8.1	6.0	5.5	4.7
NRCOP 36	28.0	155.4	19.3	5.5	5.9	5.2	6.3	4.4
NRCOP 37	25.8	138.4	20.7	4.8	11.0	9.7	7.7	10.6
NRCOP 38	24.8	142.4	17.0	5.1	9.0	7.5	5.6	6.2
NRCOP 39	22.0	129.0	19.0	5.3	8.9	7.2	5.6	5.9
NRCOP 40	23.5	137.3	16.0	5.9	6.7	4.9	5.6	3.8
CD (P=0.05)	**NS**	**NS**	**1.31**	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**16.82**	**11.22**	**4.22**	**27.14**	**40.33**	**49.05**	**13.44**	**51.91**

General view of the experiment (Pasighat)

Bunch yield of NRCOP 37 (Pasighat)

highest palm girth (2.1 m). NRCOP 32 registered the highest FFB yield (41.2 kg/palm) and yield per ha (5.8 t).

Among the non replicated trial hybrids, the highest palm height (3.1 m) and palm girth (2.1 m) were recorded in the hybrid NRCOP 37. The highest FFB yield (36.4 kg/palm) and yield per ha (5.2 t) were registered in the hybrid NRCOP 36 (Table 74).

Table 74. Growth parameters of oil palm

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production (Nos)	FFB (kg/palm)	FFB yield (t/ha)
NRCOP 31	3.0	1.8	24.0	35.5	5.1
NRCOP 32	3.3	1.9	23.0	41.2	5.8
NRCOP 33	2.8	2.1	22.0	26.8	3.8
NRCOP 38	3.1	2.1	24.0	30.8	4.4
NRCOP 39	3.0	1.8	24.0	29.8	4.3
S.Em±	**4.88**	**0.08**	**1.14**	**1.18**	**0.34**
CD (P=0.05)	**9.80**	**0.21**	**2.32**	**2.38**	**0.71**

Field view of Gen. 8 D trial (Pattukkottai)

Vijayarai

Palm height was significantly the highest in NRCOP 32 and 33 (1.0 m), whereas, girth was the highest in NRCOP 39 (3.0 m). There was no significant variation in annual leaf production among the crosses. Average bunch weight was significantly the highest in NRCOP 33 (12.5 kg) followed by NRCOP 39. The highest FFB yield per palm was recorded in NRCOP 39 (165.6 kg) with a yield of 23.7 t/ha followed by NRCOP 38 (Table 75).

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

Vijayarai

Eleven hybrids *viz*., NRCOP 41 to 51 were planted during the year 2013 with RCBD. Growth parameters recorded for palm height was significantly the lowest in NRCOP 51 (4.6 m), which was on par with NRCOP 42. Girth and number of leaf produced per palm were non-significant. Among the yield parameters, the highest number of bunches were

Table 75. Performance of different cross combinations on vegetative parameters of oil palm

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production (Nos)	Sex ratio	Number of bunches/ palm/year	Bunch yield (kg/palm/year)	FFB yield (t/ha)
NRCOP 31	0.7	2.7	23.4	0.73	15.6	100.4	14.3
NRCOP 32	1.0	2.7	23.3	0.80	15.2	158.0	22.6
NRCOP 33	1.0	2.8	23.2	0.50	13.6	159.6	22.8
NRCOP 34	0.8	2.9	23.3	0.77	19.2	159.4	22.8
NRCOP 35	0.9	3.0	23.4	0.70	13.2	121.9	17.4
NRCOP 36	0.7	2.9	23.1	0.73	17.5	131.4	18.8
NRCOP 37	0.8	3.0	23.2	0.60	19.2	161.5	23.0
NRCOP 38	0.7	2.9	23.3	0.60	17.8	163.2	23.3
NRCOP 39	0.8	3.0	23.7	0.60	17.6	165.6	23.7
NRCOP 40	0.9	2.9	23.3	0.63	12.4	114.5	15.7
S.Em ±	**9.13**	**0.32**	**10.3**	**0.38**	**39.80**	**10.92**	**3.81**
CD (P=0.05)	**NS**	**NS**	**NS**	**-**	**13.77**	**16.16**	**14.07**

Table 76. Influence of various hybrids on vegetative and yield parameters of oil palm

Hybrids	Palm height (m)	Number of bunches/ palm/year	FFB yield (kg/palm/ year)	Average bunch weight (kg)	FFB yield (t/ha)
NRCOP 41	5.1	6.1	19.5	3.0	2.8
NRCOP 42	5.3	6.2	19.0	2.9	2.7
NRCOP 43	5.0	4.1	13.2	2.5	1.9
NRCOP 44	5.7	6.2	21.2	3.3	3.0
NRCOP 45	4.8	2.5	7.0	2.3	1.7
NRCOP 46	4.7	5.9	15.7	2.5	2.3
NRCOP 47	5.1	3.9	13.1	2.9	1.9
NRCOP 48	4.6	2.2	8.7	2.4	1.3
NRCOP 49	5.0	2.2	7.5	2.5	1.4
NRCOP 50	4.9	6.9	19.6	3.0	2.8
NRCOP 51	4.6	5.9	15.1	2.5	2.2
LSD at 5%	**0.57**	**1.28**	**7.04**	**NS**	**0.65**
CV (%)	**6.78**	**16.43**	**29.28**	**17.98**	**18.05**

recorded in NRCOP 50 (6.9), whereas, FFB yield per palm (21.2 kg) was the highest in NRCOP 44 with a yield of 3.0 t/ha (Table 76).

5.2. CROP PRODUCTION

Agron. 13: Demonstration on oil palm production potential in North East region

Pasighat

The 29 oil palm seedlings planted in 2006 were taken up as the material for "maximization plot" and all the recommended crop management practices were adopted to reach maximum yield. The average plant height, collar girth and number of leaves per plant recorded during 2016-17 as per the suggestion received from ICAR-IIOPR, Pedavegi were 207.1 cm, 258.1 cm and 22.0 leaves per palm, respectively. Flowering and fruiting in all the palms have been observed. Pollinating weevil brought in January, 2013 from ICAR-IIOPR, Pedavegi was released in the plantation. After releasing the pollinating agents in the plantation, fruit set was improved. The palms produced high number of female flowers (11.4/ palm) and less number of male flowers (2.5/palm). The number of FFB produced per plant was 10.7 with an average bunch weight of 17.9 kg and the yield was recorded up to 27.4 t/ha.

Field view of Agron. 13 trial (Phasighat)

Agron. 15: Intercropping in young oil palm garden

Mulde

Objectives: Demonstration of intercrops in juvenile garden

Experimental Details:

Intercrops:

A) Banana - Variety : Konkan Safed Velchi

Spacing : 2 x 2.5 m

Date of planting : 07.03.2014

B) Pineapple - Variety : Kew and Queen

Spacing : Planted in trench prepared for soil and water conservation

Trench size : 3 x 0.45 x 0.45 m (No. of plants= 20/ trench)

C) Elephant foot yam - Variety : Gajendra

Spacing : 0.75 x 0.75 m (Plot size 4.7 x 2 m; 12 plants)

Additional return in oil palm due to intercrops over sole crop was Rs. 85,000/- ha and total return from the cropping system was Rs. 2,19,510/-. It was observed during the demonstration that yield of oil palm under intercrops was increased as compared to yield of oil palm without intercrops.

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

Pedavegi and Bavikere

Objectives

- To standardise the optimum planting density in oil palm.
- To optimise nutrient requirement in oil palm under different planting densities.

The site for the experiment was selected and necessary steps were initiated for setting up of the experiment. Sprouts of Tenera (170D x 17P) were collected on 15th February, 2016 from ICAR-IIOPR and they are being raised in the nursery for planting in the experimental field. Sprouts were sown in the primary nursery during February, 2016 and the seedlings were shifted to the secondary nursery during July, 2016. Observations on height of the seedlings, stem girth and number leaves per seedling were recorded at monthly intervals and they were in the range of 31.2 to 104.1 cm, 3.1 to 10.4 cm and 13 to 22 numbers, respectively during February, 2017.

VI. EXPERIMENTAL RESULTS IN ARECANUT

6.1. CROP IMPROVEMENT

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

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

Shivamogga

Varieties: Mangala, Sumangala, Sreemangala, Mohitnagar, Swarnamangala, Madhuramangala and Shriwardhan

Year of planting: 2015

Among the seven varieties evaluated for their growth characters, Mangala showed maximum height (97.0 cm) from base to tip of the spindle leaf and Madhuramangala recorded the lowest height (50.7 cm). Leaf production was almost similar in all the varieties and ranged from 5 to 7.

Wakawali

For performance evaluation, seven varieties *viz*. Sumangala, Swarnamangala, Shriwardhan, Mangala, Mohitnagar, Madhurmangala and Sreemangala were planted with three replications at Asond Research Farm of Dr B.S.K.K.V., Dapoli during 2015. Analysis of data revealed that mean palm length ranged between 34.8 and 53.3 cm. Variety Sumangala was reported to have the highest length (53.3 cm), while palms of variety Mohitnagar recorded the maximum

Field view of experimental block at Wakawali

Performance of arecanut variety Shriwardhan under Wakawali conditions

number of leaves (5.4), maximum leaf length (42.9 cm) and leaf breadth (45.5 cm).

Activity II: Establishment of nucleus seed garden of arecanut

Varieties:

1. Goa : Hirehalli Dwarf
2. Port Blair : Andaman Dwarf and Samrudhi
3. Shivamogga : Hirehalli Dwarf
4. Wakawali : Shriwardhan and Hirehalli Dwarf

Goa

Twenty two palms of Hirehalli Dwarf planted during 2011 started bearing this year. Nuts were harvested from five of these palms and a new block of nucleus seed garden was established. Observations were recorded on seedlings at the new block. Another new block was developed at Farm C. Land clearing and levelling works have been concluded and pits have been dug to accommodate 75 palms.

Port Blair

Seedlings of Andaman Dwarf and Samrudhi have been raised in the polybag and are ready for

transplanting in the main field. For the establishment of nucleus seed garden, land shaping activities were undertaken in the Garacharma farm of ICAR- Central Island Agricultural Research Institute, Port Blair. Terraces have been made and land has been levelled for the planting of both the varieties. Seedlings will be transplanted with the onset of monsoon in the experimental block during 2017.

Shivamogga

Hirehalli dwarf seedlings planted in August 2015 showed a mean growth of 30.7 cm height with an average number of 6.0 leaves/plant at the end of July 2016.

Wakawali

Nucleus seed garden of Hirehalli Dwarf and Shriwardhan was established during August 2015. Observations on various growth parameters were recorded at a quarterly interval in both the varieties. After 18 months of planting, satisfactory growth was noticed in the variety Hirehalli Dwarf and the growth parameters ranged as: palm crown length (14.0 to 25.0 cm), number of leaves (4.0 to 6.0), leaf length (12.0 to 22.0 cm) and leaf breadth (18.0 to 38.0 cm). In the variety Shriwardhani, growth parameters after 18 months of planting ranged between 42.0-82.0 cm (crown length), 4.0-6.0 (number of leaves), 34.0-60.0 cm (leaf length) and 35.0- 60.0 cm (leaf breadth).

Activity III: Demonstration block of Shriwardhan variety of arecanut

Wakawali

A demonstration block of variety Shriwardhan was established on an area of 0.4 ha at the Asond Research Farm of Dr. B.S.K.K.V., Dapoli during August 2015. The range of various growth parameters after 18 months of planting was 42.0 to 81.0 cm (palm crown length) 4.0 to 7.0 (number of leaves), 35.0 to 85.0 cm (leaf length) and 33.0- 68.0 cm (leaf breadth).

6.2 CROP PRODUCTION

Agron. 18: Development of Arecanut based cropping systems for different agro-climatic regions

Expt. 1: Evaluation of arecanut based cropping system models

Port Blair

Arecanut based cropping system models comprising of banana, ginger, black pepper and elephant foot yam as intercrops were established at the Sippighat farm during July 2015. Various models evaluated were arecanut alone (T_1), arecanut + blackpepper + banana (T_2), arecanut + blackpepper + ginger (T_3) and arecanut + blackpepper + elephant foot yam (T_4). Of the various intercrops, black pepper is still in the juvenile phase, whereas flowering commenced in some banana plants.

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

Locations: Kuruva (Honnali Tk.) and Anveri (Bhadravathi Tk.)

Treatment details

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 (*T. harzianum* + *P. fluorescence* and *Bacillus megaterium* (Shivamogga isolates) @ 100 g/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 Sep. – Oct.

   (Application of fertilizers based on soil and leaf analysis).

Observation on mean number of leaves in healthy and infected plants revealed that a mean of 9.4 to 11.6 leaves were recorded in healthy plants, in comparison to 4 to 5 leaves in infected plants. Mean number of healthy primary roots/sq. ft. area in healthy plants found to be in between 19.2 to 20.2, before treatment, followed by improvement in number of roots from 26.8 to 30.0 roots after one year of treatment imposition at Kuruva and Anaveri respectively. Similarly, improvements in number of secondary and tertiary roots were observed at both places (Table 77).

The biocontrol agents like *Trichoderma*, *Pseudomonas* and *Bacillus* population was increased after a year of imposition of the treatments in both Kuruva and Anveri experimental gardens.

Table 77. Integrated management of hidimundige disorder in affected arecanut garden

Place		Healthy plants (Mean numbers)				Infected plants (Mean numbers)			
		Primary roots	Secondary roots	Tertiary roots	Leaves	Primary roots	Secondary roots	Tertiary roots	Leaves
Kuruva	BT	20.2	31.6	13.2	9.4	12.0	19.4	0.0	5.0
	AT	30.0	34.2	19.0	10.0	20.6	26.0	3.0	5.0
Anveri	BT	19.2	28.6	12.4	10.2	12.2	13.2	0.0	4.0
	AT	26.8	35.4	21.6	11.6	18.0	23.8	5.0	4.0

BT: Before treatment; AT: After treatments.

6.3. CROP PROTECTION

Path. 7: Studies on integrated management of Koleroga disease of arecanut under field condition

Location: Melige, Koluru (Thirthahalli Tk.) and Manchale (Sagar Tk.)

Objectives: To develop integrated management package for koleroga disease through bio-control agents

Design: RCBD; **Treatments:** 7; **Replications:** 3 (No. of plants/replication: 16)

Treatment details

T_1: *T. harzianum* (Shivamogga isolate) @ 20 ml (105×10^7 cfu/ml stock soln/l water) + soil application of microbial consortia (Shivamogga) @ 100 g + 1 kg FYM/palm.

T_2: *P. fluorescence* (Shivamogga isolate) @ 20 ml (105×10^7 cfu/ml stock soln/l water) + soil application of microbial consortia (Shivamogga) @ 100 g + 1 kg FYM/palm.

T_3: *B. megatarium* (Shivamogga isolate) @ 20 ml (105×10^7cfu/ml stock soln/l water) + soil application of microbial consortia (Shivamogga isolate) @ 100 g + 1 kg FYM/palm.

T_4: *T. harzianum* (Shivamogga isolate) @ 20 ml (105×10^7 cfu/ml stock soln/l water + *P. fluorescence* (Shivamogga isolate) @ 20 ml (105×10^7 cfu/ml stock soln/l water + *B. megatarium* (Shivamogga isolate) @ 20 ml (105×10^7cfu/ml stock soln/l water + soil application of microbial consortia @ 100 g/plant along with 1 kg of FYM/decomposed compost to the soil per year.

T_5: Fenamidone 10% + Mancozeb 50% (W/W) (Sectin) (@ 0.3% spray) + adhesive

T_6: Application of Bordeaux mixture @ 1% + adhesive

T_7: Control

The results revealed that application of Bordeaux mixture resulted in the least number of fallen nuts in all the three experimental plots *viz*., Melige, Koluru and Manchalewith 6.0, 7.4 and 6.7 fallen nuts, respectively, compared to control with 20.2, 19.7, 20.5 fallen nuts at Melige, Koluru and Manchale, respectively.

The observations on infected nuts fallen/plant revealed that, the treatment T_6 had the least number of infected nuts fallen/plant in all the three experimental plots with 2.6, 2.8 and 3.3 infected nuts at Melige, Koluru and Manchale respectively followed by T_5 (spraying Sectin @ 0.3 %), whereas in control a mean of 11.6, 10.5 and 10.9 infected nuts were fallen per plant at all the three locations (Table 78).

The results revealed that all the treatments were significantly superior to the control. Among the treatments, T_6 (Bordeaux mixture @ 1%) showed the least per cent disease incidence in all the three experimental plots *viz*., Melige, Koluru and Manchale with 7.64, 6.94 and 6.94 per cent incidence, respectively, followed by T_5 (Sectin 3 ml/lit) which showed 9.72, 8.33 and 7.64 per cent disease incidence, in all the three experimental plots. However, all the treatments differed significantly compared to control.

Ent. 18: Evaluation of entomopathogenic nematodes (EPN) for the management of areca white grubs

Zone: 7 and 9**; Place:** Koluru (Thirthahalli Tk.) and Harakere (Shivamogga Tk.)

Design: RCBD; **Treatments:** 6; **Replications:** 3 (No of plants/replication:15)

Table 78. Effect of biological and chemical treatments on per cent incidence of koleroga disease

Treatments	Location			Mean
	Melige	Kolur	Manchale	
T_1	15.28 (23.02)	15.97 (23.57)	17.36 (24.00)	16.20 (23.74)
T_2	14.58 (22.46)	14.58 (22.46)	15.28 (23.02)	14.81 (22.65)
T_3	13.89 (21.89)	13.89 (21.89)	15.28 (23.02)	14.35 (22.27)
T_4	11.81 (20.11)	11.81 (20.11)	11.11 (19.48)	11.57 (19.90)
T_5	9.72 (18.18)	8.33 (16.79)	7.64 (16.05)	8.56 (17.01)
T_6	7.64 (16.05)	6.94 (15.29)	6.94 (15.29)	7.18 (15.54)
T_7	27.08 (31.38)	25.00 (30.02)	22.92 (28.62)	25.00 (30.00)
SEm±	1.14	0.95	0.80	0.63
CD (P=0.05)	3.51	2.92	2.47	1.94

Values in parenthesis are square root transformed values.

Treatment details

T_1: *Heterorhabditis indica* @ 5 g/l water (25 g/palm) – (commercial formulation)

T_2: *Steinerema carpocapsae* (CPCRI isolate) @ 1.5 billion IJs/ha (1.2 crore IJs/palm)

T_3: Imidacloprid 17.8 SL (2.5 ml/5 l water) + *S. carpocapsae* @ 0.75 billion IJs/ha

T_4: *Metarrhizium* commercial formulation (20 g/palm) + *S. carpocapsae* @ 0.75 billion IJs/ha

T_5: Imidacloprid 17.8 SL @ 0.0045% (2.5 ml/ 5 l water) (standard check)

T_6: Control

The results revealed that at Koluru, initially the grub population varied from 2.25 to 2.75. After 30 days of treatment, T_3 treatment showed the least grub count (0.50) followed by T_4 treatment with 1.25 grub count and at 60 days after treatment, T_3 treatment showed the least number of grubs per palm (0.25) (Table 79).

At Harakere slightly higher grub count was noticed ranging from 2.50 to 3.25. After 30 days of treatment, T_3 treatment showed the least grub count (0.75) followed by T_5 with 1.50 grub count and at 60 days after treatment also T_3 treatment showed least number of grubs per palm (0.50) (Table 79).

Table 79. Mean population of root grubs per palm in root grub affected garden at Harakere

Treatments	Pre-treatment		30 DAT		60 DAT	
	Koluru	Harakere	Koluru	Harakere	Koluru	Harakere
T_1	2.50 (1.73)	2.50 (1.73)	2.00 (1.56)^{ab}	2.00 (1.56)	1.50 (1.35)	1.75 (1.49)^{a}
T_2	2.25 (1.65)	2.75 (1.80)	1.75 (1.48)^{ab}	1.75 (1.48)	1.75 (1.48)	2.00 (1.56)^{a}
T_3	2.25 (1.65)	2.75 (1.80)	0.50 (0.97)^{c}	0.75 (1.10)	0.25 (0.84)	0.50 (0.97)^{b}
T_4	2.75 (1.79)	3.00 (1.86)	1.50 (1.40)^{ab}	1.75 (1.49)	1.25 (1.27)	1.75 (1.49)^{a}
T_5	2.25 (1.57)	3.00 (1.86)	1.25 (1.31)^{bc}	1.50 (1.40)	1.50 (1.40)	2.25 (1.65)^{a}
T_6	2.25 (1.64)	3.25 (1.92)	2.50 (1.73)^{a}	2.50 (1.73)	2.00 (1.58)	2.00 (1.58)^{a}
F value	NS	NS	*	NS	NS	*
CV (%)	18.25	11.46	18.42	18.11	26.18	14.96
CD (P=0.05)	0.53	0.36	0.45	0.46	0.60	0.38

DAT: Days after treatment; Values in parenthesis are square root transformed values.

VII. EXPERIMENTAL RESULTS IN PALMYRAH

7.1. GENETIC RESOURCES

Gen. 9: Survey, collection and evaluation of palmyrah germplasm

Survey and collection of palmyrah germplasm was done to identify dwarf and superior palmyrah genotypes for high neera and nungu yield. So far 272 palmyrah germplasm accessions were collected and are being maintained as separate year wise germplasm blocks at Horticultural Research Station, Pandirimamidi. In Agricultural College and Research Institute, Killikulam, about 265 accessions were collected and being maintained. In both the centres, the germplasm accessions are being evaluated for various biometric, yield and yield related characters.

Pandirimamidi

The data on biometrical observations as well as flowering and fruiting characters were recorded for all the germplasm accessions assembled. The fruiting and neera yield observations recorded in year wise blocks is represented in Tables 80 and 81.

Among the 1991 planted germplasm accessions, the highest neera yield was recorded in Acc. No. 11/91 (48.7 l). The highest average number of fruits (12.0) was recorded in Acc. No. 12/91 and the highest average number of bunches (6.8) was recorded in Acc. No. 12/91 (Table 80).

Table 80. Yield related characters of 1991 planted germplasm block

Sl. No.	Accession number	Number of bunches/tree	Number of fruits/ bunch	Neera yield/ tree (l)
1.	1/91	6.2	9.8	22.6
2.	2/91	5.6	8.5	31.8
3.	3/91	3.5	10.5	28.5
4.	4/91	5.5	11.3	29.6
5.	5/91	4.3	8.6	34.4
6.	6/91	3.0	7.7	37.2
7.	7/91	4.5	9.4	44.0
8.	8/91	4.3	10.1	45.5
9.	9/91	3.5	8.9	27.6
10.	10/91	5.0	9.2	21.6
11.	11/91	6.0	8.6	48.7
12.	12/91	6.8	12.0	31.5
13.	13/91	3.5	9.9	38.8

Among 1993 planted germplasm accessions, the highest neera yield (37.55 l) was recorded with the Acc. No.3/93 and Acc. No. 7/93 has recorded the highest number of fruit bunches (7.0). The maximum number of fruits per bunch (11.0) was recorded in Acc.No. 4/93 (Table 81).

Table 81. Yield related characters of 1993 planted germplasm block

Sl. No.	Accession number	Number of bunches/ tree	Number of fruits/ bunch	Neera yield/tree (l)
1.	1/93	3.2	9.5	27.6
2.	2/93	2.4	8.8	29.2
3.	3/93	6.0	9.7	37.6
4.	4/93	5.5	11.0	21.6
5.	5/93	5.5	10.3	24.5
6.	6/93	6.0	9.7	30.6
7.	7/93	7.0	8.1	19.7
8.	8/93	3.3	6.7	26.5
9.	9/93	4.8	8.6	15.3
10.	10/93	3.5	9.8	31.6

Field view of palmyrah germplasm maintained at Pandirimamidi

7.2. CROP PRODUCTION

Agron. 16: Studies on use of growth inhibiting substances for induction of early flowering in palmyrah

Expt. 1: Studies on use of growth regulators for induction of early flowering in palmyrah

Treatment details

T_1	Root feeding with Chlormequat chloride 200 ppm
T_2	Root feeding with Chlormequat chloride 400 ppm
T_3	Root feeding with Mepiquat chloride 200 ppm
T_4	Root feeding with Mepiquat chloride 400 ppm
T_5	Root feeding with Triacontanol 200 ppm
T_6	Root feeding with Triacontanol 400 ppm
T_7	Pouring on the crown with Chlormequat chloride 2 ppm
T_8	Pouring on the crown with Chlormequat chloride 4 ppm
T_9	Pouring on the crown with Mepiquat chloride 2 ppm
T_{10}	Pouring on the crown with Mepiquat chloride 4 ppm
T_{11}	Pouring on the crown with Triacontanol 2 ppm
T_{12}	Pouring on the crown with Triacontanol 4 ppm
T_{13}	Control

Killikulam

The trial was initiated during the month of February 2016. Already existing four, six and eight years old trees were selected and the three chemicals namely Chlormequat chloride, Mepiquat chloride, and Triacontanol were applied to the selected plants by pouring on the apical bud as well as by root feeding according to the treatment requirements. The application of chemicals was done at three months interval. Data on all the biometrical observations were recorded before starting the application of growth regulators.

Date of application of growth regulators

Sl. No.	Date of application
1.	4th week of February 2015
2.	4th week of May 2015
3.	4th week of August 2015
4.	4th week of November 2015
5.	4th week of February 2016
6.	4th week of May 2016
7.	4th week of August 2016
8.	4th week of November 2016
9.	4th week of February 2017

On 10 year old palms, among the different treatments, treatment T_6 (root feeding with Triacontanol 400 ppm) recorded the highest plant height (9.87 cm), number of leaves (36.87 No.) and leaf length (95.95 cm) followed by treatment T_4 (root feeding with Mepiquat chloride 400 ppm) with the highest plant height (9.75 cm), number of leaves (36.56 No.) and leaf length (95.74 cm). The least plant height, number of leaves and leaf length were recorded in control.

On 8 year old palms, among the different treatments, treatment T_6 (root feeding with Triacontanol 400 ppm) recorded the highest plant height (8.89 cm), number of leaves (35.58 No.) and leaf length (100.29 cm) followed by treatment T_4 (root feeding with Mepiquat chloride 400 ppm) with the highest plant height (8.75 cm), number of leaves (35.37 No.) and leaf length (99.89 cm). The least plant height, the number of leaves and leaf length were recorded in control.

On six year old palms, among the different treatments, treatment T_6 (root feeding with Triacontanol 400 ppm) recorded the highest plant height (5.95 cm), number of leaves (35.89 No.) and leaf length (70.25 cm) followed by treatment T_4 (root feeding with Mepiquat chloride 400 ppm) with the highest plant height (5.74 cm), number of leaves (35.47 No.) and leaf length (69.87 cm). Control recorded the lowest values for all the characters like plant height, number of leaves and leaf length.

Pandirimamidi

The trial was initiated during January 2015. The existing on-farm trees of four, six and eight years old were selected and the three chemicals namely Chlormequat chloride, Mepiquat chloride and Triacontanol were given to the selected plants by pouring on the apical bud as well as by root feeding, according to the treatment requirements. The application of chemicals was done at three months interval. In two years schedule, a total number of 9 applications were done. The biometric observations were recorded in all the palms, before the application of chemicals and after the completion of the two years. Recording of the observations like earliness in flowering will be done at six months intervals.

Date of application of chemicals

Sl. No.	Date of application	Sl. No.	Date of application
1.	2nd week of January 2015	6.	2nd week of April 2016
2.	2nd week of April 2015	7.	2nd week of July 2016
3.	2nd week of July 2015	8.	2nd week of October 2016
4.	2nd week of October 2015	9.	2nd week of January 2017
5.	2nd week of January 2016		

In 10 year old palms there was no early flowering in all the treatments imposed. There was no significant change in the observations recorded before the start of application of chemicals and after finishing the scheduled application of chemicals compared to the control treatment. A similar result was recorded in both eight year and six year old palms.

Expt. 2: Composting technology of palmyrah pith

To evaluate different methods of composting of palmyrah pith, analysis of composted pith for nutrients and microbial population was carried out.

Treatment details:

T_1	Palmyrah pith (100 kg) + Urea (1 kg)
T_2	Palmyrah pith (100 kg) + *Pleurotus* fungus 2 bottles (1 kg)
T_3	Palmyrah pith (100 kg) + Urea (1 kg) + *Pleurotus* fungus 2 bottles (1 kg)
T_4	Palmyrah pith (100 kg) + Urea (1 kg) + *T. viride* (1 kg) (Palmyrah pith + Urea, turning at 15 days interval up to 45 days. Application of *T. viride* on 46th day and again turning at 15 days interval)
T_5	Palmyrah pith (100 kg) + *Pleurotus* fungus 2 bottles (1 kg) + *T. viride* (1 kg). (Palmyrah pith + *Pleurotus* fungus 2 bottles (1 kg) and turning for 15 days interval up to 45 days. Application of *T. viride* on 46th day and again turning at 15 days interval)
T_6	Palmyrah pith (100 kg) + Poultry manure (10 kg) + Urea (1 kg) + *Pleurotus* fungus 2 bottles (1 kg) + *T. viride* (1 kg). (Palmyrah pith + Poultry manure + Urea (1 kg) + *Pleurotus* fungus 2 bottles (1 kg) and turning for 15 days interval up to 45 days. Application of *T. viride* on 46th day and again turning at 15 days interval.)
T_7	Palmyrah pith (100 kg) + Poultry manure (10 kg) + Urea (1 kg) + *Pleurotus* fungus 2 bottles (1 kg) + Bio mineralizer (0.2 kg). (Palmyrah pith + Poultry manure + Urea (1 kg) + *Pleurotus* fungus 2 bottles (1 kg) and turning for 15 days interval up to 45 days.
T_8	Palmyrah pith (100 kg) + Poultry manure (10 kg) + Urea (1 kg) + *Pleurotus* fungus 2 bottles (1 kg) + Ligno-cellulolytic fungi 2 bottles (1 kg) + *T. viride* (1 kg). (Palmyrah pith + Poultry manure + Urea (1 kg) + *Pleurotus* fungus 2 bottles (1 kg) + Ligno-cellulolytic fungi 2 bottles (1 kg) and turning for 15 days interval up to 45 days. Application of *T. viride* on 46th day and again turning at 15 days interval)

Killikulam

The experiment was started during the month of October 2016. Analysis of the palmyrah pith sample was done before imposing the treatments and the pith had 0.48% N, 0.03% P and 0.38% K.

Pandirimamidi

The experiment was initiated on 20th February 2017. All the treatments were imposed and the experiment was completed during the third week of May. Analysis of the samples is in progress.

7.3. POST HARVEST TECHNOLOGY

PHT 1: Standardization and commercialization of inflorescence sap (neera) extraction and inflorescence sap based products (jaggery, palm sugar and candy)

Pandirimamidi

Palmyrah sap is rich in sugar, minerals and proteins. The shelf life of sap was observed to be 5-6 hours at room temperature for fresh sap of both male and female palmyrah, but in lime added neutralised sap it was about 24 hours. Under refrigerated conditions shelf life of fresh neera was 12-14 days and chemical processed neera was about 15-18 days, which can be extended up to 30 days by thermal processing. Nutritional values change slightly upon storage (Table 82).

Palmyrah syrup is the most economical product with high nutritional values. The TSS of syrup is 65-68° Brix and vitamin C is less as compared to neera. The syrup can be used as a sweetener or it can be dried at low temperature to produce palm sugar or jaggery.

Table 82. Shelf life of sap under different conditions

Conditions	Fresh sap (CPCRI)	Lime added sap
Room temperature	5-6 hrs	24 hrs
Refrigerated	12 days	15 days
KMS 100 ppm	14 days	20 days
KMS 200 ppm	15 days	20 days
KMS 300 ppm	18 days	20 days
Thermal treatment	30 days	30 days

Killikulam

The quality of the palmyrah sap collected using CPCRI method was analysed. The average pH of the sap collected from the male and female tree was 6.6 and 6.7 respectively. The TSS of the sap collected from the male and female tree was found to be the same and was ranging between 11 and 13º Brix. The total sugar of the sap was ranging from 9 to 13 g per 100 ml. The ash content of the sap was ranging between 0.2 to 0.4 g and the ascorbic acid content of the sap was ranging from 21 to 28 mg per 100 ml.

An attempt was made to enhance the shelf life of neera by thermal processing method. The sap collected by CPCRI method was pasteurised with different time-temperature combinations. The various levels of temperature and time of processing selected were 80, 85 and 90°C and 10, 15 and 20 minutes respectively. It was observed that the sample pasteurised at 80°C for 15 minutes was better in terms of biochemical qualities. The change in biochemical qualities of pasteurised neera was insignificant when compared to fresh neera. The sensory qualities of pasteurised neera were on par with fresh neera. Also, experiments were conducted to test different types of packaging material (LDPE, HDPE and PP) for storage of pasteurised neera at ambient and refrigerated conditions. The storage studies of pasteurised neera were conducted with and without preservatives and stored at ambient and refrigerated conditions. The biochemical, sensory and microbial analysis was carried out for 10 days. The samples stored under ambient conditions exhibited significant variation in biochemical attributes between samples with and without preservatives. Whereas there was insignificant variation in biochemical parameters between samples stored under refrigerated conditions. The cloudiness was noticed at the bottom of the bottles due to the presence of protein and other compounds, which led to a clumsy appearance during storage.

PHT. 2: Standardization of tuber flour based food products (pizza, bakery items, confectionery, health mix etc.)

Pandirimamidi

Objective: Development of tuber based food products and quality analysis

Fresh palmyrah tuber (apicolon) flour blend with tapioca and banana flour at various proportions and found that tapioca with tuber flour (1:1) combination having 79.3% starch was the best for the development of cookies. The nutritional values such as texture (6 score), appearance (6.5 score), taste (7 score) and overall acceptability (excellent) were also good as compared to other combinations.

Palmyrah flour based cookies

VIII. MONITORING VISITS AND MEETINGS

Monitoring

The technical programmes of all the centres were monitored by the Project Coordinator by visiting them and keeping constant touch with all the centres through phone and email. Time to time advice and direction was given for proper implementation of the technical programmes. Monthly progress report and budget utilization information were obtained from centres regularly and the same was 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. After each visit, suggestions were given for improving the technical programmes.

Centres visited

Centre	Date of visit
Killikulam (Tamil Nadu)	11.04.2016
Port Blair (A & N Islands)	13.04.2016 to14.04.2016
Sabour (Bihar)	07.06.2016
Mondouri (West Bengal)	08.06.2016 to 09.06.2016
Mulde (Maharashtra)	03.08.2016 to 04.08.2016
ICAR-CCARI, Goa	04.08.2016 to 05.08.2016
Wakawali (Maharashtra)	30.08.2016
Ratnagiri (Maharashtra)	31.08.2016 to 02.09.2016
Madhopur (Bihar)	27.10.2016 to 28.10.2016
Arsikere (Karnataka)	07.11.2016 to 08.11.2016
Aliyarnagar (Tamil Nadu)	13.11.2016
Pilicode (Kerala)	10.03.2017

Visits made to centres

Ambajipeta

Arsikere

Killikulam

Mondouri

Mulde

Portblair

Sabour

Shivamogga

XXV Annual Group Meeting

The Annual Group meeting of All India Coordinated Research Project on Palms was organized from 19-21st May, 2016 at ICAR-Central Plantation Crops Research Institute, Kasaragod. The Annual Group Meeting was inaugurated by Dr. K. Ramasamy, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore. The inaugural meeting was graced by the presence of Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod, Dr. R. K. Mathur, Director, ICAR-Indian Institute of Oil Palm Research, Pedavegi, Dr. P. L. Saroj, Director, Directorate of Cashew Research, Puttur, scientists working in various centres of the project and scientists of ICAR-CPCRI, Kasaragod. At the outset, house paid homage to the departed soul of Dr. Y. R. Sharma, Former Director of ICAR-Indian Institute of Spices Research, Kozhikode. Meeting began with welcome address, followed by the Swachhata pledge by participants of the meeting.

Dr. H. P. Maheswarappa, Project Coordinator (Palms), presented a brief report highlighting activities carried out during 2015-16 in various centres of the project. He informed the house that AICRP on Palms was bagged the Chaudhary Devi Lal Best AICRP for 2014 amongst AICRPs operating in the country during 87th Foundation Day of ICAR, held at Patna in 2015. He further briefed that the project was initiated during 1972 for addressing location specific needs of the farmers in the mandate crops and is being implemented in 27 centres spread across 13 states and one Union Territory of the country. During this period, TxT coconut hybrid was recommended for release, promising high yielding oil palm hybrids have been evaluated at various centres and incorporation of flower crops as intercrops was found to be a profitable option at different centres. Black headed caterpillar was found to be a growing concern in the states of Tamil Nadu and Karnataka. However, successful management of the pest through mass multiplication of the bio-control agents was demonstrated at various centres. Slug caterpillar incidence was reported in Andhra Pradesh and Karnataka where its successful management was demonstrated using light traps. A number of activities including demonstrations, trainings and diagnostic field visits were carried out during the year for the benefits of the stakeholders.

Dr. P. L. Saroj, during his address, appreciated the research works being carried out at various centres of the AICRP on Palms and by ICAR-CPCRI for a century. He emphasized that considering the changing scenario, improved varieties should be developed for multiple traits including those for various purposes and locations. Package of practices need to be developed or modified considering the existing varieties, local climate and resource availability. Multispecies cropping systems are known to increase the profitability of the farmers and hence suitable component crops should be identified, which could additionally help maintenance of soil health. Development of technologies for value addition and dissemination of technologies through mobile phones need to be promoted. At the end he appreciated honoring best performing centre to improve the quality of work being carried out.

Dr. R. K. Mathur appreciated 100 years of the service of the institute and congratulated the scientists working in various AICRP centres for bagging best AICRP award at national level. He suggested that as the challenges of price fluctuation are growing, intercropping has become the need of the hour. Integrated nutrient management is highly relevant in the present context as it reduces the dependence on inorganic fertilizers, reduces production cost and improves soil health. He critically suggested that the experiments should be designed to improve the basic understanding of the subject, as it could help in solving the problems effectively apart from assisting in publishing the findings as research articles.

Dr. K. Ramasamy, while addressing the gathering suggested that, research works are being carried out in isolation and hence coordinated research is required to be emphasized. He opined that the resources are scarce, so their utilization should be done in efficient way. In order to reduce the dependence on the imports, efforts should be made to promote and market the local produce with minimum support price. He opined that value addition of coconut with diversified products could help in improving the profitability of the farmers. He emphasized the importance of skill development and identification of potential markets for tapping the potential of value added products.

Four publications released from AICRP centres during the inaugural session. The performance of AICRP centres is being evaluated every year and during 2015-16, AICRP centres, Aliyarnagar has been judged as the best performing centre.

Inauguration of 25th AGM

Release of publication by dignitaries

Best centre Award – AICRP on Palms, Aliyarnagar

Group Discussion on Technical programme of Pest Management

A group discussion on formulation of Technical Programme of Pest Management was held at ICAR-CPCRI RS, Kayamkulam under the chairmanship of Dr. P. Chowdappa, Director, ICAR-CPCRI on 13.07.2016. During the programme, ongoing Technical Programmes were reviewed and after attaining the objectives, those programmes were closed. New Technical Programmes were formulated as per the need of each region.

IX. EXTENSION, POPULARIZATION OF TECHNOLOGIES AND TSP

Coconut

Aliyarnagar

- Twelve training programmes were organised under different aspects of coconut cultivation, which benefited 267 extension workers and 754 farmers at Coimbatore, Tiruppur, Pollachi, Aliyarnagar, Kanyakumari and Tirunelveli districts of Tamil Nadu.
- Scientists of the centre delivered twenty special lectures on crop improvement, crop production and crop protection topics at Trichy, Sempatti, Pongalur, Manakkadavu, Coimbatore, Aliyarnagar, Dindigul and Pallipalayam districts.
- Three talks were delivered in All India Radio and four programmes were telecasted in Podhigai TV channel on different aspects of coconut cultivation.
- Press coverage: 11 Nos.

International Training programme on "Technological intervention and best practices for coconut hybridization" was organized by EEI, Rajendranagar, Hyderabad, Department of Agriculture and Cooperation, Government of India.

Participants of training on hybridization

Awareness meetings and sensitisation campaigns at CRS, Aliyarnagar and farmers fields

Ambajipeta

Training programme on hybridization in coconut

- Skill training on "Hybridization technique in coconut" to officers of Department of Horticulture (3.06.16 to 4.06.16) and Ministry of Agriculture (28.12.16 to 29.12.16), Government of Bangladesh as part of the

FOCT Training programmes

- Conducted four on-campus 'Friends of Coconut Tree' (FOCT) training programmes of 6 days duration to 20 trainees per batch and imparted training on the harvesting of coconuts using climbing machines, scientific management practices on crop production and protection

aspects with the assistance of Coconut Development Board, Kochi.

- Delivered lectures on coconut production and protection technologies to 100 FOCT trainees organized by Noveeal Coconut Producer Company Limited along with CDB at HRS, Ambajipeta on 21st and 28th October 2016.
- Sixty trainees of FOCT organized by Noveeal coconut producer company Ltd, Amalapuram visited Horticulture Research Station, Ambajipeta on 11th to 18th November 2016. The scientists imparted training on technical aspects of quality seedlings production and protection measures in coconut.

Other trainings

- Three day training programme on cocoa cultivation aspects and marketing options with the financial assistance of Directorate of Cashew and Cocoa Development Board, Kochi was conducted from 21st to 23rd February 2017.
- Imparted training on latest aspects of production and protection technologies along with practical exposure to thirty cocoa farmers of Amalapuram division, organised by the Regional Horticultural Training Institute, Eluru, Department of Horticulture on 10.08.16.
- Participated as resource persons in one day training programme on "Cocoa canopy management" organized by Department of Horticulture, East Godavari District at Agriculture Market Committee, Ambajipeta and delivered lectures on cocoa production and protection technologies.
- Participated in one day training cum awareness programme on "Coconut technologies and insurance to coconut palms" organised by Department of Horticulture to the coconut farmers (300 Nos.) at Amalapuram on 17.10.16 and the programme was preceded by Hon'ble Deputy Chief Minister, A. P.
- Imparted one day training programme for seven Multipurpose Extension Officers, Department of Horticulture, Razole on "Slug caterpillar damage and management practices under field conditions" at Horticultural Research Station, Ambajipeta on 23.01.17.
- Conducted one day district level seminar on cocoa to 120 farmers sponsored by Directorate of Cashew and Cocoa Development Board, Kochi, Kerala at Bhupalapatnam (village), Rajanagaram mandal of East Godavari district in coordination with Horticulture Department and explained about the latest production, protection and post harvest technologies pertaining to cocoa crop.

Cocoa training to farmers

- Participated and delivered lectures in one-day awareness programme to the farmers on "Production and protection technologies of Horticultural crops" organised by the Department of Horticulture, East Godavari district on 11.07.2016 at Lakkavaram village of Razole Mandal and exhibits on coconut technologies from HRS, Ambajipeta were also displayed.
- Conducted an awareness meeting to nursery men and farmers and released the pamphlet (Telugu) on 'Coconut rugose spiraling whitefly' on 17.02.2017 at MDD office, Kadiyam mandal, East Godavari district.
- Organized field day programme to thirty farmers on cocoa production and protection technologies at Avidi village on 23.02.2017.

Release of the pamphlet on 'Coconut rugose spiraling whitefly' during awareness meeting to nursery men and farmers

Arsikere

Training cum demonstration

- Conducted training programme on Integrated pest and disease management in coconut, Benefits of modern technologies adoption in coconut cultivation, 'Farming system in coconut and Moisture conservation to farmers at Arsikere and a total of 312 farmers got benefited.

Training programme for farmers

Diagnostic field visits

- A total of 80 field diagnostic visits were carried out to monitor and forecast the pest and disease incidence on coconut and coconut based farming system, and 312 phone queries were answered.

Field demonstration of basal stem rot management

- Around 4000 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, coconut based cropping system, integrated pest and disease management and value addition of coconut.

Participation in Krishi Mela/ Horticulture Mela - 6 Nos.

- Participated in Horticulture Mela, Siridhanya Mela, Flower show-2017 and 8th Agriculture Science Congress Exhibition organised by Universities and other organisations. The specimens of different varieties, value added products of coconut and information on production and protection technologies of coconut were exhibited.

Bhubaneswar

- Conducted three on-campus and seven off-campus FOCT training programmes and one on-campus farmers training programme organised by CDB, State centre, Bhubaneswar. A total of 569 farmers and other participants attended the programme.

Training programme for farmers

- Participated in one exhibition and displayed exhibits for wider publicity of the technologies on coconut farming in the state.
- Participated and imparted training on coconut farming on the eve of "World Coconut Day celebration programme".

Goa

- Delivered lecture on "Propagation and nursery management of coconut and arecanut" during 21 days training programme on 'Nursery management in Horticultural crops'.
- Delivered lecture on 'Biodiversity and ecosystems' at Kshitij 2016, Seminar on Science

and Engineering for Sustainable Development, Don Bosco College of Engineering, Fatorda, Margao on 29th July 2016.

- Delivered lecture on 'Spices, plantation, medicinal and aromatic plants in agro-ecotourism models' during the short course on 'Agro eco-tourism: An emerging enterprise for agricultural diversification' on 31st October to 9th November 2016.
- Participated in the exhibitions at ICAR-CCARI and outside the campus including the Krishi unnathi farmers mela at IARI, New Delhi during 15-17th March 2017.

Kahikuchi

- During the year 2016-17, five trainings on 'Improved production technology of coconut' were conducted at Khetri, Mukalmua, Sikharhati, Barihat and Chaigaon.

Training on 'Improved production technology of coconut'

- World coconut day was celebrated on 2nd September in the farmers' field by conducting awareness and generated interest on the importance of coconut among the farmers.

World coconut day celebration

- **Demonstration:** Four demonstrations *viz*., nursery raising technique in coconut, integrated nutrients management practices in coconut, low-cost drip irrigation and disease and pest management in coconut were conducted at Hajo, Rani, Lapatul during the period.
- Coconut block plantation has been initiated in the farmers' field namely Sri Umesh Bora of Lapatul having 40 palms and Sri Milon Bora of Rani having 25 palms. Intercropping of turmeric and banana has been taken up in the block plantation by both the farmers.
- **Exhibition:** The major technologies developed were transferred by participating time to time in the various exhibitions like State level Annual Horticultural Show, Assam International Agri-Horti Show and North East Agri Fair.
- **TV Talk**: A TV programme on 'Production technology of coconut' was telecasted in DD Guwahati on 24.06.2016.

Mondouri

- Scientists were associated as the resource person with 20 number of FOCT training groups (around 800 farmers). Training programmes *viz*., coconut cultivation and management, integrated farming in coconut, establishment of coconut

Training programme to farmers

nursery and its management, coconut based multi-tier cropping system and its importance for increasing net return per unit area were conducted and the programmes were sponsored by Coconut Development Board.

- On 2nd September 2016, 'World coconut day' was celebrated at the Horticultural Research Station, Mondouri, BCKV as well as in the farmers' field.

Navsari

Training programmes

- Training on "Production technology of coconut" was conducted.
- Four demonstrations of coconut technology in the farmer's field.
- Two field days/ training programmes were organised by the centre in Valsad district of Gujarat state.
- Special lecture was delivered on 'Production technology of coconut' for farmers of Junagadh district (ATMA project) at KVK, NAU, Navsari.
- Diagnostic visits to farmers field -10 Nos.
- FLD's organized - 04 Nos.
- Participation in *Krishi mela*/ Horticulture *Mela*/ Exhibitions - 03 Nos.
- Radio talk on '*Naliyarima Bahuudeshiy Pak Paddhati'* (Gujarati) (Coconut based cropping system) was broadcasted on 19.10.16 on Daman Radio frequency in *Krishidarshan* programme.
- **World Coconut day:** Organised 'World Coconut Day' on 2nd September 2016 at Nargol village, Umargaon Tk., Valsad Dist. and created awareness on the importance of coconut as well as covered the important points like planting systems, improved varieties, organic and inorganic fertilizer management, irrigation management, intercropping, marketing channels and information regarding health benefits of value added products of coconut to the farmers. Approximately 300 farmers and youths participated in the mela.

Participation in exhibition

Port Blair

- Conducted field visits and training programme on 'Black pepper as an intercrop in coconut and arecanut plantations' at Kanyapuram, South Andaman. During the programme, planting materials of improved varieties of black pepper were distributed to the island farmers.
- A field demonstration on coconut climbing device was organised for the benefit of Nicobarese tribal farmers of Little Andaman island on 20.08.2016. During the event, farmers were provided with the leaflets on the handling and use of this device for carrying out various operations in coconut gardens.
- A programme entitled 'Arecanut based cropping systems' was broadcasted on Doordarshan Port Blair and subsequently on Doordarshan Kisan Channel (29.11.2016). The programme was recorded in the experimental block of the project and Dr Ajit Arun Waman, Scientist in Charge, Port Blair centre, served as an expert.

Demonstration on coconut climbing device in Nicobarese tribal villge of Little Andaman

Ratnagiri

Training programme for farmers

- Total 15 trainings were conducted at RCRS Bhatye on vermicompost preparation, coconut cultivation, protection, intercropping

Training programme for farmers

system, vegetable cultivation and spices crops cultivation.

- One day district level seminar on 'Prospects of cocoa cultivation in palm based cropping systems, spice crops cultivation, pest and diseases identification and management, black pepper cultivation etc.' was organized and a total of 230 female and 259 male farmers were participated.
- Around 3601 students and 143 staff members from various colleges, 667 farmers and 130 officers from Ratnagiri, Gujrat, Kolhapur, Rajapur and Sangali were visited RCRS Bhatye, Ratnagiri.
- World coconut day was celebrated on 2nd September 2016 and Dr. Tapas Bhattacharya, Honorable Vice Chancellor presided over the function along with Dr. H. P. Maheswarappa, PC (Palms) and about 400 farmers from different districts were participated.

World coconut day celebration

Sabour

- Organised awareness programme on 'Scientific cultivation and problems of coconut cultivation in Bihar', in KVK of Madhepura, Katihar. A total of 122 extension functionaries of Madhepura, Katihar district and progressive farmers were attended the programme.
- 10 numbers of training programmes on different aspects of palmyrah cultivation like economic uses and scope, value added products and neera collection and preservation were conducted. A total of 980 members including toddy tappers, persons from extension functionaries, Govt. officials and JIVIKA participated.
- Queries regarding coconut cultivation and different problems faced by farmers were solved during kisangosthi, organized by KVKs, DHO, ATMA and Kisan Mela. Advisory services were also given through video conferencing.

Diagnostic Field Visit (DFV)

- Scientists of the centre visited Nalanda and studied the quality of date palm and palmyrah palm neera.

Training programme on coconut cultivation at KVK, Madhepura

Veppankulam

- 3 days training programme on 'Cocoa - varietal wealth, production technology, pest and disease management' was conducted during 22-24th March 2017 and the programme was sponsored by DCCD, Kochi.
- One day training on 'Application of organics and integrated pest and disease management in coconut' with exposure visit was conducted for coconut farmers.

Cocoa training for farmers

Participation in exhibition

Coconut training for farmers

Training programme on oil palm cultivation

Oil palm

Gangavathi

Horticulture Mela/ Krishi Mela/ Campaigns/ Exhibitions

- Participated and exhibited stall in Krishi Mela 2016-17 at UAS, Raichur on 5th-7th November 2016 and Krishi Abhiyana 2016 at Koppal district, Karnataka on 29th August 2016.
- One day training programme was organised by two resource persons.
- Eight HRD training programmes on 'Oil palm cultivation' were conducted at Gangavathi.
- **Radio Programmes:** One radio talk broadcasted on the topic "Irrigation management technologies in oil palm in Krishi varthe" on 27.12.2016, organised by DD 1 Chandana TV Channel, Bengaluru.

Phasighat

- Lecture delivered on oil palm cultivation in different training programmes related to horticulture, organised by College of Horticulture and Forestry, Central Agricultural University -10 Nos.
- Participated as resource person and evaluator in "Skill training of rural youth on oil palm development" organised by gram sevak training centre, Pasighat during 19th to 24th December 2016 and "Inaugural ceremony of oil palm plantation in East Siang district" on 27th April 2016 organised by Ruchi Soya Ltd.
- Organised field visit to oil palm plantations of farmers – 02 Nos.

- Exhibition stalls in Agri Fair and Agri. Expo.-02 Nos.
- Acted as resource person in different training programmes at the college: 11 Nos.
- Organised exposure visits for farmers, school students and officials of state department : 03 Nos.
- Imparted consultancy service to farmers regarding cultivation of oil palm: 20 Nos.

Farmers training on oil palm cultivation

Pattukkottai

Training programmes/ field days organized

- Pattukkottai centre was associated with 12 Nos. of NMOOP II- oilpalm training conducted for officials and farmers of different districts like Salem, Sathyamangalam, T. N. Palayam, Nammakkal, Pattukkottai, Tenkasi, Kabilarmalai, Coimbatore and Thirunelveli.

Visit of trainees to oil palm field

- Conducted one day training programme on oil palm cultivation technologies and exposure visit to oil palm processing unit, for about 10 extension officials from the agricultural department and 15 farmers from Thanjavur Dist.

Exposure visit to Godrej processing unit at Ariyalur

Vijayarai

- Six number of one day training programmes were conducted on different aspects of crop production like micro irrigation in plantation crops, water saving techniques in horticultural crops, moisture conservation practice in summer vegetables, package of practices for successive yield in oil palm, pruning techniques in cocoa and organic farming prospects and limitations in plantation crops. A total of 375 farmers were benefited.

Training on oil palm cultivation

- Scientists delivered lectures on micro-irrigation management in horticultural crops, production technology and nursery management in oil palm and cocoa.

- Conducted method demonstration on cocoa pruning. Field day was conducted on use of rhino lures (bio control traps) in oil palm.
- A TV programme on '*Oil palm lo eruvula yajamanyam*' was recorded on 11.07.16 and telecasted by ETV Annadata. One radio talk on 'Water management in horticultural crops during summer' was delivered in All India Radio.
- **Diagnostic visit:** Three diagnostic field visits were carried out on oil palm stem wet rot, mealy bug infestation, flower drop and low yield in cocoa.

Diagnostic field visit at Vijayarai

Palmyrah

Killikulam

Training on palmyrah and its value addition

- A five-day training programme was conducted during the period 25.7.2016 to 29.07.2016 at AC & RI, Killikulam. A total of 15 scientists from Bihar Agricultural University attended the training. Field visits were arranged to traditional jaggery and candy making units. The participants were taken to the private fibre extraction units and the entire process of fibre extraction was thoroughly demonstrated.
- Delivered lecture on palmyrah and its value addition during a zonal level seminar on Agro-based food processing industry organised by KVIC, Mumbai on 22.12.2016 at Nagercoil, Tamil Nadu, and farmers' mela cum exhibition on palmyrah chaired by Honourable Chief Minister of Bihar from 26.8.16 to 29.8.16.
- Doordharshan programme: A video programme on palmyrah research activities at AICRP on Palms, Killikulam centre was recorded and telecasted by podhigai TV.

Training on palmyrah and its value addition to Scientists from Bihar Agricultural University, Sabour, Bihar

Pandirimamidi

Training programmes and other extension activities conducted

- Conducted training programme on palmyrah processing and value addition at Chinturu, East Godavari Dist., training cum demonstration on palmyrah neera and palm jaggery production at Chinturu, East Godavari Dist., demonstration on palmyrah jaggery production for tribal farmers at Ammigunta village, West Godavari Dist., training to the tribal farmers on 'Uses of palmyrah and cashew production technology' organized by RHTI, Elur in Addateegala village.
- Scientists delivered lecture on mechanization in food processing and value addition, post harvest technology of palmyrah at KVK, V. R. Gudem

Training on palmyrah climbing and value addition

for BSc home science students, palmyrah neera and its value added products at national seminar on palmgur and palm neera at Patna organized by KVIC and MSME, Government of India, pamyrah neera and its value addition at Nidadavolu organized by KVIC.

- **Radio/ TV programmes:** Two radio talks were broadcasted on 'Uses of palmyrah (*Tati upayogalu*) and modern techniques in cashew cultivation' ("*Jeedimamidilo Adhikadhigubadulaku soochanalu*") through All India Radio Station.
- Dr. P. C. Vengaiah, scientist (FST), participated in a phone in live programme '*Tati aadarita parisramalu vati adyavyayalu*' (Palmyrah based industries – economics) through DD Saptagiri on 08.12.2016 and telecasted almost every week. He also gave a programme on '*Tati Neera upayogalu'* (Uses of palmyrah inflorescence sap) telecasted on 25.08.16 at HMTV and gave a programme through DD Saptagiri, "*Tati sagu-upayogalu*" (Palmyrah cultivation and uses) on 08.08.2016 and telecasted almost every week. All India radio programme was broadcasted on 22.03.2017.

Arecanut

Shivamogga

- Six training programmes were held at different locations and nearly 800 farmers participated in the programmes. Twenty two field visits were made to the problematic arecanut gardens of farmers' and suitable advice was given to the farmers by the scientists. Totally 117 farmers were visited the AICRP (arecanut) lab, UAHS, Shivamogga for obtaining solutions to the different problems of arecanut cultivation.

Tribal Sub Plan (TSP)

Bhubaneswar

- Organised two off-campus one-day farmer training programmes on "Livelihood improvement through integrated coconut farming" for tribal farmers under TSP programme in Keonjhar and Rayagada districts of Odisha.
- Organised one off-campus field day programme on different practical aspects of coconut farming for tribal farmers under TSP programme in Rayagada district. A total of 55 tribal farmers were directly benefited from the programme.
- New coconut plantations were developed by the centre in the current year with 4800 coconut seedlings in 20 villages involving 679 tribal farmers particularly in non-traditional areas in three tribal districts (Keonjhar, Rayagada and Sundargarh) under TSP programme.

Development of coconut plantations in the tribal districts under TSP programme

Name of the district	No. of the villages involved	No. of tribal farmers involved	No. of coconut seedlings planted
Keonjhar	3	177	1600
Rayagard	11	190	1600
Sundargarh	6	312	1600
Total	20	679	4800

Seedling distribution to tribal farmers

Coconut planting in tribal farmers plot

Navsari

- 31 acres of land came under the coconut plantation through TSP by selecting 64 enthusiastic ST farmers from seven villages of Valsad district in south Gujarat region. Inputs (coconut seedlings) along with guidelines for different operation were provided to beneficial farmers of Valsad district.
- Distribution of coconut seedling (WCT-2200 plants) to beneficial farmers.
- Two training programmes with four FLDs were conducted on different aspects of coconut plantation (including the celebration of World coconut day).
- Different extension activities were carried out as well as distribution of coconut seedlings along with guidelines to beneficial farmers for improving soil health, better seedling establishment and pest and disease management in main field.

Jagdalpur

- Supplied coconut seedlings to 150 farmers and conducted various extension activities as mentioned in the table.

Training and distribution of inputs to beneficial farmers under TSP (Navsari)

Trainings conducted under TSP (Jagdalpur)

Sl. No	Trainings conducted	Village	No. of farmers attended the training	No. of seedlings distributed
1.	Cultivation of coconut	Biringpal	73	198
2.	Field visit cum training	Tatiras	68	55
3.	Celebration of 'World coconut day'	Kumhrawand	97	80
4.	Disease management in coconut	Tahakapal	48	160
5.	Intercropping in coconut	Ghumiapal	132	370
6.	Insect pest management in coconut	Teerathgarh	102	195
7.	Fertilisers management in coconut	Lamker	102	112
8.	Recycling of coconut waste through vermicomposting	Kasoli	106	500
9.	Coconut cultivation technique	Ghhatkawali	59	25
10.	Field visit cum training	Bodanpal	76	45
11.	5000 seedlings were distributed to the tribal farmers of Bastar region			

Coconut seedling distribution under TSP programme (Jagdalpur)

Training programme to tribal farmers (Jagdalpur)

Ratnagiri

- Two training programmes were organised in Borincha mala and Gavthan village, Jawhar tahsil, Palghar district of Maharastra. Total 50 female and 65 male farmers were participated.
- Supply of coconut, nutmeg and cinnamon planting material under TSP programme in consultation with State Department of Agriculture was carried out in Jawhar tahasil of Palghar district. Total 862 families (794 men and 68 women) were benefitted with this intervention.
- Five coconut (Banawali) seedlings along with six cinnamon (Konkan Tej) and three nutmeg (Konkan swad) grafts were distributed to each tribal family. This programme was covered in the four villages *viz.* Chok, Manmohadi, Vanvasi and Dehere.
- Two training programmes with 115 TSP farmers (88 men and 27 women) in Dehare village and one workshop at Taluka place for 65 (54 men and 11 women) farmers were conducted and the training and demonstration were given to them.

Farmers rally conducted at Jawhar Dist. Palghar under TSP

Demonstration on coconut planting to TSP families at Jawhar Dist. Palghar

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XI. WEATHER DATA OF COORDINATING CENTRES
(APRIL 2016 – MARCH 2017)

Coconut centres

Aliyarnagar

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	25.1	21.8	92.3	53.6	128.7
May'16	34.6	22.3	88.8	61.3	115.2
June'16	33.1	22.2	83.9	54.8	132.0
July'16	32.4	21.4	83.6	56.1	70.6
Aug'16	33.6	20.1	87.5	67.3	92.3
Sep'16	33.8	20.2	91.3	78.1	44.9
Oct'16	32.2	20.4	89.7	72.7	66.0
Nov'16	30.0	19.5	91.4	73.1	284.6
Dec'16	30.5	17.1	89.5	67.6	127.4
Jan'17	33.0	17.6	86.6	54.9	–
Feb'17	34.2	14.5	85.6	42.0	–
Mar'17	35.1	22.5	84.7	56.2	98.4

Ambajipeta

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	42.3	35.7	58.6	38.5	–
May'16	40.0	35.8	57.8	45.2	235.4
June'16	33.8	31.9	76.0	75.0	313.6
July'16	33.8	31.8	73.9	65.6	86.0
Aug'16	34.3	32.7	60.5	56.3	82.8
Sep'16	32.3	30.5	80.5	75.4	156.8
Oct'16	31.4	30.9	70.4	57.4	–
Nov'16	35.5	30.8	64.6	54.0	–
Dec'16	29.5	27.3	70.0	58.2	–
Jan'17	30.7	26.9	75.2	58.0	–
Feb'17	32.4	26.6	78.0	53.2	–
Mar'17	33.1	21.7	99.8	56.2	–

Arsikere

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	37.0	20.5	65.8	37.0	8.0
May'16	34.1	20.5	65.8	37.0	86.0
June'16	28.7	19.7	81.1	71.5	105.1
July'16	27.9	19.0	81.1	72.5	79.2
Aug'16	28.6	18.7	75.7	67.4	23.2
Sep'16	28.3	18.2	76.4	68.0	34.8
Oct'16	30.0	16.4	72.8	60.9	–
Nov'16	30.8	12.7	63.7	45.5	–
Dec'16	28.0	12.0	73.0	64.3	37.8
Jan'17	29.4	10.2	66.1	38.5	2.6
Feb'17	31.2	10.0	63.3	37.5	–
Mar'17	33.7	14.7	64.3	37.1	–

Bhubaneswar

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	40.7	26.5	85.8	36.3	7.6
May'16	38.7	26.3	81.8	47.3	114.9
June'16	34.7	26.3	88.6	68.9	264.8
July'16	32.2	25.8	91.8	78.6	222.2
Aug'16	31.7	25.4	93.5	79.5	247.8
Sep'16	31.4	25.3	93.0	80.0	238.2
Oct'16	32.1	22.6	89.2	67.7	132.8
Nov'16	31.0	17.4	91.5	45.7	20.3
Dec'16	30.0	15.0	85.3	38.1	–
Jan'17	29.7	14.5	89.6	38.2	–
Feb'17	33.7	19.0	93.7	38.0	–
Mar'17	34.7	22.7	90.6	42.2	45.4

Jagdalpur

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	38.3	24.8	73.7	28.5	3.6
May'16	37.5	25.7	67.2	33.2	47.0
June'16	33.4	24.4	85.7	60.9	296.2
July'16	29.1	23.2	91.9	77.0	481.2
Aug'16	29.3	23.8	90.0	70.6	335.9
Sep'16	29.6	23.4	93.3	75.4	308.6
Oct'16	30.0	19.4	95.6	52.4	182.0
Nov'16	29.6	13.5	96.5	32.2	–
Dec'16	28.9	10.0	94.2	30.8	–
Jan'17	24.3	9.4	94.4	28.7	–
Feb'17	32.7	11.7	87.8	23.0	–
Mar'17	35.1	17.5	80.0	26.0	11.9

Kahikuchi

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	23.9	16.9	75.0	64.2	240.0
May'16	25.8	20.6	78.0	70.3	295.0
June'16	30.6	24.6	88.0	84.5	424.0
July'16	32.1	24.7	90.0	86.4	237.0
Aug'16	34.9	25.9	89.9	85.7	114.0
Sep'16	28.0	24.1	87.7	83.6	87.0
Oct'16	25.9	18.2	85.3	79.6	–
Nov'16	22.4	13.2	84.3	81.1	1.0
Dec'16	23.7	8.2	83.0	80.2	–
Jan'17	15.9	8.9	79.9	74.0	–
Feb'17	18.7	10.4	74.2	62.6	–
Mar'17	22.0	14.2	65.4	60.1	2.1

Kasaragod

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	34.1	27.0	78	62	0.2
May'16	33.8	25.3	81	66	151
June'16	29.7	21.9	93	84	977
July'16	28.7	21.4	96	86	725
Aug'16	29.4	21.8	93	82	471
Sep'16	29.1	21.8	90	79	129
Oct'16	30.1	23.0	85	75	36.2
Nov'16	32.1	22.9	83	63	24.4
Dec'16	31.9	21.7	80	59	26.8
Jan'17	31.9	21.3	81	54	11.2
Feb'17	32.6	22.9	82	54	–
Mar'17	32.9	23.8	79	60	–

Mondouri

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	39.4	26.6	89.0	47.0	1.0
May'16	35.5	25.0	91.0	60.0	223.4
June'16	34.2	26.5	95.0	75.0	160.3
July'16	31.9	26.2	97.0	86.0	370.0
Aug'16	31.9	26.1	97.0	85.0	448.4
Sep'16	33.8	26.0	95.0	68.0	200.7
Oct'16	33.0	23.9	96.0	69.0	101.4
Nov'16	29.7	17.7	93.0	59.0	16.6
Dec'16	26.3	12.9	94.0	59.0	–
Jan'17	26.0	10.9	91.0	50.0	–
Feb'17	30.3	15.2	90.0	45.0	–
Mar'17	35.6	20.1	91.0	46.0	3.0

Navsari

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	35.6	22.1	82.4	39.9	–
May'16	34.4	26.7	82.8	58.2	–
June'16	33.8	27.3	84.7	71.5	91.0
July'16	29.7	24.8	93.6	83.4	497.0
Aug'16	29.7	24.9	91.5	79.5	196.0
Sep'16	30.1	23.6	96.6	76.9	529.0
Oct'16	32.0	20.5	90.0	58.7	96.0
Nov'16	33.0	14.5	74.5	28.9	–
Dec'16	32.1	13.6	72.6	28.5	–
Jan'17	32.9	15.6	85.5	34.1	–
Feb'17	34.1	16.2	77.0	26.6	–
Mar'17	35.7	17.0	80.5	30.0	–

Pilicode

Month	Temperature (^{O} C)		RH (%)FN	Rainfall (mm)
	Max.	Min.		
April'16	34.0	26.0	74.0	–
May'16	34.0	25.0	76.0	58.1
June'16	29.7	23.4	86.0	937.3
July'16	28.6	23.0	89.0	877.9
Aug'16	29.4	23.0	88.0	444.9
Sep'16	28.7	22.3	86.0	136.2
Oct'16	29.9	22.0	80.0	21.3
Nov'16	31.2	21.0	78.0	87.6
Dec'16	31.5	19.4	80.0	18.2
Jan'17	31.5	18.7	72.0	–
Feb'17	32.2	19.0	75.0	–
Mar'17	33.0	22.2	75.0	1.2

Ratnagiri

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	33.0	23.9	75.0	72.0	0.1
May'16	34.1	27.8	77.0	71.8	0.8
June'16	31.4	25.3	89.4	84.6	252.2
July'16	30.1	24.7	93.8	89.0	271.1
Aug'16	30.5	25.0	92.4	86.0	157.0
Sep'16	30.4	23.8	97.3	83.0	149.9
Oct'16	31.3	22.5	94.3	80.3	26.9
Nov'16	34.7	17.8	88.8	59.8	–
Dec'16	34.8	17.0	89.4	54.8	–
Jan'17	33.3	16.3	88.1	56.9	–
Feb'17	33.6	17.3	88.9	58.5	–
Mar'17	35.1	19.8	82.0	56.0	–

Sabour

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	38.6	21.4	67.7	35.4	23.2
May'16	35.2	23.2	85.8	56.2	106
June'16	34.1	25.5	84.02	68.9	116.2
July'16	31.9	25.5	89.5	79.9	309.8
Aug'16	32.5	25.9	86.9	75.6	70.4
Sep'16	31.2	24.7	89.8	80.2	320.9
Oct'16	31.6	21.7	89.0	68.4	31.2
Nov'16	28.9	14.1	90.2	55.9	–
Dec'16	22.7	9.7	95.9	70.0	–
Jan'17	22.6	7.8	94.9	60.8	12.4
Feb'17	26.3	9.8	88.8	48.5	–
Mar'17	29.9	15.2	86.7	53.8	9.7

Veppankulam

Month	Temperature (^{O} C)		RH (%) FN	Rainfall (mm)
	Max.	Min.		
April'16	38.5	29.5	86.5	–
May'16	37.5	28.2	83.0	138.0
June'16	38.0	25.0	79.5	25.0
July'16	39.5	24.0	81.0	55.0
Aug'16	36.5	24.5	80.0	83.1
Sep'16	35.5	25.5	82.5	37.0
Oct'16	35.5	24.5	85.0	70.0
Nov'16	33.5	24.5	90.0	48.0
Dec'16	35.5	22.5	91.0	90.0
Jan'17	31.5	20.0	89.0	100.0
Feb'17	32.0	21.5	87.5	–
Mar'17	35.5	25.5	88.5	9.4

Oil palm centres

Gangavathi

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	40.4	26.3	46.0	16.6	–
May'16	37.0	26.0	55.7	25.6	46.2
June'16	32.3	23.5	67.0	46.2	134.9
July'16	30.4	23.3	67.5	54.5	68.3
Aug'16	30.7	22.9	67.2	53.2	48.0
Sep'16	29.5	22.5	72.4	61.8	72.4
Oct'16	31.9	20.1	62.7	31.4	1.0
Nov'16	31.1	15.7	60.4	18.7	–
Dec'16	30.6	15.0	52.1	16.9	2.3
Jan'17	30.0	15.6	53.8	15.6	–
Feb'17	33.8	19.4	49.8	24.9	–
Mar'17	37.3	21.9	37.3	21.9	–

Madhopur

Month	Temperature (^{0} C)		RH (%) FN	Rainfall (mm)
	Max.	Min.		
April'16	25.5	38.4	75.5	2.5
May'16	26.3	36.9	82.3	81.0
June'16	28.2	37.1	84.7	141.0
July'16	27.8	35.1	86.7	292.0
Aug'16	29.1	38.4	84.2	97.0
Sep'16	27.0	33.7	86.7	501.0
Oct'16	25.5	34.5	83.6	52.0
Nov'16	18.8	31.0	83.9	–
Dec'16	13.4	22.0	87.3	–
Jan'17	11.3	22.8	86.2	2.5
Feb'17	14.6	27.6	84.4	–
Mar'17	19.7	33.0	80.9	144.0

Mulde

Month	Temperature (^{0} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	37.4	22.7	88.0	52.0	–
May'16	37.1	24.4	86.0	61.0	8.1
June'16	30.7	22.3	93.0	83.0	1061.3
July'16	28.3	22.3	95.0	90.0	1208.0
Aug'16	29.4	22.6	94.0	84.0	736.9
Sep'16	29.7	21.9	94.0	80.0	465.8
Oct'16	32.7	20.9	93.0	65.0	155.0
Nov'16	35.4	16.3	90.0	57.0	4.2
Dec'16	35.0	14.9	91.0	37.0	–
Jan'17	34.8	14.3	91.0	37.0	–
Feb'17	36.7	15.9	90.0	35.0	–
Mar'17	36.5	17.7	86.0	42.0	–

Pasighat

Month	Temperature (^{0} C)	RH (%)		Rainfall (mm)
	Max.	FN	AN	
April'16	22.9	74.1	65.2	18.5
May'16	22.2	77.6	68.6	79.7
June'16	24.8	77.5	69.8	91.7
July'16	24.4	89.4	81.0	501.2
Aug'16	29.3	79.7	71.9	281.0
Sep'16	35.8	83.6	74.6	482.9
Oct'16	23.1	69.7	66.7	1108.0
Nov'16	33.9	73.1	63.3	144.0
Dec'16	29.6	86.4	74.4	642.0
Jan'17	30.7	71.5	65.9	56.6
Feb'17	28.0	71.4	64.4	–
Mar'17	26.5	63.1	61.0	10.6

Pattukkottai

Month	Temperature (^{o} C)		RH (%) FN	Rainfall (mm)
	Max.	Min.		
April'16	32.6	28.0	86.9	–
May'16	32.4	28.8	84.4	–
June'16	38.0	28.9	82.9	25.2
July'16	38.5	27.9	85.4	71.4
Aug'16	35.5	30.0	78.5	20.0
Sep'16	38.1	29.5	81.6	27.6
Oct'16	36.9	27.8	86.0	64.6
Nov'16	32.5	26.5	82.0	44.6
Dec'16	30.8	23.2	81.0	91.1
Jan'17	36.1	25.6	86.0	–
Feb'17	36.1	26.2	88.0	130.6
Mar'17	33.6	23.8	85.0	12.0

Arecanut centres

Goa

Month	Temperature (^{o} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	35.1	24.2	87.0	52.0	0.2
May'16	35.7	25.2	82.0	54.0	0.6
June'16	30.7	21.6	93.0	81.0	1089.6
July'16	29.0	23.1	95.0	88.0	850.7
Aug'16	29.8	23.6	94.0	80.0	522.3
Sep'16	29.7	24.5	95.0	77.0	245.6
Oct'16	31.9	23.5	93.0	65.0	124.3
Nov'16	34.8	20.1	81.0	36.0	29.2
Dec'16	34.5	19.8	76.0	36.0	–
Jan'17	34.5	19.0	78.0	32.0	–
Feb'17	35.5	21.0	86.0	40.0	–
Mar'17	34.0	22.3	88.3	44.2	–

Port Blair

Month	Temperature (^{o} C)		RH (%)	Rainfall (mm)
	Max.	Min.	FN	
April'16	33.4	25.6	44.0	7.0
May'16	33.3	26.5	73.0	271.0
June'16	30.0	25.0	87.0	495.5
July'16	30.6	25.2	86.0	425.3
Aug'16	31.0	25.2	84.0	325.3
Sep'16	29.5	24.0	89.2	956.1
Oct'16	31.0	24.3	81.8	358.8
Nov'16	31.0	25.1	77.7	167.0
Dec'16	29.3	24.1	78.1	444.7
Jan'17	27.2	21.3	69.6	94.7
Feb'17	30.7	24.2	68.3	0.6
Mar'17	33.0	25.0	69.0	–

Shivamogga

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	39.1	23.2	75.7	45.1	11.2
May'16	36.1	23.1	76.1	58.6	88.2
June'16	29.8	21.9	88.4	84.8	149.8
July'16	28.4	21.6	90.4	88.1	158.2
Aug'16	29.1	21.3	89.2	87.4	93.8
Sep'16	29.3	20.8	86.7	77.3	26.0
Oct'16	32.3	18.9	85.4	57.4	18.2
Nov'16	32.2	16.1	70.7	43.0	21.2
Dec'16	31.7	14.9	73.9	42.5	7.2
Jan'17	31.1	15.2	76.1	50.5	0.6
Feb'17	34.3	18.2	73.7	48.9	–
Mar'17	37.7	21.1	73.8	35.4	–

Wakawali

Month	Temperature (^{O} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	28.9	18.2	74.6	70.3	–
May'16	29.1	19.1	70.8	66.6	0.5
June'16	29.0	20.3	74.7	74.4	950.2
July'16	28.3	20.2	82.9	77.1	1901.2
Aug'16	28.5	20.7	80.4	80.2	942.9
Sep'16	28.0	20.5	81.3	78.0	870.4
Oct'16	28.4	19.4	78.6	77.0	204.6
Nov'16	27.4	13.4	79.3	68.2	–
Dec'16	25.6	11.6	82.8	69.5	–
Jan'17	28.5	11.6	79.9	57.6	–
Feb'17	28.4	13.9	79.7	65.5	–
Mar'17	28.7	14.7	81.4	72.8	–

Palmyrah centres

Killikulam

Month	Temperature (^{0} C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
April'16	37.6	25.4	84	46	–
May'16	37.2	25.2	86	53	23.0
June'16	35.3	25.3	76	56	6.6
July'16	35.9	26.3	77	52	–
Aug'16	36.6	26.9	67	43	–
Sep'16	36.6	26.4	65	41	–
Oct'16	35.9	24.8	74	45	80.8
Nov'16	31.0	21.6	91	63	98.6
Dec'16	32.7	20.5	80	48	5.0
Jan'17	32.3	20.5	86	48	36.0
Feb'17	33.9	19.7	84	50	–
Mar'17	35.5	22.9	83	46	24.4

Pandirimamidi

Month	Temperature (^{0} C)		RH (%)	Rainfall (mm)
	Max.	Min.	FN	
April'16	40.6	18.2	68.0	–
May'16	43.6	21.5	65.2	60.0
June'16	40.8	23.1	88.5	238.0
July'16	35.5	23.1	89.2	97.4
Aug'16	36.1	22.3	85.3	279.6
Sep'16	33.7	21.8	92.7	326.8
Oct'16	35.3	16.6	85.3	37.4
Nov'16	34.2	12.6	81.2	24.2
Dec'16	32.1	10.4	79.3	4.8
Jan'17	29.3	14.8	82.1	0.4
Feb'17	36.7	12.7	74.2	3.6
Mar'17	36.6	13.7	75.9	30.0

FN: Forenoon, AN: Afternoon

Palmyrah Jaggery

भाकृअनुप
ICAR

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

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