ICAR-AICRP on Palms

ANNUAL REPORT 2020

वार्षिक प्रतिवेदन

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

ICAR- All India Co-ordinated Research Project on Palms
ICAR-Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
Kasaragod, Kerala, India – 671 124

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Contents...

आमुख

भारतीय कृषि परिदृश्य में रोपण फसल बागवानी का एक प्रमुख खण्ड है । हमारे देश की ग्रामीण आर्थिकता में ताड़ जैसे नारियल (*कोकस न्यूसिफेरा एल*), तेल ताड़ (*इलेयिस ग्युनीसिस जाक*) सुपारी (*अरिका काट्च्यु एल*) और पॉमैरा (*बोरासस फ्लाबेल्लिफेर एल*)तथा कोको(*थियोब्रोमे कोको*) की भूमिका महत्वपूर्ण है । गॉव के 2करोड़ से अधिक लोग इन तीनों फसलों के उत्पादन, संसाधन और विपणन में मग्न हैं । इन फसलों पर शोध की लंबी अवधि की प्रकृति, शोध निवेश से उच्च आय की संभावनाएँ, लघुजोत किसानों और समाज के आर्थिक रूप से वंचित वर्गों को वितरण करना आदि इन फसलों पर अनुसंधान कार्यक्रम को प्रबल करने में अत्यावश्यक देखा गया है ।

राष्ट्रीय कृषि अनुसंधान पद्धति के अधीन भा कृ अनु प - अखिल भारतीय समिन्वत ताड़ अनुसंधान परियोजना वर्ष 1972 में मुख्य फसलों पर स्थानीय विशेष और मांग आधारित नए आविष्कारों के लिए देश की विभिन्न सस्य जलवायु परिस्थितियों में शुरु की गई ।

वर्तमान में इस परियोजना के अधीन मुख्य फसल के रूप में पॉच फसल हैं जिनका कार्यान्वयन 28 केंद्रों में किया जाता है । यह 14 राज्यों में, एक संघ राज्य क्षेत्र में, 13 राज्य कृषि विश्वविद्यालय/राज्य बागवानी विश्वविद्यालय, एक केंद्रीय कृषि विश्वविद्यालय और चार भाकृअनुप संस्थानों में स्थित है । विभिन्न सस्य - पारिस्थितिक क्षेत्रों में समान समस्याओं पर कार्य करने के लिए विचारों और सामग्रियों को हस्तांतरण करने और सामूहिक रूप से समाधान का विकास करने के लिए यह परियोजना एक फ्लाटफॉर्म के रूप में वैज्ञानिकों को अवसर प्रदान करती है । वे एक साथ फसल सुधार, प्रभावी प्रबंधन और पादप संरक्षण तथा लाभदायकता बढ़ाने और किसानों की आय बढ़ाने के मुख्य लक्ष्य के साथ फसलों की स्थिरता और लाभदायकता की ओर प्रौद्योगिकियों के प्रचार-प्रसार में कार्यरत हैं ।

वर्ष 2020 जनवरी से दिसंबर की अवधि में इस परिययोजना के अधीन प्राप्त की गई उपलब्धियॉ इस वार्षिक रिपोर्ट में संक्षेपित की गई हैं ।

अम्बाजिपेट केंद्र में 2014-2020 की अवधि में मूल्यांकित प्रजातियों/संकरों के बीच गोदावरी गंगा से उच्चतम उपज 144.4 गुठली /ताड़/वर्ष रिकार्ड की गयी और वी एच सी-2 से (134.9 गुठली) और केरा गंगा से (133.3 गुठली) और उच्चतम गुठली भार (1393 ग्रा.) पाया गया ।

वर्ष 2011 में रोपित बौनी x बौनी संयुक्त के मूल्यांकन के अधीन संकर सीओडी x एम वाई डी से उच्चतम मृदुफल (डाब) उपज (76.7 गुठली) और संकर जीबीजीडी x एम ओ डी से(68.3 गुठली) रिकार्ड की गयी । रत्नगिरी में सी ओ डी x एम वाई डी में डाब पानी की मात्रा अधिक (602.7 मि. ली /गुठली) जबकि टी एस एस अधिकतम जीबीजीडी x एम ओ डी संकर में (5.7^0 ब्रिक्स) पाया गया । चारा घास (*कुम्बु नेपियर संकर + डेसमेन्थस*), चारा घास (*सेस्बानिया ग्रान्डिफ्लोरा +ल्यूकेइनल्यूकोसिफाला +ग्लिरिसिडिया*) और टेलिच्चेरी संकर बकरी से 3,18,400/- रुपए प्रति हेक्टर सकल आय प्राप्त किया गया जबकि अलियार केंद्र में नारियल इकफसल से केवल 2,03,400/- रुपए प्रति हेक्टर प्राप्त किया गया । पाट्टुकोटाई में वर्ष 2007 में रोपित 10 संकरों की वृद्धि और उपज प्राचल से यह देखा गया कि उच्चतम गुच्छ भार 173.2 कि.ग्रा/ताड़ और उपज प्रति हेक्टर 24.78 टन/हेक्टर संकर एनआरसीओपी 9 से प्राप्त हुई ।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के विभिन्न केंद्रों जैसे अलियार नगर, अरसिकरे, काहिकुची, रत्नगिरी और विजयराय में ताड़ों के अधीन कोको क्लॉन का बहु स्थानीय परीक्षण प्रगति पर है । अम्बाजिपेट में वी टी एल सी एच-2 से उच्च सूखा बीज /पौध (2.1 कि. ग्रा) जो वीटीएलसीसी-1 और वीटीएलसीएच-4 (1.8 कि. ग्रा/पेड़)के समतुल्य था । अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की उन्तीसवीं वार्षिक समूह वर्चुअल बैठक वर्ष 2019-2020 की अवधि में किए गए कार्यों की समीक्षा दिनांक 10-11 अगस्त 2020 को आयोजित की गई । प्रौद्योगिकी हस्तांतरण के संबंध में फार्म पर, फार्म के बाहर प्रशिक्षण आयोजित करना, किसान मेले और प्रदर्शनियों में भागीदारी, नैदानिक प्रक्षेत्र संदर्शन और प्रेस एवं मीडिया द्वारा विस्तार कार्यक्रमों में विभिन्न केंद्रों का भी योगदान रहा । अनुसूचित जाति उप योजना का कार्यान्वयन विभिन्न राज्यों में उनकी आजीविका सुधार और आर्थिक लाभ के लिए किया गया ।

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

फरवरी 2021

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

I. PREFACE

Plantation crops constitute an important segment of horticulture in Indian agriculture scenario. Palms such as Coconut (*Cocos nucifera* L.), Oil palm (*Elaeis guineensis* Jacq.), Arecanut (*Areca catechu* L.), and Palmyrah (*Borassus flabellifer* L.) as well as Cocoa (*Theobroma cocoa*) have contributed significantly for the rural economy of our country. More than 20 million people in rural areas are engaged in the production, processing and marketing the products of the three palm crops. The long term nature of research on these crops, the prospects of higher returns from research investment and the likely distribution of research benefits to the small holders and economically disadvantaged sections of the society, make it imperative to strengthen the research programme on these crops.

The All India Coordinated Research Project on Palms started functioning from 1972 with the objective of conducting location-specific research in the mandate crops. At present the project has five mandate crops and it is implemented in 28 centres, which are located in 14 states and one union territory covering 13 SAUs/SHUs, one CAU and four ICAR institutes. This Project provides a platform and opportunities to the scientists for exchanging ideas and materials for working on similar problems in different agro-ecological regions for collectively developing solutions. They work together in crop improvement, effective management and plant protection and disseminating the technology in the region towards stability and profitability of the mandate crops with a prime objective of increasing profitability as well as farmer's income.The achievements made during January - December, 2020 under the project are briefed in this annual report.

At Ambajipeta centre, among the varieties/hybrids evaluated for a period of 2014-2020 revealed that Godavari Ganga recorded significantly the highest yield/palm/year (144.4 nuts) followed by VHC-2 (134.9 nuts) and Kera Ganga (133.3 nuts) with the highest fruit weight (1393 g). Under evaluation of Dwarf x Dwarf combinations (2011 planted), the hybrid COD x MYD recorded the highest tender nut yield (76.7 nuts) followed by the hybrid GBGD x MOD (68.3 nuts). The quantity of tender nut water was higher in COD x MYD (602.7 ml/nut) whereas, the Total soluble solids (TSS) was maximum in the hybrid GBGD x MOD (5.7^{o}Brix) at Ratnagiri. Integration of coconut with pasture crops (*Cumbu Napier hybrid + Desmanthus*), fodder trees (*Sesbania grandiflora + Leucaena leucocephala + Glyricidia)* and Tellicherry breed of goats recorded gross income of Rs. 3,18,400/- per ha as compared to Rs. 2,03,400/- per ha in the monocrop of coconut at Aliyarnagar centre. Among the 10 oil palm hybrids evaluated for growth and yield parameters at Pattukkotai (planted during 2007), the highest bunch weight of 173.2 kg/palm and per ha yield of 24.78 t/ha was recorded in hybrid NRCOP 9. A multi location trial (MLT) of cocoa clones under palms is in progress at different AICRP centres *viz*., Aliyarnagar, Arsikere, Kahikuchi, Ratnagiri and Vijayarai. Under evaluation of performance of cocoa varieties/hybrids as intercrop in coconut garden, at Ambajipeta, VTLCH-2 recorded higher dry beans/ plant (2.1 kg) and was at par with VTLCC-1 and VTLCH-4 (1.8 kg/tree). The ICAR-AICRP on Palms organized the *"Virtual 29th Annual Group Meeting of All India Coordinated Research Project on Palms"* from 10th to 11th August, 2020 to review the work carried out during 2019-20. With respect to transfer of technology, different centres were involved in conducting on-farm, off-farm trainings, kisan melas, and participation in exhibition, diagnostic field visits and coverage through press and media. The Scheduled Caste Sub Plan (SCSP) was implemented to benefit and improve their livelihood security in different states.

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

February, 2021

(Dr. Maheswarappa H. P.)

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कार्य सारांश

राष्ट्रीय कृषि अनुसंधान पद्धति के अधीन भा कृ अनु प - अखिल भारतीय समिन्वत ताड़ अनुसंधान परियोजना वर्ष 1972 में मुख्य फसलों पर स्थानीय विशेष और मांग आधारित नए आविष्कारों के लिए देश की विभिन्न सस्य जलवायु परिस्थितियों में शुरु की गई। इस पद्धति के अधीन भाकृअनुप और राज्य कृषि विश्वविद्यालय दोनों बजट सहभाजन क्रमश: 75% और 25% के साथ अंतरानुशासनिक दृष्टिकोण के साथ भागीदार के रूप में कार्यरत है। विभिन्न सस्य -पारिस्थितिक क्षेत्रों में समान समस्याओं पर कार्य करने के लिए विचारों और सामग्रियों को हस्तांतरण करने और सामूहिक रूप से समाधान विकास करने के लिए यह परियोजना एक फ्लाटफॉर्म के रूप में अवसर प्रदान करती है । वे एक साथ फसल सुधार, प्रभावी प्रबंधन और पादप संरक्षण तथा लाभदायकता बढ़ाने और किसानों की आय बढ़ाने के मुख्य लक्ष्य के साथ फसलों की स्थिरता और लाभदायकता की ओर प्रौद्योगिकियों के प्रचार-प्रसार में कार्यरत है ।

वर्तमान में इस परियोजना के अधीन मुख्य फसल के रूप में नारियल, तेल ताड़, सुपारी, पॉमैरा और कोको हैं जिनका कार्यान्वयन 28 केंद्रों में किया गया है । इसका मुख्यालय भाकृअनुप-कैरोफअसं कासरगोड़ है और नारियल पर 15 केंद्र, तेल ताड़ पर 6 , सुपारी पर 4 , पॉमैरा पर 4 और कोको पर 7 केंद्रों में शोधकार्य जारी है । 14 राज्यों और केंद्र -शासित प्रदेश में स्थापित अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना 13 राज्य कृषि विश्वविद्यालय/राज्य बागवानी विश्वविद्यालय, एक केंद्रीय कृषि विश्वविद्यालय और चार भाकृअनुप संस्थानों में अनुसंधान किया जा रहा है । वर्ष 2020 के लिए 491.84 लाख रुपए का बजट था और 75:25 अनुपात में क्रमानुगत राज्य कृषि विश्वविद्यालय और बागवानी विश्वविद्यालयों की ओर से योजनाओं को कार्यान्वित किया जाता है जिसमें भाकृअनुप का अंश 75% और 25% अंश राज्यकृषि विश्विद्यालय का है और केंद्रीय कृषि विश्विद्यालयों और भाकृअनुप संस्थानों के तौर पर 100 प्रतिशत निधि भाकृअनुप की है ।

अनुसंधान उपलब्धियॉ

नारियल फसल सुधार

अम्बाजिपेट केंद्र में 2014-2020 की अवधि में मूल्यांकित प्रजातियों /संकरों के बीच गोदावरी गंगा से उच्चतम उपज/ताड़/वर्ष 144.4 गुठली रिकार्ड की गयी और वी एच सी-2 से 134.9 गुठली और केरा गंगा से 133.3 गुठली और उच्चतम गुठली भार 1393 ग्रा. पाया गया ।

रत्नगिरी में वर्ष 2011 में रोपित बौनी xबौनी संयुक्त के मूल्यांकन के अधीन जीबीजीडी x एम ओ डी संकर पूर्व पुष्पित देखा गया और संकर सीओडी x एम वाई डी से उच्चतम मृदुफल (डाब) उपज (76.7 गुठली) और संकर जीबीजीडी x एम ओ डी से (68.3 गुठली) रिकार्ड की गयी । सी ओ डी x एम वाई डी में डाब पानी अधिक (602.7 मि. ली /गुठली) जबकि टी एस एस अधिकतम जीबीजीडी x एम ओ डी संकर में 5.7^0 ब्रिक्स पाया गया ।

फसल उत्पादन

नारियल बौनी प्रजातियों में उत्पादन क्षमता बढ़ाने और डाब पानी गुण सुधारने के लिए किए गए समीकृत कीट नियंत्रण प्रौद्योगिकियों पर परीक्षण कोयम्बत्तूर जिले के पोल्लाची में अवलचिन्नपालयम गॉव के किसान बाग में वर्ष 2015 में 10 वर्ष आयु की चौघाट नारंगी बौनी (सी ओ डी) प्रजाति में किया गया । प्रारंभिक मृदा विश्लेषण से यह देखा गया कि मृदा में नाईट्रोजन निम्न और फोसफोरस मध्यम और पोट्टासियम निम्न और जैविक कार्बन मध्यम पाया गया । वृद्धि गुणों का रिकोर्डिंग, 4 वर्षों के परीक्षण बाद, में एक संख्यात्मक वृद्धि, सॉख्यिकीय विशिष्टता उपचार के बीच देखी गयी । उपचार T_3 (T_2 + मृदा परीक्षण आधारित नाईट्राजन फोसफोरस पोटाश और सूक्ष्म पोषण तत्व प्रयोग) में महत्वपूर्ण उच्च मृदुफल गुठली उपज 159 गुठली प्रति ताड़ प्रति वर्ष, और T_2 (जैव-खाद और जैव उर्वरक (हरा पत्ता खाद 10 कि. ग्रा. दर में *गिलीरिसिडिया लोप्पिंस* + 10 कि. ग्रा दर में नारियल कचड़े का पुन चक्रमण कर प्राप्त वर्मीकंपोस्ट +नारियल प्रपर्ण मल्चिंग + 100 ग्रा. दर में *एज़ोस्पिरिल्लम* 100 ग्रा दर में फोसफोबाक्टीरिया + वर्ष में दो बार सन्नहम्प हरी खाद का प्रयोग +100 ग्रा. दर में वीएएम) 148 गुठली प्रति ताड़ प्राप्त की गयी । T_1 (किसान पद्धति) में निम्नतम 135 गुठली प्रति ताड़ रिकार्ड की गयी ।

अलियार केंद्र में नारियल के इकफसलन से प्राप्त आय (2,03, 400/- रुपए प्रति हेक्टर) की तुलना चारागाह फसल (*कुम्बु नेपियर संकर डेसमेन्थस*) के साथ नारियल का समीकरण, चारा पेड़ (*सेस्बानिया ग्रान्डिफ्लोरा + ल्यूसीना ल्यूकोसिफाला +गिलरिसिडिया*) और टेलिच्चेरी प्रजनित बकरियों से 3,18,400/- रुपए प्रति हेक्टर रिकॉर्ड की गयी ।

अरसिरे केंद्र में नारियल इकफसलन 36,060/- रुपए प्रति एकड़ (90,150 रुपए प्रति हेक्टर) की तुलना में नारियल के साथ चारा और भेड़ के समीकृत सस्यन से अधिक संख्या में गुठली इस अवधि में प्राप्त की गयी । नारियल के साथ समीकृत सस्यन से उच्च कुल आय 1,30,916/- रुपए प्रति एकड़ (3,27,290/- प्रति हेक्टर) रिकार्ड की गयी ।

काहिकुची में नारियल बाग में मिश्रित फसल के रूप में काली मिर्च प्रजातियों की आर्थिकता के निर्धारण से यह देखा गया कि पन्नियूर-1 से उच्चतम सकल आय 2,50,903/- रुपए प्रति हेक्टर तथा लाभ मूल्य अनुपात 3.73 और श्रीकरा से 2,21,776/- रुपए प्रति हेक्टर, लाभ मूल्य अनुपात 3.30 और निम्नतम सकल आय 1,84,846/-रुपए प्रति हेक्टर और लाभ मूल्य अनुपात 2.72, रत्नगिरी केंद्र में आई आई एस आर-मलबार एक्सेल में देखी गयी।

नारियल आधारित फसलन पद्धति के अधीन मसाला एवं कंदमूल फसल के अंतर फसलन में नारियल काली मिर्च, अदरक, कोलोकेशिया से अधिकतम सकल आय 4,55,107/- रुपए प्रति हेक्टर, 2.34 लाभ मूल्य अनुपात के साथ रिकार्ड की गयी । नारियल, काली मिर्च, प्याज, आलू मॉडल से निम्नतम लाभ मूल्य अनुपात 1.65 लेकिन नारियल इकफसलन में निम्नतम सकल आय 1,05,400/- रुपए प्रति हेक्टर रिकार्ड की गयी ।

फसल संरक्षण

रोग प्रबंधन

100, 250 और 500 पी पी एम के कृत्रिम वातावरण *गैनोडेरमा* जाति की वृद्धि के विरुद्ध 13 नए फफूंदनाशी का परीक्षण किया गया । परीक्षण से यह देखा गया कि अन्य फफूंदनाशी की तुलना में 4% हेक्साकोनज़ोल+16% एस सी कारबेन्डाज़िम + 5% हेक्साकोनज़ोल+ 2.5% एस सी वालिडामैसिन और 11% एज़ोक्सिस्ट्रोबिन +18.3% एस सी टेबुकोनज़ोल की अवरोधन क्षमता श्रेष्ठ पायी गयी ।

मौसम प्राचल जैसे आपेक्षिक आद्रता, तापमान और वर्षा आदि सहसंबंधित हैं नियत प्लॉट के अधीन अलवाल तना सड़न रोग के उदग्र और समतल क्षैतिज फैलाव के साथ परिणाम से यह देखा गया कि महत्वपूर्ण अनुकूल सहसंबंध आपेक्षिक आद्रता (+0.875) वर्षा (+0.41) और अलवाल तना सड़न रोग के विकास और फैलाव के साथ प्रतिकूल सहसंबंध तापमान में (-0.877) देखा गया ।

नारियल के तना स्त्रवण रोग के विरुद्ध कॉपर ऑक्सीक्लोराइड के लेपन की तुलना में *टी. हरज़ियानम* और *टी. रीसेइ* केक फोरमुलेशन से रोग प्रभावित ताड़ को पूर्ण रूप से रोग मुक्त किया जा सकता है । अम्बाजिपेट केन्द्र में ट्रैकोडेरमा हरज़ियानम केक (केरोफअसं केक) और ट्राइकोडेरमा रीसेइ केक फोरमुलेशन के प्रयोग के 50 दिनों के अंदर रोग सूचकांक 7.96 और 6.95 को 0.0 प्रतिशत तक कम किया जा सकता ।

कीट प्रबंधन

अम्बाजिपेट केंद्र में आंध्रपदेश के पूर्व गोदवारी और पश्चिम गोदावरी, विशाखापट्टनम, श्रीकाकुलम और तेलंगाना के भद्राद्री कोतगुदम, मेडचाल कम्मम जिला मेडचाल और खम्मम जिलों के किसानों को कुल 6600 *ब्राकोन हेबेटोर* 177050 *जी. निफान्टिडिस* 17100 *पी. इम्ब्रूस* 242 *ट्राइकोकोर्डस* और 3261100 *पी. एस्टूर* अण्डों का वितरण किया गया । परजीव्याभ्य प्यूपेरिया निहित पर्णक या पर्णांग संग्रहित किए गए । प्रभावित परिस्थिति और संक्रमण के नए क्षेत्रों में विमोचित किए गए । अलियार नगर केंद्र में *एन्कार्सिया* परजीव्याभ के कुल 12,561 पैकट 4000 किसानों को वितरित किए गए ।

रूगोस सर्पिल सफेद मक्खी प्रबंधन के लिए समीकृत कीट प्रबंधन रणनीतियॉ शुरु की गयी। अलियार नगर केंद्र में 15 वर्ष आयु के सी ओ डी ताड़ में परीक्षण से यह देखा गया कि समीकृत कीट प्रबंधन रणनीतियॉ स्वीकृत प्लॉट में प्राकृतिक नियंत्रण की तुलना में रोग लक्षण 52.2% प्रतिशत से 22.5% प्रतिशत कम और 48.2% से 20.5% कम देखा गया । लेकिन लक्षण प्रतिशत और कीट तीक्ष्णता क्रमश: 45.2 से 56.2% और 50.5 से 58.8 प्रतिशत वृद्धि पायी गयी ।

तेल ताड़

पाट्टुकोटाइ में वर्ष 2007 में रोपित 10 संकरों की वृद्धि और उपज के प्राचल मूल्यांकन से संकर एनआरसीओपी 4 से उच्चतम ताड़ ऊँचाई 5.2 मीटर और निम्नतम एनआरसीओपी 9 में 4.7 मीटर पायी गयी । प्रति वर्ष उत्पादित पत्तों की संख्या एनआरसीओपी 2 में उच्चतम (25.6) और उच्चतम गुच्छ भार 173.25 कि ग्रा /ताड़ और प्रति हेक्टर उपज 24.78 टन प्रति हेक्टर एनआरसीओपी 9 में रिकॉर्ड की गयी ।

पासिघाट (अरुणाचल प्रदेश) में संकर मूल्यांकन परीक्षण (अगस्त 2010 में रोपित) से यह देखा गया कि एनआरसीओपी-22 में औसत गुच्छ भार उच्च 13.4 कि. ग्रा पाया गया और एनआरसी ओपी-22 में उच्चतम उपज 20.07टन/हेक्टर लेकिन एनआरसी ओपी-29 में निम्नतम उपज 11.07 टन प्रति हेक्टर रिकॉर्ड की गयी ।

विजयराय में जुलाई 2011 में प्रारंभ किए गए परीक्षण में प्रति ताड़ प्रति वर्ष उत्पादित गुच्छों की संख्या एनआरसीओपी-37 में उच्चतम पायी गयी (10.83) जो एनआरसीओपी-32 एनआरसीओपी-34 (8.27) और 38.(8.82) के समान थी। संकरों के साथ वार्षिक पत्ता उत्पादन प्रति ताड़, औसत गुच्छ भार (कि. ग्रा) और ताज़ा फल गुच्छ भार में भिन्नता नहीं पायी गयी ।

मुल्डे तेल ताड़ बाग में सात विभिन्न अंतरफसलों का मूल्यांकन किया गया । तेल ताड़ +लाल अदरक+काली मिर्च अंतर फसलन से 166.2 कि. ग्रा /ताड़ तेल ताड़ का गुच्छ भार देखा गया । बुश काली मिर्च से अधिकतम उपज 0.726 ग्रा. प्रति पौध और सूखा फल की अधिकतम उपज 1.05 कि ग्रा /प्लॉट रिकॉर्ड की गयी।

सुपारी

द्वीपों में सुपारी खेती की लाभदायकता बढ़ाने के लिए सुपारी आधारित फसलन पद्धति जड़ी-बूटी मसाला जैसे सुपारी + बरमीस धनिया + सीएआरआई ब्रोड धनिया 1, सुपारी+ धनिया अरका इषा और सुपारी पुदीना स्थापित किया गया और अण्डमान और द्वीप क्षेत्रों में किसानों को उच्च रूप से लाभप्रद पाया गया ।

क्राउन चोकिंग छत्र रोधन की प्रदर्शनी बाग में मूलपरिवेश जाति जैसे *ट्राइकोडेरमा* जाति, *स्यूडोमोनस* जाति और *बेसिलस* जैवनियंत्रण एजेंट की संख्या गति-विज्ञान जाति में उपचार के आरोपण के बाद उनकी संख्या में विचारणीय वृद्धि पायी गयी । लेकिन जैव

नियंत्रण एजेंट के बीच *स्यूडोमोनस* जाति और *बेसिलस* जाति और बाद में ट्राइकोडेरमा जाति से तुलनात्मक रूप से उच्च संख्या देखी गई ।

कोको

नारियल बाग में अंतर फसल के रूप में कोको प्रजातियों/संकरों के निष्पादन के मूल्यांकन के आधार पर बहुस्थानीय परीक्षण के अधीन उत्तम निष्पादन क्लॉन्स पहचाने गए । अम्बाजिपेट, काहिकुची, रत्नगिरी और नवसारी से क्रमश: वी टी एल सी एच-2 वीटीएलसीपी-16 वीटीएलसी-20 वीटीएलसी-17 और वीटीएलसीएच-4 फली भार, एकल सूखा बीज भार, बीन की संख्या और सूखी बीन उपज/ताड़/वर्ष अधिकतम पंजीकृत किया गया ।

पॉमैरा

ताज़ा नीरा से शक्कर पाउडर बनाते (सीपीसीआरआई संग्रहण तरीका) समय अच्छा रंग, एक वर्ष तक का जीवन काल है लेकिन पारंपरिक विधि से शक्कर का रंग गहरा हो जाता है और 3 महीने के अंदर कमरा तापमान और साधारण पैकिंग के अधीन खराब हो जाती है।

सीआईएई द्वारा विकसित पॉमैरा मृदु फल प्रक्रमण यंत्र का मूल्यांकन किया गया और पाया गया कि भ्रूणपोष निकालने का समय और कड़ी मज़दूरी को कम करता है । यह भी देखा गया कि कुटीर स्तर पर भ्रूणपोष बेचनेवाले कुशल और अकुशल व्यक्तियों के लिए यह बहुत उपयोगी है ।

निर्जलीकृत कंद और कंद चूर्ण वाणिज्यिकीकरण के लिए तैयार है और गैरसरकारी संख्या (आशा चिन्दुरु, आंध्रप्रदेश) द्वारा लंदन भेजा गया जो जनजातिय लोगों के लिए आय का साधन स्ताबित हुआ ।

अखिल भारतीय समन्वित ताड़ अनुसंधान की 29 वीं वार्षिक समूह बैठक

भाकृअनुप - केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़ की ओर से अखिल भारतीय समन्वित ताड़ अनुसंधान की 29 वीं वार्षिक समूह बैठक वर्चुल तरीके से दिनांक 10-11 अगस्त, 2020 को आयोजित की गई । डॉ ए. के सिंह, उप महानिदेशक (बागवानी) समारोह के मुख्य अतिथि रहे और डॉ बी. के पाण्डे, सहायक महानिदेशक (बागवानी विज्ञान -II) भाकृअनुप ,नई दिल्ली माननीय अतिथि रहे ।

डॉ .अनिता करुण, निदेशक, कैंरोफअसं, कासरगोड़ ने पदाधिकारियों और प्रतिनिधियों का स्वागत किया और देश के ताड़ वैज्ञानिकों के स्वास्थ्य के प्रति महानिदेशक महोदय के अनुकूल संबंध को साधुवाद किया । उन्होंने सहायक महानिदेशक की कर्मचारियों के स्वास्थ्य के प्रति चिन्ता से अभिभूत किया । निदेशक महोदया ने एक सावधानी सूचना दी कि नारियल को कमज़ोर करने वाले कीट एवं रोग के कारण नारियल का अम्ल परीक्षण जारी किया जा रहा है और ताड़ की प्रशस्ति बनाए रखने के लिए ताड़ वैज्ञानिकों को साथ मिलाकर काम करना चाहिए ।

डॉ. एच. पी. महेश्वरप्पा , परियोजना समन्वयक, अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना ने 14 राज्यों के और 13 राज्य कृषि विश्वविद्यालय, चार भाकृअनुप संस्थान और एक केंद्रीय कृषि विद्यालय के साथ एक संघशासित प्रदेश के 28 अभासप (ताड़) केंद्रों में मुख्य फसल जैसे नारियल, तेल ताड़, पॉमैरा, सुपारी और कोको के साथ जारी परियोजनाओं की गतिविधियॉ संक्षेप में प्रस्तुत कीं । पिछले वर्ष का बजट 543.60 लाख रुपए था । 23 शोध पत्र, 62 विख्यात लेख, 6 विस्तार फॉल्डर्स और 2 तकनीकी बुलेटिन वर्ष 2019-20 में प्रकाशित किए गए । देश के पश्चिम घाट में प्रभावित ऑधी-तूफान के प्रभाव पर सूचना दी ; नारियल का नाशकारी कीट - रुगोस सर्पिल सफेद मक्खी का प्रबंधन, परीजीव्याभ *एनकार्सिया गुडेलूपे* और मल्टि टायर और समीकृत सस्यन पद्धति मॉडल का विकास आदि अ भा स ताड़ अनुसंधान परियोजना का उल्लेखनीय अंशदान है । विभिन्न विधियों द्वारा प्रयोगशाला से फार्म तक प्रौद्योगिकियों का हस्तांतरण और अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना कार्यक्रम का मुख्य बल है । उन्होंने यह भी दर्शाया कि तीन प्रौद्योगिकियों का विमोचन और उनकी सिफारिश किसान परिवारों के लिए की गयी । सहायक महानिदेशक महोदय ने यह भी सूचित किया कि अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के अनुसंधान कार्यक्रम वर्तमान असाधारण परिस्थिति के साथ अग्रणी होकर आवश्यकता आधारित हों ।

उद्घाटन समारोह में माननीय उप महानिदेशक ने बागवानी क्षेत्र के ऊपर सिंहावलोकन किया और जीडीपी के लिए महत्वपूर्ण अंशदान और तेल ताड़ पर विशेष बल के साथ देश की पोषण सुरक्षा की सूचना दी । उन्होंने सूचित किया कि जलवायु परिवर्तन के इस युग में अनुसंधान को आगे जारी करने के लिए ताड़ की कार्बन पृथक्करण क्षमता को खोजा जाए। उन्होंने उच्च उपज प्रदत्त प्रजातियों, प्रयोक्ता अनुकूल प्रौद्योगिकियों के विकास, फार्म की खुशहाली, हितकारी प्रौद्योगिकीय निष्पादन के साथ किसानों के साथ संबंध जोड़ने की आवश्यकता को रेखांकित किया । उन्होंने वर्णन किया कि एकल फसलन की अपेक्षा उत्तम आय की प्रत्याशा में लाभकारी स्थानीय विशेष अंतर फसल को अपनाना और आई एफ एस पहल द्वारा नारियल पारिस्थितिक तंत्र में पशु उद्योगों का समीकरण किसानों को महसूस कराया जाए । भारत सरकार के वित्तीय अनुदान के बारे में उन्होंने आभार के साथ सूचित किया, कोविड महामारी के पृष्ठपट में ताड़ वैज्ञानिकों को प्रेरित किया और प्रौद्योगिकीय फ्लाटफार्म के साथ राजस्व उत्पादन करने के लिए विभिन्न मार्गों पर किसानों को समर्थन कर ताड़ अनुसंधान में सफलता की चोटी पर पहुँचाने की सभी संभाव्यताओं का अन्वेषण करने को प्रेरित किया ।

डॉ आर के माथुर, निदेशक, भारतीय तेल ताड़ अनुसंधान संस्थान पेड़वेगी ने सुझाव दिया कि उच्च उपज प्रदाय परंपरागत तेल ताड़ प्रजातियों का, उनका उत्पादन बढ़ाने के लिए, संरक्षण किया जाए। डॉ महेश्वरप्पा एच. पी, परियोजना समन्वयक ने धन्यवाद ज्ञापन दिया । ताड़ पर अखिल भारतीय समन्वित अनुसंधान परियोजना की क्षमता सुधारने के लिए विशेषज्ञों ने अपने बहुमूल्य सुझाव/सिफारिश दीं। वर्ष 2019-2020 का विस्तृत विवरण प्रस्तुत किया गया और अगामी वर्ष के तकनीकी कार्यक्रम का वेबिनार के दौरान निर्णय लिया गया। अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्रों और भाकृअनुप संस्थानों से कुल 70 प्रतिभागियों ने भाग लिया । उद्घाटन समारोह के बाद आनुवंशिक संसाधन और फसल सुधार, फसल उत्पादन और फसल संरक्षण और कटाई उपरांत प्रौद्योगिकी पर तकनीकी सत्रों का संचालन किया गया ।

किसान समुदाय के लिए निम्नलिखित प्रौद्योगिकियों की सिफारिश की गयी :-

पन्नियूर -1 का अंतरफसलन

अन्य प्रजातियों/संकरों की तुलना में मूल्यांकन के आधार काली मिर्च, पन्नियूर-1 प्रजाति की शूकिका की उच्च संख्या, शूकिका लंबाई, शूकिका प्रति फल और उच्च सूखा उपज पायी गयी। इसलिए असम और पस्चिम बंगाल क्षेत्र में नारियल बाग के अधीन अंतर फसलन पन्नियूर -1 की सिफारिश की गयी है ।

एरियोफिड़ कीट का समीकृत प्रबंधन

20 कि. ग्रा वर्मीकंपोस्ट और 5 कि. ग्रा नीम केक, हरी खाद फसल का वर्द्धन, केराप्रोबायो 100 ग्रा/ताड़ का प्रयोग और फेनपैरोक्सिमेट 5 प्रतिशत ईसी 10 मि. ली दर में मूल वेधन (मार्च) और पॉम तेल-सल्फर मिश्रण (दिसंबर), समीकृत पोषण प्रबंधन तथा समीकृतकीट प्रबंधन सम्मिलित पैकेज सिफारिश किया गया है और नारियल में एरियोफिड का सक्रमण कम करने में प्रभावी पाया गया है ।

स्लग रोमिल इल्ली का समीकृत प्रबंधन

लारवल और प्यूपल स्थिति में यांत्रिक रूप से निकालने और नाश करने की समीकृत कीट प्रबंधन विधियॉ, 5/हेक्टर दर में लाइट ट्राप का प्रतिष्ठापन,अनुमोदित उर्वरकों की मात्रा का प्रयोग, कीटनाशिनी क्लोरोन्तरनिलिप्रोल 18.5% एस सी 0.3 मि.ली/लीटर और क्षमतावाली परजीव्याभ *पेडियोबायस इन्ब्रुवस* का 60/ताड़ दर से सिफारिशकी गयी ।

रूगोस सर्पिल सफेद मक्खी का प्रबंधन

नारियल बाग में नारियल में रुगोस सर्पिल सफेद मक्खी के लक्षण को कम करने के लिए चिपचिपा पीला ट्राप का संस्थापन प्रभावी आकर्षण के लिए सिफारिश किया गया है ।

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II. EXECUTIVE SUMMARY

The All India Coordinated Research Project on Palms of Indian Council of Agricultural Research (ICAR) under National Agricultural Research System (NARS) started functioning from 1972 is an unique mechanism for testing location-specific and need-based innovations in different agro-climatic conditions of the country. Under this system, both the ICAR and State Agricultural Universities (SAUs) work as partners with 75% and 25% budget sharing, respectively in an interdisciplinary approach. The Project provides a platform and opportunities to the scientists for exchanging ideas and materials for working on similar problems in different agro-ecological regions for collectively developing solutions. They work together in crop improvement, effective management and plant protection and disseminating the technology in the region towards stability and profitability of the crops with a prime objective of increasing profitability as well as farmer's income.

At present the project has coconut, oil palm, arecanut, palmyrah and cocoa as mandate crops and it is implemented in 28 centres. Its headquarters is at ICAR-CPCRI, Kasaragod and 15 centres are conducting research on coconut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa. The coordinating centres are located at 14 states and one union territory covering 13 SAUs/SHUs, one CAU and four ICAR institutes. The budget for the year 2020 was Rs. 491.84 lakhs and the scheme is implemented through the respective state Agricultural/Horticultural Universities on 75:25 basis, with 75% ICAR share, 25% share from State Agricultural Universities and with 100% ICAR funding in the case of Central Agricultural Universities and ICAR Institutes.

RESEARCH ACHIVEMENTS

COCONUT

CROP IMPROVEMENT

- At Ambajipeta centre, among the varieties/hybrids evaluated for a period of 2014-2020 revealed that Godavari Ganga recorded significantly the highest yield/palm/year (144.4 nuts) followed by VHC-2 (134.9 nuts) and Kera Ganga (133.3 nuts) with the highest fruit weight (1393 g).
- Under evaluation of Dwarf x Dwarf combinations at Ratnagiri (planted during 2011), hybrid GBGD x MOD has shown earliness for the flowering. The hybrid COD x MYD recorded the highest tender nut yield (76.7 nuts) followed by the hybrid GBGD x MOD (68.3 nuts). The quantity of tender nut water was more in COD x MYD (602.7 ml/nut) whereas, the Total soluble solids (TSS) was maximum in the hybrid GBGD x MOD (5.7 ^{o}Brix).

CROP PRODUCTION

- Experiment on INM technologies to enhance the productivity and quality of tender nut in dwarf coconut was initiated during 2015 in a 10 years old Chowghat Orange Dwarf (COD) variety in a farmer's garden at Avalchinnampalayam village, Pollachi, Coimbatore district. Initial soil sample analysis revealed that soil was low in nitrogen, medium in phosphorus low in potassium and medium in organic carbon. Growth attributes recorded after four years of experimentation although registered a numerical increase, statistical parlance was witnessed among the treatments whilst significantly higher tender nut yield (159 nuts per palm per year) was witnessed in the treatment T_3 (T_2 + soil test based NPK and micronutrient application), followed by 148 nuts per palm in T_2 (Bio-manures and biofertilizers (green leaf manuring @ 10 kg with Glyricidia loppings + organic recycling of coconut waste through vermicompost @ 10 kg + coconut frond mulching + *Azospirillum* @ 100 g + *Phosphobacteria* @ 100 g + VAM @ 100 g + green manuring with sunn hemp twice a year). Lowest nut yield of 135 per palm was recorded in T_1 (Farmer's Practice).
- Integration of coconut with pasture crops (*Cumbu Napier hybrid* + *Desmanthus*), fodder trees (*Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia)* and Tellicherry breed of goats recorded gross income of Rs. 3,18,400/- per ha as compared to Rs. 2,03,400/- per ha in the monocrop of coconut at Aliyarnagar centre.
- Integrated farming system with coconut, fodder and sheep recorded more number of nuts and fodder yield during the period. Integrated farming system with coconut recorded higher net returns of Rs. 1,30,916 per acre (3,27,290 /ha) when compared with Rs. 36,060/- per acre (90,150 / ha) in coconut monocropping at Arasikere centre.
- An assessment of economics of pepper varieties as mixed crop in coconut garden at Kahikuchi revealed that Panniyur-1 gave the highest net returns (Rs. 2,50,903/- per ha) as well as B:C ratio of 3.73 followed by Sreekara (Rs. 2,21,776/- per ha, B:C = 3.30) and the lowest net returns (Rs. 1,84,846/ha)

and B:C ratio (2.72) was observed in IISR- Malabar Excel.

- Under coconut based cropping system with spices and tuber crops at Mondouri Centre, Coconut + black pepper + ginger + colocasia combination recorded maximum B: C ratio (2.34) with a maximum net returns of Rs. 4,55,107/- per ha. Coconut + black pepper + onion + potato model recorded the lowest B:C ratio of 1.65, while the lowest net returns of Rs. 1,05,400- per ha was recorded in coconut monocrop.

CROP PROTECTION

Disease Management

- 13 new systemic fungicides were tested against the growth of *Ganoderma spp.* under *in vitro* at 100, 250 and 500 ppm. The results revealed that, Hexaconazole 4% + Carbendazim 16% SC, Hexaconazole 5% + validamycin 2.5% SC and Azoxystrobin 11% + Tebuconazole-18.3% SC were found superior as compared to other fungicides in terms of per cent inhibition indicating their effectiveness against the pathogen.

- The weather parameters such as relative humidity, temperature and rainfall were correlated with vertical and horizontal spread of Basal Stem Rot disease under fixed plot. The result implied that, there was a significant positive correlation observed among relative humidity (+0.875), rainfall (+0.41) and negative correlation was noticed in temperature (-0.877) with spread and development of BSR disease.

- Application of *T. harzianum* and *T. reesei* cake formulation completely recovered the diseased palms when compared to the paste application of copper oxychloride against stem bleeding disease of coconut. Disease index of 7.96 and 6.95 at Ambajipeta centre was brought down to 0.0 per cent within 50 days of cake application *Viz*., *Trichoderma harzianum* cake (CPCRI cake) and as well as *Trichoderma reesei* cake formulation.

Pest Management

- At Ambajipeta centre, a total of 6600 numbers of *Bracon hebetor*, 1,77,050 numbers of *G. nephantidis*, 17100 numbers of *P. imbrues*, 242 Tricho cards and 32,61,100 number s of *P. astur* eggs were supplied to the farmers of East Godavari, West Godavari, Visakhapatnam and Srikakulam districts of Andhra Pradesh, Bhadradri Kothagudem, Medchal and Khammam districts of Telangana. Coconut fronds or leaflets containing parasitized puparia were collected from the affected ecosystem and released in newer areas of infestation. At Aliyarnagar centre, a total of 12,561 packets of *Encarsia* parasitoid were distributed to about 4000 farmers.

- The IPM strategies for the management of rugose spiralling whitefly was started during the month of November 2018, in the COD palms (Age 15 years old) at Aliyarnagar centre. The results revealed that in the IPM strategies adapted plot the incidence and intensity of RSWF was significantly reduced to from 52.2% to 22.5% and 48.2 % to 20.5% respectively when compared to the natural control where the percent incidence and pest intensity was increased from 45.2 to 56.2% and 50.5% to 58.5% respectively.

OIL PALM

- Among the 10 hybrids evaluated for growth and yield parameters at Pattukkotai (planted during 2007), the hybrid NRCOP 4 recorded significantly the highest palm height of 5.3 m and it was lowest in NRCOP 9 (4.7 m). Number of leaves produced per year (25.6) was highest in NRCOP 2, whereas, the highest bunch weight of 173.25 kg/palm and per ha yield of 24.78 t/ha was recorded in hybrid NRCOP 9.

- At Pasighat (Arunachal Pradesh), the hybrids evaluation trial planted during August 2010, indicated that, the average bunch weight recorded was significantly the highest (13.4 kg) in NRCOP-22. Significantly the highest yield was recorded in NRCOP-22 (20.07 t/ha) whereas NRCOP-29 recorded the lowest yield (11.07t/ha).

- At Vijayarai, the trial was laid out during July, 2011 to evaluate the performance of hybrids, number of bunches produced per palm per year was significantly higher in the cross NRCOP-37 (10.83) which was on par with the crosses NRCOP-31(8.69), 34(8.27) and 38(8.82). Annual leaf production per palm, average bunch weight (kg) and fresh fruit bunch yield were not significantly differed among the crosses.

- Seven different intercrops were evaluated in oil-palm garden (At Mulde), the maximum yield of oil palm recorded in treatment Oil Palm + Red Ginger + Black pepper with bunch yield of 166.2 kg /palm. The bush pepper recorded maximum yield 0.73g per plant.

ARECANUT

- In order to increase the profitability of arecanut farming in the islands, arecanut based cropping systems with herbal spices *viz*. arecanut + Burmese coriander 'CARI Broad Dhaniya 1', arecanut + coriander 'Arka Isha' and arecanut + mint were established and found highly remunerative to farmers in Andaman and Island regions.
- Population dynamics of biocontrol agents such as *Trichoderma* spp*, Pseudomonas* spp. and *Bacillus* spp. in the rhizosphere soil of crown chocking demonstration garden showed considerable increase in their population after imposition of the treatments. However, among the biocontrol agents, *Pseudomonas* spp. *and Bacillus spp*. showed comparatively higher population enumeration followed by *Trichoderma* spp.

COCOA

Based on the evaluation of cocoa varieties/hybrids as intercrop in coconut garden, the best performing clones were identified under multilocational trial. VTLCH-2, VTLCP-16, VTLC- 20, VTLC-17 and VTLCH-4 from Ambajipeta, Aliyarnagar, Kahikuchi, Ratnagiri and Navasari respectively which registered the maximum pod weight, single dry bean weight, numbers of beans/ pod and dry bean yield/tree/year.

PALMYRAH

- Jaggery powder prepared form fresh neera (CPCRI method collection) gives good colour and shelf life up to one year, whereas jaggery from traditional method turns into dark colour and spoil within 3 months under room temperature with normal packing.
- Palmyrah tender fruit processing machine developed by CIAE was evaluated and it reduces drudgery and time for endosperm separation. Also observed that much useful for both skilled and unskilled person at cottage level endosperm selling people.
- Dehydrated tuber and tuber flour was developed and ready for commercialization.

MEETINGS HELD:

29th Annual Group meeting of AICRP on Palms

The ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala organized the *"Virtual 29th Annual Group Meeting of All India Coordinated Research Project on Palms"* from 10th to 11th August, 2020. Dr. A. K. Singh, Deputy Director General (Hort. Sci.) was the chief guest of the function and Dr. B. K. Pandey, Assistant Director General (Hort. Sci-II), ICAR; New Delhi was the guest of honour of the event.

Dr. Anitha Karun, Director, CPCRI, Kasaragod welcomed the dignitaries and delegates in which she applauded the positive concern of the Deputy Director General over the health of the palm scientists across the nation. She also overwhelmed on the long standing relation of the Assistant Director General with CPCRI. The Director painted a caution note that coconut is undergoing acid test due to debilitating pests and diseases and that palm scientists should join hands to restore the glory of the palm.

Dr. H. P. Maheswarappa, Project Co-ordinator, AICRP (Palms), briefed about activities of project dealing with the mandate crops such as coconut, oil palm, palmyrah, arecanut and cocoa distributed across 28 AICRP centres of 14 states and one Union Territory with collaboration of 13 SAUs, four ICAR institutes and one CAU. He added that total budget outflow during last year was 543.60 lakhs. Twenty three research papers, 62 popular articles, 6 extension folders and 2 technical bulletins were published during 2019 -20. He enlisted that Impact assessment of cyclone hit areas in the Western Ghats of the country, Management of the debilitating pests of coconut - Rugose Spiraling Whitefly employing the parasitoid *Encarsia guadeloupe* and Development of Multi-tier and Integrated Farming System models are the noteworthy contributions of AICRP (Palms). Effective Transfer of Technology from lab to land through diverse tools and modes remain the major strength of this AICRP programme. He also highlighted that AICRP (Palms) has contributed for release of three technologies which are recommended to the farming community. The Assistant Director General highlighted that all the research a programme of AICRP (Palms) needs to be tailored to go in tandem with the present extra–ordinary situation.

In his inaugural address, the honorable Deputy Director General gave a bird's eye view of the overall growth of horticultural sector and its significant contribution to GDP and nutritional security of the nation with special emphasis on oil palm. He hinted that carbon sequestration potential of palms may be explored, to take over research forward in the era of climatic vagaries. He underlined the need for developing high yielding varieties, user friendly technologies for the betterment of the farm front and to connect ourselves with the farmers with benefitting technological outputs. He portrayed that adoption of remunerative location specific intercrops and integration of animal enterprises in coconut ecosystem through IFS approaches can help farmers to realize better income

than sole cropping. He noted the fluent financial grants of Government of India for Agricultural sector, with gratitude. In the backdrop of COVID pandemic, he inspired the palm scientists and invited them to explore every possibility to reach the pinnacle of success in Palm research by advocating the farmers on diverse avenues for revenue generation with technological platform.

Dr. R. K. Mathur, Director, IIOPR, Pedavegi suggested that high yielding traditional varieties of oil palm be conserved for scaling up its production. The crops experts also provided their valuable suggestions / recommendations for further improving the efficacy of the AICRP on Palms. The detailed progress made during 2019-20 was presented and the technical programmes for ensuing *next year* were finalized during the Webinar. A total of 70 participants from various parts of the country participated in the Virtual Meeting including scientists from AICRP centres and ICAR institutes. The inaugural session was followed by technical sessions on genetic resources and crop improvement, crop production, crop protection and post harvest technology.

Following technologies have been recommended to farming community:

- **Intercropping of Panniyur-1:** Based on evaluation, black pepper variety Panniyur-1 recorded significantly higher number of spikes, spike length, number of berries per spike and dry yield compared to other varieties/hybrid. Hence, Panniyur-1 is recommended as suitable for intercropping under coconut gardens in the Assam and West Bengal region.
- **Integrated management of Eriophyid mite**: Integrated Nutrient management as well as Integrated Pest management packages involving application of recommended dose of fertilizers with 20 kg vermicompost and 5 kg neem cake, growing of green manuring with Cowpea / sunnhemp in the inter rows, application of Keraprobio (100 g/palm) and root feeding with fenpyroximate 5% EC @ 10 ml (March) and spraying of palm oil-sulphur emulsion (December) is recommended as it was found effective in reducing infestation of Eriophyid mite in coconut.
- **Integrated management of slug caterpillar**: The IPM packages comprising mechanical removal and destruction of larval and pupal stages, installation of light traps @ 5/ha, application of recommended dose of fertilizers, spraying of insecticide chlorantraniliprole 18.5 % SC @ 0.3 ml/litre and release of potential parasitoid *Pediobius imbreus* @ 60/palm is recommended in order effectively manage the incidence of slug caterpillar in coconut.
- **Management of rugose spiralling whitefly**: Installation of yellow sticky traps in coconut garden is recommended for effective attraction of RSW in coconut in order to mitigate their incidence.

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III. PROFILE OF AICRP ON PALMS

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

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

List of Centres

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

State	Center/Location	Area of Research	University/ Institution
Andhra Pradesh	Ambajipeta: Horticultural Research Station, Ambajipeta, East Godavari Dt. - 533 214 Phone: 08856-244436/243711	Coconut: Crop Improvement, Crop Production & Crop Protection	Dr. Y.S.R Horticultural University, West Godavari Dt., Andhra Pradesh - 534 101
	Pandirimamidi: Horticultural Research Station, Pandirimamidi, Ramapachodaram, East Godavari Dt. - 533 288 Phone : 08864-246577	Palmyrah: Crop Improvement, Crop Production & Post Harvest Technology	
	Vijayarai: Horticulture Research Station, Vijayarai, West Godavari Dt. - 534 475 Phone : 08812-225431 Pedavegi centre	Oil palm: Crop Improvement & Crop Production Cocoa: Crop Improvement	
	Pedavegi: Indian Institute of Oil Palm Research, Near Jawahar Navodaya Vidyalaya, Pedavegi, West Godavari Dt. -534 450 Phone :08812-259409/259532	Oil palm: Crop Improvement & Crop Production	Indian Council of Agricultural Research
Andaman and Nicobar	Port Blair: Central Island Agricultural Research Institute, Port Blair - 744 101 Phone : 03192-250436	Coconut and Arecanut: Crop Improvement & Crop Production	Indian Council of Agricultural Research
Arunachal Pradesh	Pasighat: College of Horticulture & Forestry, Pasighat - 791 102 Phone : 0368-2224887	Oil palm: Crop Improvement & Crop Production	Central Agricultural University, P.O. Box 23, Imphal, Manipur - 795 004

Assam	Kahikuchi: Horticultural Research Station, Kahikuchi, Guwahati Kamrup Dt. - 781 017 Phone : 0361-2840232	Coconut: Crop Improvement & Crop Production Cocoa: Crop Improvement	Assam Agricultural University, Jorhat, Assam - 785 013
Bihar	Sabour: Bihar Agricultural College, Sabour, Bhagalpur Dt. - 813 210 Phone : 0641-2451001	Coconut: Crop Improvement & Crop Production Palmyrah: Crop Improvement & Post Harvest Technology	Bihar Agricultural University, Sabour, Bhagalpur, Bihar - 813 210
Chhattisgarh	Jagdalpur: Shaheed Gundadhur College of Agriculture & Research Station, Kumharawand Farm, Jagdalpur - 494 005 Phone : 07782-229360	Coconut: Crop Improvement & Crop Production	Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh - 492 012
Goa	Goa: Central Coastal Agricultural Research Institute, Ela, Old Goa Dt. - 403 402 Phone : 0832-2285448	Coconut and Arecanut: Crop Improvement & Crop Production	Indian Council of Agricultural Research
Gujarat	Navsari: ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari - 396 450 Phone : 02637-282144	Coconut: Crop Improvement & Production Cocoa: Crop Improvement	Navsari Agricultural University, Navsari, Gujarat - 396 450
Karnataka	Arsikere: Horticultural Research and Extension Station, Arsikere, Hassan Dt. -573 103 Phone: 08174-291565/291711	Coconut: Crop Improvement, Crop Production & Crop Protection	University of Horticultural Sciences, Navanagar, Bagalkot, Karnataka - 587 102
	Sirsi: Horticulture Research and Extension Centre, Sirsi, Uttara Kannada Dt.- 581 401 Phone: 08384-226797/247787	Cocoa: Crop Improvement	
	Bavikere: Agricultural and Horticultural Research Station, Bavikere, Chikkamagaluru – 577 144 Phone :08261 255122	Oil palm: Crop Production	University of Agricultural & Horticultural Sciences, Navile, Shivamogga, Karnataka - 577 225
	Shivamogga: Arecanut Research Centre, College of Agriculture, Navile, Shivamogga Dt. – 577 225 Phone : 08181-267011	Arecanut: Crop Improvement, Crop Production & Crop Protection	
Kerala	Kasaragod: Central Plantation Crops Research Institute, Kasaragod - 671 124 Phone : 04994-232733	Coconut: Crop Production	Indian Council of Agricultural Research
	Pilicode: Regional Agricultural Research Station, Pilicode P.O., Kasaragod - 670 353 Phone:0467-2260450	Coconut: Crop Improvement	Kerala Agricultural University, KAU, Vellanikkara, Thrissur, Kerala - 680 656

Kerala	Thrissur: Cocoa Research Centre, Kerala Agricultural University, Vellanikkara, Thrissur Dt. – 680 656 Phone: 0487-2438457	Cocoa: Crop Improvement	
Maharashtra	Mulde: College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. - 416 520 Phone: 02362-244231/244232	Oil palm: Crop Improvement & Crop Production	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri Dt., Maharashtra - 415 712
	Ratnagiri: Regional Coconut Research Station, Bhatye, Ratnagiri Dt. - 421 612 Phone : 02352-255077	Coconut: Crop Improvement, Crop Production & Crop Protection Cocoa: Crop Improvement	
	Wakawali: Central Experimental Station, Asond block, Wakavali, Dalopli Taluk. Phone : 02358-282417	Arecanut: Crop Improvement & Crop Production	
Odisha	Bhubaneswar: Department of Horticulture, (OUAT), Bhubaneswar - 751 003 Phone : 0674-2397463	Coconut: Crop Improvement & Crop Production Cocoa: Crop Improvement	Odisha University of Agriculture and Technology, Bhubaneswar, Odisha - 751 003
Tamil Nadu	Aliyarnagar: Coconut Research Station, Aliyarnagar, Coimbatore Dt. - 642 101 Phone: 04253-288722/288662	Coconut: Crop Improvement, Crop Production & Crop Protection Cocoa: Crop Improvement	Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu - 641 003
	Killikulam: Agricultural College & Research Institute, Killikulam, Vallanad, Tuticorin Dt. - 628 252 Phone : 04630-261226	Palmyrah: Crop Improvement & Crop Production	
	Pattukkottai: Agricultural Research Station, Pattukkottai, Thanjvur Dt. -614 602 Phone : 04373-235832	Oil palm: Crop Improvement & Crop Production	
	Veppankulam: Coconut Research Station, Veppankulam, Thanjavur Dt. - 614 906 Phone: 04373-260205/202534	Coconut: Crop Improvement, Crop Production & Crop Protection	
Telangana	Konda Mallepally: Horticultural Research Station, Konda Mallepally Mandal, Nalgonda Dt.- 508 243	Palmyrah: Crop Improvement & Post Harvest Technology	Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad, Telangana – 500 030

West Bengal	Mondouri: Directorate of Research, P. O. Kalyani, Nadia Dt. - 741 235 Phone :033-25827574	Coconut: Crop Improvement & Crop Production	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal - 741 252

Budget

The budget for the year 2020 was Rs. 491.84 lakhs (ICAR Share)

(Rs. in lakhs)

Sl. No.	Head	Expenditure
1.	Pay and allowances	392.81
2.	T.A.	1.25
3.	RC	75.42
4.	TSP	3.99
5.	SCSP	18.37
	Total	**491.84**

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

Centre	*Pay*	*TA*	*RC*	*HRD*	*Eqpt.*	*TSP*	*SCSP*	*Total*
Aliyarnagar	57.68	0.00	3.01	0.00	0.00	0.68	2.33	**63.70**
Ambajipeta	26.86	0.00	2.83	0.00	0.00	0.00	1.82	**31.51**
Arsikere	39.60	0.00	2.23	0.00	0.00	0.68	1.81	**44.32**
Jagdalpur	18.93	0.00	2.11	0.00	0.00	0.65	1.00	**22.69**
Kahikuchi (NEH)	37.65	0.00	7.82	0.00	0.00	0.00	1.76	**47.23**
Bhubaneswar	10.25	0.00	2.29	0.00	0.00	0.00	1.18	**13.72**
Mondouri	15.40	0.00	1.75	0.00	0.00	0.00	0.00	**17.15**
Ratnagiri	59.24	0.00	2.73	0.00	0.00	0.68	1.81	**64.46**
Veppankulam	38.30	0.00	2.29	0.00	0.00	0.00	1.76	**42.35**
Killikulam	14.00	0.00	1.13	0.00	0.00	0.00	1.24	**16.37**
Pandirimamidi	11.10	0.00	1.44	0.00	0.00	0.65	0.50	**13.69**
Pattukotai	14.95	0.00	1.69	0.00	0.00	0.00	0.00	**16.64**
Mulde	12.50	0.00	2.71	0.00	0.00	0.00	0.00	**15.21**
Vijayarai	9.75	0.00	2.23	0.00	0.00	0.00	0.76	**12.74**
Navasari	7.20	0.00	1.73	0.00	0.00	0.65	0.00	**9.58**
Sabour	11.30	0.00	1.73	0.00	0.00	0.00	1.16	**14.19**
Shivamogga	8.10	0.00	3.56	0.00	0.00	0.00	0.00	**11.66**
Wakawali	0.00	0.00	3.30	0.00	0.00	0.00	0.00	**3.30**
Pilicode	0.00	0.00	3.55	0.00	0.00	0.00	0.00	**3.55**

Bavikere	0.00	0.00	3.40	0.00	0.00	0.00	0.00	**3.40**
K Mallapally	0.00	0.00	0.60	0.00	0.00	0.00	1.24	**1.84**
Sirsi	0.00	0.00	0.60	0.00	0.00	0.00	0.00	**0.60**
Thrissur	0.00	0.00	0.60	0.00	0.00	0.00	0.00	**0.60**
Pasighat (NEH)	0.00	0.00	3.44	0.00	0.00	0.00	0.00	**3.44**
Port Blair (ICAR)	0.00	0.00	3.60	0.00	0.00	0.00	0.00	**3.60**
Goa (ICAR)	0.00	0.00	3.30	0.00	0.00	0.00	0.00	**3.30**
IIOPR, Pedavegi (ICAR)	0.00	0.00	3.05	0.00	0.00	0.00	0.00	**3.05**
Kasaragod (ICAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
PC cell (ICAR)	0.00	1.25	6.70	0.00	0.00	0.00	0.00	**7.95**
Total	**392.81**	**1.25**	**75.42**	**0.00**	**0.00**	**3.99**	**18.37**	**491.84**

Mode of implementation

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

Staff strength

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

Staff Position

HEAD QUARTERS

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

Project Coordinator : Dr. Maheswarappa, H. P
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Private Secretary : Mrs. K. Narayani
Skilled supporting staff : Mr. M. Shankara
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Technical Assistant : Shri. Rajaram Patowari

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Scientist (Agronomy) : Shri. P. K. Salam
Technical Assistant : Mr. Rajesh Kumar Patel

GOA

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GUJARAT

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* * * * *

IV. EXPERIMENTAL RESULTS IN COCONUT

4.1 GENETIC RESOURCES AND CROP IMPROVEMENT

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

Expt. 1: Evaluation of conserved germplasms

Centers: Bhubaneswar, Navsari and Sabour

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

List of germplasms under evaluation

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

Bhubaneswar

This experiment was initiated with sixteen germplasm accessions comprising of 4 Dwarf and 12 Talls during 2004 as an un-replicated observation trial (Table1). During 2020, shortest height (3.9 m) was recorded in Java Tall followed by Pratap (4.2 m) and maximum girth (196.25 cm) at base was observed in WCT. Highest number of functional leaves/palm (21.4), rate of annual leaf production (7.6/palm/year) and number of inflorescences (7.2/palm/year) were observed in Guam; longest leaf length (6.1 m) was recorded in the accession BSI. In the yield contributing characters, maximum number of female flowers per palm(156.4) was observed in SSG, whereas, maximum nuts/palm/year (19.0) was noted in AO. Among the dwarf cultivars, shortest plant height (3.5 m) was recorded in MYD followed by COD (3.5 m). However, the accession GBGD performed better by producing maximum plant girth (137.7 cm), number of functional leaves (19.8/palm), rate of productionof leaves (7.4/palm/year) as well as highest number of inflorescences (6.6/palm/year) and number of female flowers (192.4/palm/year). However, the highest number of nuts (27.0/palm/year) was recorded in MGD. The poor performance of palms was due to cyclonic storm of "FANI" occurred during 3rd May, 2019.

Table 1: Growth, floral and yield attributes of conserved germplasm accessions at Bhubaneshwar (Year of planting: 2004)

Germplasm	Plant height (m)	Plant girth (cm)	Annual leaf production (nos.)	Inflorescence/ palm/year (nos.)	No. of female flowers/ palm/year (nos.)	Nut yield (nuts/palm/ year)
IND 007 (COD)	3.5	90.0	6.60	5.4	120.8	24.8
Kalparaksha (MGD)	5.4	129.7	7.0	6.0	118.6	**27.0**
IND 058 (MYD)	**3.5**	88.5	6.0	5.5	163.	17.0
GBGD (Gangabondam)	3.6	**137.7**	**7.4**	**6.6**	**192.4**	16.8
IND 009 (SSG)	5.3	117.6	7.4	7.2	**156.4**	10.4
IND 025 (Guam- I)	5.7	190.6	**7.6**	**7.2**	150.2	11.2
Kerakeralam (WCT)	6.2	**196.2**	6.2	6.0	102.0	6.5
Kalpatharu (Tiptur Tall)	4.9	155.7	6.8	5.6	111.8	6.6

IND 053 (St. Vincent)	6.6	152.4	6.6	5.8	121.6	8.8
Kalpamitra (Java Tall)	**3.9**	142.6	7.0	6.2	126.2	8.2
IND 036 (BSI)	7.80	184.8	6.8	6.0	136.0	11.6
IND 018 (A.O.)	6.4	169.2	6.8	6.4	122.2	**19.0**
IND 037 (Zanzibar Tall)	6.98	185.2	7.0	6.0	127.2	9.7
Benaulim(Pratap)	4.2	126.3	7.3	6.0	117.3	7.3
IND 034 (San Ramon)	4.5	150.8	7.0	**6.6**	127.2	6.8
IND 041 (Sakhigopal)	6.5	191.0	7.3	6.3	99.0	6.3
Mean	5.3	148.11	6.93	6.18	130.8	13.38
SD	1.35	33.40	0.43	0.53	24.16	6.61
CV %	25.52	22.55	6.26	8.58	18.47	53.41

Navsari

At this centre, two dwarf and fourteen tall genotypes were planted during August, 2014. During 2020, the growth characters like plant height (295 cm) recorded was maximum in Pratap and minimum (111.7 cm) was in BYL whereas, collar girth (199.3 cm), functional leaves on crown (25.5 nos), maximum numbers of inflorescence per annum (10.3 nos) and nut yield/palm/year (36.7 nuts) recorded were maximum in Kappadam. The highest leaf length (558.3 cm) and petiole length (184.3 cm) was recorded in PHOT while, LCOT flowered earlier at the age i.e. 43.3 months. Regarding to reaction of biotic stresses, 3-5% and 23-26% palms of all genotypes are infected by rhinoceros beetle and Eriophyid mite, respectively whereas, there was no other infestation of pests and diseases observed in the experimental plot.

Sabour

A total of fourteen germplasms were planted during 2013 at Sabour centre and seedlings are under establishment phase. However, varietal difference against tolerant to cold stress was observed. As per growth parameter is concerned maximum plant height was noted in variety Shakhi Gopal followed by MYD and IND 007(COD) with plant height of 662 cm ,635 cm and 510cm, respectively. The minimum plant height of 335 cm was noted in Asrampatti Tall followed by Tiptur Tall (350 cm). The maximum number of functional leaves was noted in Shakhigopal Tall (21.2 leaves per plant) followed by IND007 (COD) with 21 leaves and minimum in Tiptur Tall (11.5). Annual leaf production was also high in variety Shakhi Gopal(7.8) followed by MYD (7.2) and IND 007(COD). All the varieties under evaluation has come into flowering .Variety Malayan Yellow Dwarf (MYD) and Chowghat Orange Dwarf (COD) were earliest to come in flowering with 63 and 65 months from date of planting and variety Gonthemballi Tall , Tiptur Tall and Zangibar Tall were latest to come into flowering that 78 ,77 and 77 months, respectively for flowering. Assam Green Tall (AGT), CRP 509(ECT), Chandra Kalpa and VPM 3 (ADOT) took 71 to 73 month to come in flowering.

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

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

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

Aliyarnagar

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

Replicated trial

Among the ecotypes being maintained under replicated experiment, analysis of observations revealed that the ecotype with IC No. 610375 recorded the minimum plant height (306.2 cm) and uttered its dwarf stature. The genotype having IC No. 610378 showed vigorous nature by registering maximum plant girth (160.5 cm), petiole length (162.2 cm) and leaf length (532.1 cm). IC number 610370 recorded the higher nut yield (93.5 nuts) which was followed by IC number 610376 (69.3 nuts). IC number 610370 also recorded higher number

of functional leaves (34.6 nos), annual leaf production (11.2 nos), number of spikelets (35.2 nos) and number of buttons (22.5 nos). Ecotype having IC No. 610378 recorded favourable nut constituent traits *viz.,* maximum whole nut weight (1942.3 g), de-husked nut weight (910.5 g) and copra weight (212.6 g) (Table 2).

Table 2: Yield performance and pest incidence of location specific germplasms of coconut at Aliyarnagar (Year of planting 2008 & 2012)

IC number	Nut yield (nuts/palm/ year)	Whole nut weight (g)	De-husked nut weight (g)	Copra weight (g)	Rhinoceros beetle leaf damage (%)	Eriophyid mite (%)
610370	93.5	1385.6	612.5	190.2	2.6	12.3
610375	68.2	1856.3	756.2	175.6	5.2	20.7
610376	69.3	1833.9	845.1	193.5	4.3	26.8
610377	60.4	1452.3	756.2	132.5	5.4	15.9
610378	65.2	1942.3	910.5	212.6	2.4	17.8
Mean	**71.3**	**1694.1**	**776.1**	**180.9**	-	-
SE d±	**0.6**	**30.2**	**7.0**	**3.2**	-	-
CD (P=0.05)	**1.5**	**70.7**	**16.4**	**7.5**	-	-

Crown view of IC No 610379 at Aliyarnagar

Ambajipeta

Thirteen local germplasms were collected from traditional coconut growing districts *viz.,* Srikakulam, East and West Godavari districts of Andhra Pradesh. The experiment was laid out during February 2013.Out of thirteen accessions, five accessions *viz.,* ECT green (IC 610311), Jonnalarasi brown (IC 610309), Pillalakodi green (IC 610306), Pillalakodi brown (IC No. 610307) and Gangabondam green dwarf (IC No. 610310) were planted in RBD with four replications and 4 palms per replication observations on growth attributing characters were recorded and significant differences were noticed among different accessions for plant height, plant girth, leaf length and petiole length. Significantly maximum plant height (281.2 cm) and plant girth (120.9 cm) was recorded in IC No. 610306 whereas, With regards to flowering, IC 610310 was the earliest to flower in 37 months followed by IC 610307 (50 months) and IC 610306) (51 months). Yield attributing characters showed significant variation for number of nuts/annum, higher number of nut yield (89.8 nuts) was recorded in IC 610307 followed by IC 610306) (87.4 nuts) were observed to be at par. Lowest yield was recorded in IC 610310 (42.1 nuts) (Table 3).

Table 3: Yield performance of location specific germplasms of coconut at Ambajipeta (Year of planting 2013)

IC number	Age at first flowering (months)	Inflorescences/ palm/year	Nut yield (nuts/palm/ year)	Tendernut water content (ml)	T.S.S. of water (0^0 Brix)
610311	54.0	7.3	49.5	235.50	7.14
610309	52.0	5.5	56.3	218.00	6.36
610306	51.0	6.9	87.4	187.00	6.17
610307	50.0	6.3	89.8	205.50	6.21
610310	37.0	2.3	42.1	338.75	7.45
SE d±	-	**0.7**	**6.5**	**11.25**	**0.16**
CD (P=0.05)	-	**2.2**	**20.1**	**34.66**	**0.51**

Bhubaneswar

A field experiment, comprising of eleven local germplams were initiated during December, 2003 as an un-replicated observational trial with 10 palms per germplasm. During the period of study it was observed that the IC No. 612467 performed better as compared to others by producing maximum plant girth at base (195.60 cm), no. of leaves (7.4/palm/year), number of inflorescences (6.4/palm/year), number of female flowers (141.50/palm/year) and no. of nuts (10.4/palm/year) in spite of cyclonic hit "FANI" on 3rdMay, 2019. However, IC No. 612467 registered shortest plant height (4.9 m). Maximum number of functional leaves (20.50/palm) was recorded in IC. No. 612459 and longest leaf (6.2 m) was found in IC. No. 612465.

Jagdalpur

The accessions of six collected germplasms were planted in July 2011 in RBD with four replications at 4 palms per replication and observations on growth parameters were recorded. During 2020, the data recorded was non-significant with respect to the plant height, annual leaf production. The maximum petiole length was observed in CRP-724 (242.8 cm) followed by CRP-725 (219 cm) whereas the leaf length of CRP-724 and CRP-725 were at par (337.3 cm and 317.3 cm respectively). CRP-725 recorded the maximum plant girth of 146 cm while the rest were at par to each other.

Kahikuchi

The experiment was initiated with 10 local accessions, IC No 61035 to IC No 610362 along with two check varieties *viz.,* Kamrupa and WCT under replicated trial during 2005.The experiment was laid out in RBD with three replications. Five new coconut germplasm *viz.,* IC No. 610363, 610364, 610365, 610366 and 610367 were also collected from two district of Assam *viz.,* Nowgaon and Marigaon and were planted during 2009 in a non replicated single row planting with six palms per genotype as an observational trial.

Replicated trial

The data showed that the highest plant height (5.4 m), plant girth (168 cm), number of functional leaf (32.8 nos) and annual leaf production (11.9 nos) were recorded in Kamrupa. The highest petiole length (167 cm) and leaf length (429 cm) were observed in IC No. 610358 and IC No.610360 respectively. With regard to reproductive characters, the highest number of inflorescence (11.6 nos.) and number of buttons (25.7 nos) were recorded in Kamrupa followed by the IC No. 610357 and lowest values were obtained in IC No. 610358. With regard to nut characteristics and nut yield, the IC No. 610354 recorded the highest nut length (28.7 cm), nut breath (49.7 cm) with whole nut weight (1476.5 g) and tender coconut water content (375.6 ml). Among the accessions, significantly the highest nut yield (80.6 nuts) was observed in IC No. 610357 while the lowest (60 nuts) was found in IC No. 610355.

Mondouri

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

Replicated trial

Among the germplasms evaluated under replicated trial, significant variations were recorded in plant height. IC 612449 recorded maximum plant height (740 cm) and IC 612450) recorded minimum plant height (296.3 cm). IC612448 recorded maximum basal girth (155.7 cm) whereas IC612449 recorded minimum basal girth (133.3cm). Number of functional leaves were recorded maximum (37.7 nos) in 612449. IC 612451) recorded maximum (7.3 nos) of inflorescence/palm/year whereas IC 612448 and IC 612449 recorded minimum (5.3 nos) of inflorescence. Number of female buds/palm/year was also recorded highest (68.7 nos/palm) in IC612447 and minimum (26.7 nos) was recorded in IC 612451). Maximum number of nuts/palm (41.3 nuts) was recorded in the collection CRP781 (612449) whereas collection CRP780 (612448) recorded minimum (12 nuts) nuts/palm/year.

Navsari

Four local germplasms (IC No. 610319, 610320, 610321 and 610322) were planted in RBD with five replications during 2013 and the seedlings are in establishment phase. The data on growth and flowering characters revealed that, the lowest plant height (265.8 cm) with maximum collar girth (162.8 cm), annual leaf production (9.8 nos), functional leaves/palm (30.4 nos) and inflorescence production per annum (10.4 nos) with nut yield (41 nuts) was recorded in C number 610319, whereas, highest leaf length (495.4 cm) and petiole length (139 cm) with minimum age at first flowering (45.3 months) was observed in IC number 610320. Regarding to reaction of biotic stresses, 3-3.65% and 27-31% palms of all genotypes were infected by rhinoceros beetle and eriophyid mite respectively whereas, there was no other infestation of pests and diseases observed in the experimental plot (Table 5).

Table 5: Growth characters and yield performance of location specific germplasms of coconut at Navsari (Year of planting 2013)

Genotype IC No.	Plant height (cm)	Plant girth (cm)	No. of functional leaves (nos.)	Annual leaf production (nos.)	Age at first flowering (months)	Inflores-cences/palm/ year	Nuts yield (nuts/palm/ year)	Rhinoceros beetle (%)	Eriophyid mite (%)
610319	265.8	162.8	30.4	9.8	47.7	10.4	41.0	3.0	27.5
610320	330.0	165.2	23.0	9.0	45.3	10.0	26.2	3.6	31.3
610321	287.6	156.8	26.0	8.3	53.8	8.0	25.8	3.4	30.5
610322	294.2	161.6	25.8	8.8	51.7	9.8	27.2	3.7	31.0
Mean	**294.4**	**161.6**	**26.3**	**9.0**	**49.6**	**9.6**	**30.1**	**3.4**	**30.1**
SE d±	**2.34**	**1.56**	**0.57**	**0.49**	**1.01**	**0.50**	**1.16**		**-**
CD (P=0.05)	**7.20**	**4.80**	**1.77**	**NS**	**3.10**	**1.53**	**3.56**		**-**

Pilicode

At Pilicode centre, six dwarf local ecotypes collected from different parts of Kerala have been raised in replicated experiment during February 2017 along with local check CGD. Three juvenile growth parameters viz., plant height, number of leaves and plant girth were observed and analysed. There was no significant difference between seven dwarf genotypes with respect to height of palm. With respect to average number of leaves, the genotype 'Nirvaram' showed the highest number of leaves (12.7 nos) followed by the check variety CGD (11.8 nos) and 'Mannukusumbil-2'(10.4 nos). There was no significant difference among genotypes on the trait plant girth. During the fourth year of planting, the genotypes Thonnooran and Chulliyod started flowering. The check variety CGD started flowering during third year of planting. Among seven genotypes, RARS - DC3 (Azheethala) showed the lowest infestation of rhinoceros beetle followed by RARS - DC7 (Chakkitapara local). The check variety CGD showed the highest rhinoceros infestation.

Ratnagiri

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

Replicated trial

Among the germplasms evaluated under replicated trial, significant variations were recorded in different vegetative characters. The data on growth and flowering characters revealed that, the accession IC 599115 recorded maximum plant height (575 cm), accession IC 599115 recorded maximum plant girth (109.0 cm), accession IC 599114 recorded maximum annual leaf production (12.3 nos.), accession IC599112 recorded maximum number functional leaves (29.7 nos.), accession IC 599112 recorded highest leaf length (407.5 cm) and accession CRP-759 recorded maximum petiole length (166.1 cm) among genotypes**.** Accession IC 599112 recorded maximum no. of inflorescence (11.5 nos.) and accession CRP-761 recorded maximum no. of buttons (178.3 nos.). The accession IC 599112 recorded maximum nuts yield (70.3 nuts) and maximum copra weight (196.2 g) among all genotypes. In respect of pest and disease incidence, the Rhinoceros beetle incidence was highest in accession IC 599115 (10 %) whereas lowest in IC 599112 (6.66 %), the highest eriophyid mite incidence and highest Rugose spiralling whitefly incidence was in accession IC599113 (26.89%) among all genotypes under study (Table 6).

Table 6: Yield performance and pest incidence of location specific germplasms of coconut at Ratnagiri (Year of planting 2007)

Genotype	IC No.	Inflorescence/ palm/year	No. of buttons (nos.)	Nut yield (nuts/ palm/ year)	Whole nut weight (g)	De-husked nut weight (g)	Copra weight (g)	Rhinoceros beetle incidence (%)	Eriophyid mite incidence (%)	Rugose Spiralling Whitefly incidence (%)	
										(%) incidence	(%) intensity
CRP 757	599111	9.2	141.4	42.2	1032.5	580.3	152.5	7.4	8.5	16.9	5.4
CRP 758	599112	11.6	167.9	70.4	1107.5	703.9	196.3	6.7	17.8	11.3	2.2
CRP 759	599113	11.3	169.7	53.2	1160.0	649.8	155.5	8.0	27.9	26.9	4.3
CRP 760	599114	11.1	170.8	60.1	1262.5	805.7	145.0	7.4	21.8	12.1	2.2
CRP 761	599115	11.3	174.4	60.9	886.3	435.8	127.5	10.0	27.8	11.5	3.7

CRP 762	599116	10.6	157.5	51.7	1057.5	603.0	142.0	7.1	20.9	14.8	2.5
Mean		**10.8**	**163.6**	**56.4**	**1084.4**	**71.9**	**153.1**	-	-	-	-
SE d±		**0.5**	**7.3**	**2.2**	**71.9**	**216.8**	**5.4**	-	-	-	-
CD (P=0.05)		**1.6**	**22.1**	**6.7**	**216.8**	**22.9**	**16.4**	-	-	-	-

'Gaja' cyclone during Noveveber 2018, 12 palms were lost and bunches in all the genotypes with different maturity were fallen down. The trees are recovering slowly after adequate irrigation and application of recommended dose of fertilizers with incorporation of vermin-compost, neem cake, bio-fertilizers and green manuring. Among the germplasms, IC. No. 599266 was found to be dwarf stature (736 cm) and IC. No. 599265 recorded higher number of nut yield (48 nuts) with superior nut quality characters, viz., maximum whole nut weight and copra content (1400 g, and 176 g respectively) (Table 7).

Table 7: Yield performance of location specific germplasms of coconut at Veppankulam (Year of planting 2005)

Genotypes	Inflorescence/ palm	Nut yield/ palm/year	Whole nut weight (g)	De-husked nut wt (g)	Nut length (cm)	Nut breadth (cm)	Kernel thickness (cm)	Kernel weight (g)	Copra weight (g)
599263	9	35	1180	440	20	14	1.3	248	136
599264	7	34	1050	450	22	13	1.5	245	143
599265	9	48	1400*	670*	26*	16*	1.4	290*	176*
599266	9	37	1050	450	23	13	1.4	205	114
599267	9	35	1060	425	22	13	1.5	220	115
KeraKeralam	8	34	960	400	21	12	1.2	180	115
ALRCN1	9	38	720	360	19	12	1.0	160	105
Mean	**8.57**	**37.28**	**1003.33**	**456.43**	**21.86**	**13.29**	**1.33**	**221.14**	**127.71**
SE d±	**0.23**	**1.19**	**70.60**	**11.41**	**1.32**	**1.61**	**0.7**	**7.32**	**12.13**
CD (P=0.05)	**0.54**	**2.28**	**141.13**	**32.61**	**3.81**	**3.19**	**NS**	**16.11**	**24.29**

Expt. 3: Evaluation of elite germplasms

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

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

Participating centres and genotypes under evaluation

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

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

Aliyarnagar

Inter-se mated seed nuts of six exotic genotypes were supplied by the ICAR-CPCRI, Kasaragod, Kerala and the experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Experiment was initiated during the year 2015 and the trial is in flowering stage. Data on growth parameters revealed that there was non-significant variation among different exotic collections except plant girth. Genotypes Gauam-III Tall registered its dwarf nature by recording lower palm height (192 cm) among the elite germplasm being evaluated, whereas the genotypes Verrikkobari Tall expressed vigorous nature by producing higher plant girth (127.3 cm). Petiole length (158.8 cm) and number of functional leaves (26.1 nos) was produced maximum in Gauam-III Tall and the rate of annual leaf production was higher in Markham Tall (9.7 nos). Average incidence of rhinoceros beetle leaf damage was found 6.4 per cent and spindle damage was found 6.1 per cent (Table 8).

Table 8: Growth characters and pest and diseases incidence of elite coconut germplasms at Aliyarnagar (Year of planting: 2015)

Genotypes	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	Leaf length (cm)	Petiole length (cm)	Rhinoceros beetle incidence (%)	
						% Leaf damage	% Spindle damage
Verrikkobari Tall	302.9	127.3	9.1	491.4	150.4	8.0	3.2
Guam-III Tall	192.0	112.4	9.4	465.5	158.8	6.3	8.8
Markham Tall	249.0	96.0	9.7	477.6	150.8	4.2	6.1
StraitsSettlement Green Tall	215.1	88.0	8.9	509.9	143.7	5.6	2.8
Nigerian Green	239.7	113.9	9.1	491.6	151.3	3.2	3.7
Palawan Tall	269.4	102.1	8.6	430.9	132.3	7.2	6.1
West Coast Tall	254.2	119.6	8.0	502.5	155.4	10.1	12.2
Mean	**246.1**	**108.5**	**9.0**	**481.3**	**148.9**	6.4	6.1
SE d±	**48.0**	**9.3**	**0.5**	**50.0**	**13.6**		
CD (P=0.05)	**NS**	**20.4**	**NS**	**NS**	**NS**		

Ambajipeta

With a view to assess few elite exotic coconut genotypes, *Inter-se* mated seed nuts of six exotic genotypes were supplied by the ICAR-CPCRI, Kasaragod, Kerala during May 2014 and seedlings were raised in polybags. The experiment was planted in March 2016 and it is in vegetative stage. The experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Data on growth parameters revealed that the lowest plant height of 625.7 cm was recorded in East coast tall while the highest plant height of 783.6 cm was recorded in Verikobbari tall. However, no significant differences were noticed among the elite germplasm selections for plant height, palm girth, number of functional leaves, total leaf length and petiole length. Verrikobbari Tall (42 months) recorded earliest for flower initiation followed by Straits Settlement Green Tall (46 months) (Table 9).

Table 9: Growth characters of elite coconut germplasms at Ambajipeta (Year of planting: 2016)

Genotypes	Plant height (cm)	Plant girth (cm)	No. of functional leaves/palm (nos.)	Leaf length (cm)	Petiole length (cm)	No. of Leaf scars in 1m	Age at first flowering
Verrikkobari Tall	165.4	89.2	25.4	588.4	172.5	12.3	42
St.Vincent Tall	140.4	94.6	26.2	614.6	176.9	10.5	50
Guam-II Tall	93.5	63.7	16.1	349.4	105.1	8.2	48
Zanzibar Tall	138.8	112.4	23.1	607.8	178.4	12.6	-
Straits Settlement Green Tall	169.1	98.4	23.2	557.9	152.8	13.1	46
Kenya Tall	144.4	107.4	23.2	561.9	169.6	10.8	-
East Coast Tall (c)	126.1	92.1	20.8	534.0	156.1	14.1	-
SE d±	**20.1**	**15.4**	**3.2**	**66.0**	**19.8**	**2.0**	
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	

Arsikere

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

Bearing palm of Kenya Tall at Bhubaneswar

Bhubaneswar

Among the germplasms evaluated, maximum plant height (6.3 m) and annual leaf production rate (12.0) was recorded in Laguna Tall whereas, maximum plant girth (103.5 cm) was observed in Kenya Tall followed by Laguna Tall (101.4 cm) and highest number of functional leaves/palm (19.2) was recorded in Palwan Tall followed by Laguna Tall (19.1). It has been noticed that the Verikkobari Tall is of dwarf stature (5.3 m), and the early flowering was observed in Verikkobari Tall, Nigerian Tall and Palwan Tall. The palms were performing very well in littoral sandy soil as 45.23% flowering was observed after 5 years of planting.

Ratnagiri

The experiment was initiated during July 2015 with the genetic material supplied from CPCRI. Experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Regarding growth parameters, the maximum plant height (353.6 cm) recorded in local check Pratap, maximum plant girth (127.5 cm) recorded in Nigerian Green Tall (NGT), maximum number of leaves/year (12.3 nos.) recorded in Straits Green Tall (SSGT), maximum functional leaves on crown (20.6 nos.) recorded in Nigerian Green Tall (NGT), maximum leaf length (340 cm) recorded in Verikkobari Tall (VKT) and maximum petiole length (145.8 cm) recorded in Verikkobari Tall (VKT) were observed among elite germplasm. Flowering was started in genotypes Straits Settlement Green Tall (SSGT) and Verikkobari Tall (VKT). The percentage of Rhinoceros beetle incidence was highest in Verikkobari Tall (VKT) (12.65 %) whereas lowest incidence was observed in St. Vincent Tall (STVT) (3.84 %). The percent of Rugose Spiralling Whitefly incidence was highest Verikkobari Tall (VKT) (7.53 %) among all elite germplasms under study (Table 10).

Table 10: Growth characters and pest incidence of elite coconut germplasms at Ratnagiri (Year of planting 2015)

CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS		
Genotypes	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/ palm (nos.)	Leaf length (cm)	Petiole length (cm)	Rhinoceros beetle incidence (%)	Rugose Spiralling Whitefly	
								% incidence	% intensity
Verikkobari Tall	104.7	103.3	12.2	20.3	340.0	145.8	12.65	7.53	7.4
St. Vincent Tall	55.6	114.2	10.8	16.9	283.4	108.3	3.84	4.10	2.46
Guam- III Tall	84.8	113.3	11.6	18.6	318.3	124.0	8.97	5.61	2.06
Zanzibar Tall	99.7	119.1	12.0	18.7	323.2	136.7	6.45	4.28	2.36
Straits Settlement Green Tall	67.5	110.5	12.3	19.4	310.0	131.8	10.14	4.16	2.15
Nigerian Green Tall	132.0	127.5	11.8	20.6	265.0	130.0	6.77	3.41	3.98
Pratap (C)	353.6	80.3	11.4	18.7	312.3	130.0	4.54	4.91	2.85
SE d±	2.4	7.3	0.3	0.7	11.7	3.9	-	-	-
CD (P=0.05)	7.5	22.5	0.9	2.0	36.2	11.9	-	-	-

Veppankulam

The germplasms were planted in August, 2015, consisting of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication. Data on growth parameters revealed that there was found significant variation among different exotic collections. Among the six ecotypes, Makham Tall showed the dwarf stature (525 cm), Laguna tall (540 cm) with slender nature (108 cm). Earliness in flowering was observed in Markham Tall (3.4 years) followed by Nigerian Green (3.8 years) among all elite germplasms under evaluation

Expt. 4: Evaluation of INGR 13065

Centers: Aliyarnagar and Ratnagiri

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

Aliyarnagar

Experiment was initiated to evaluate the performance of the dwarf genotype INGR 13065 (*Niu Lekha*). The seedlings supplied by the ICAR-CPCRI, Kasaragod, Kerala were used for planting as un-replicated trials along with local checks (COD and KTD) during July, 2015 and they are started spathe emergence. INGR 13065 was found to be highly vigorous than check varieties. INGR 13065 proved its earliness by producing spathe emergence at the age of 33 months after planting at Aliyarnagar. Data on growth attributes revealed that, the maximum plant height (662.4 cm), plant girth at base (133.2 cm), number of functional leaves (26.5 nos), leaf length (463.7 cm), petiole length (121.8 cm) were registered by INGR 13065. The least values for all the above character were registered by the local check varieties viz., COD and KTD. The average rhinoceros beetle leaf damage was found to be 7.4 per cent (Table 11).

Table 11: Growth characters of coconut germplasm INGR 13065 at Aliyarnagar (Year of planting: 2015)

Genotypes	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm (nos.)	Leaf length (cm)	Petiole length (cm)	No. of spikelet (nos.)	No. of buttons (nos.)	Rhinoceros beetle leaf damage(%)
INGR 13065	662.4	133.2	12.5	26.5	463.7	121.8	31.6	29.4	5.2
KTD	591.0	87.4	12.2	24.6	408.9	110.9	23.4	11.6	8.3
COD	593.7	92.9	11.9	23.5	420.9	116.1	21.6	10.7	8.8
Mean	**615.7**	**104.5**	**12.2**	**24.9**	**431.2**	**116.3**	**25.5**	**17.2**	**7.4**
SD	**40.5**	**25.0**	**0.3**	**1.5**	**28.8**	**5.5**	**5.3**	**10.5**	**2.0**
CV%	**6.6**	**23.9**	**2.5**	**6.1**	**6.7**	**4.7**	**20.9**	**61.2**	**26.2**

Ratnagiri

Experiment is being started at Ratnagiri for performance evaluation of the dwarf genotype INGR 13065 (*Niu Lekha*). The data on growth parameters revealed that the average initial plant height of INGR 13065 was 502.7 cm. The average initial plant girth of INGR 13065 was 122.1 cm. The least values for all the above character were registered by COD. In respect of pest incidence, generally 10-15 % palms are infected by Rhinoceros beetle and Rugose Spiralling Whitefly among the INGR 13065 while minimum observed in genotype COD.

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

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

Centers: Bhubaneswar

A field experiment, comprising of eight different hybrids cross combinations along with one tall cultivar (CRP 509) as a check was initiated during November, 2005 at Bhubaneshwar in RBD with four replications for evaluation of yield, quality and tolerance to biotic and abiotic stresses **(Table 12).** Data with respect to plant girth, number of functional leaves, number of buttons and nut yield revealed significant variation among different cross combinations. Total number of female flower per palm exhibited significant differences among the hybrids evaluated. The highest numbers of female flowers per palm were observed in ECT × GBGD (286.5) and on par with GBGD × ECT (285.7), GBGD × PHOT (271.9) and ECT× MYD (283.6). Among the different hybrid combinations, the mean nut yield per palm during 2018-20 was significantly higher in ECT × GBGD (99.1 nuts) which was followed by ECT × MYD (86.9 nuts) and par with LCT× COD, GBGD × PHOT, GBGD × ECT and LCT × GBGD.

Table 12: Growth, floral and yield attributes of new cross combinations at Bhubaneshwar (Year of planting: 2005)

Germplasms	Plant height (m)	Plant girth (cm)	No. of functional leaves/palm (nos.)	Annual leaf production (nos.)	No. of inflores cence/ palm/year	No. of female flowers (nos.)	Nut yield (nuts/palm/ year)
Chandra Laksha (LO x COD)	4.4	90.9	33.0	12.7	12.6	271.9	88.1
VHC 1 (ECT x MGD)	4.9	100.4	32.0	12.7	12.7	283.6	93.2
Konkan Bhatye coconut hybrid 1 (GBGD x ECT)	4.3	86.9	31.5	12.8	12.5	271.6	91.3
Gautami Ganga x Kera Chandra (GBGD x PHOT)	4.3	100.5	31.9	12.5	12.5	281.0	90.3
ECT (CRP 509)	4.3	90.5	32.4	12.8	12.7	279.9	87.9
VHC 2 (ECT x MYD)	4.1	90.5	33.6	12.7	12.6	286.5	108.5
Laksha Ganga (LCOT x GBGD)	4.2	87.9	31.1	12.8	12.7	285.7	90.1
KeraSree (WCT x MYD)	4.5	89.2	32.6	12.7	12.6	271.9	90.9
Godavari Ganga) (ECT x GBGD)	4.6	94.6	31.9	12.7	12.5	231.2	80.1
CD (P=0.05)	0.22	4.80	NS	NS	0.21	4.80	

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

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

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

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

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

Aliyarnagar

This trial consists of five locations specific cross combinations, which were planted during 2012 in RBD with four replications as set I. Besides this five location specific hybrid combinations in set I, three new combinations viz., COD x Etamozhi Tall, Kenthali x Etamozhi Tall and WCT x Kenthali were also planted with four replications and six palms per replication along with local check WCT as set II. Data recorded in set I revealed that, COD x WCT recorded minimum palm height (297.2 cm) and maximum was recorded in ALR x MGD (365.7 cm) whereas, the maximum plant girth (95 cm) was noticed in ALR x MGD. The cross combination MGD x ALR was observed to be the earliest to start flowering (34 months). Higher leaf length (535.3 cm), number of leaves (28.5 nos), number of spikelets (36.8 nos) and number of female flowers (17.6 nos) were registered by KTD x ALR. Maximum nut yield was recorded in COD x ALR (97.6 nuts). The cross combination COD x WCT recorded higher whole nut weight (2289.5 g). Maximum de-husked nut weight (906.0 g) and copra weight (199.3 g) were recorded in MGD x ALR. Among the hybrid combinations in Set II, KTD X ET recorded short palm stature by registering lowest palm height of 227.2 cm than other hybrids. KTD x ET also recorded the maximum petiole length (139.4 cm), leaf length (531.8 cm), annual leaf production (11.4 nos), number of spikelts (35.7 nos) and number of female flowers (15.2 nos). The nut yield was recorded maximum in the hybrid KTD x ET (69.7 nuts) followed by COD x ET (59.8 nuts) (Table 13).

Table 13: Yield performance of new location specific hybrids of coconut at Aliyarnagar (Year of planting 2012)

Hybrids (Set I)	No. of spikelet	Nut yield (nuts/palm/ year)	Whole nut weight (g)	De-husked nut weight (g)	Kernel thickness (cm)	Copra weight (g)	Rhinoceros beetle leaf damage (%)
COD x ALR	35.0	97.6	1629.8	844.0	1.3	180.3	5.9
ALR x MGD	35.3	86.5	1691.5	615.5	1.4	163.8	7.4
MGD x ALR	36.2	80.2	2141.3	906.0	1.2	199.3	11.6
COD x WCT	36.7	83.4	2289.5	888.5	1.3	186.8	14.6
KTD x ALR	36.8	86.7	1442.3	723.5	1.4	166.5	8.3
WCT (c)	21.0	44.0	1296.5	604.0	1.2	154.3	9.3
Kalpatharu (c)	27.8	47.3	1034.8	537.0	1.1	141.3	13.7
Mean	**32.7**	**75.1**	**1646.5**	**731.2**	**1.3**	**170.3**	**10.1**
SE d±	**1.9**	**4.0**	**74.8**	**30.9**	**0.1**	**6.7**	**--**
CD (P=0.05)	**4.0**	**8.5**	**158.4**	**65.5**	**NS**	**14.1**	**--**

Yield of MGD x ALR at Aliyarnagar

Ambajipeta

In Ambajipeta centre, six hybrid cross combinations were planted during June, 2011 in RBD with four replications. However due to Helen and Philin cyclones during October and November, 2013, some of the hybrids were adversely affected. Gap filling was done during the month of February, 2014 and the experiment is in bearing stage. The data on growth and yield characters revealed that, the cross combination ECT x PHOT recorded significantly the highest plant height (396.5 cm) and plant girth (123.8 cm). Minimum plant height in GBGD x Cochin China (271 cm), and plant girth was noted in PHOT x GBGD (93.3 cm). ECT x

GBGD noted more number of leaf scars in 1m (15.18 nos). ECT x Cochin China recorded maximum petiole length (175.1 cm). PHOT x GBGD recorded minimum number of days to first flowering (45 months) followed by GBGD x Cochin china (46 months). ECT x GBGD has recorded the highest nut yield (65.4 nuts) and it was on par with all other cross combinations. Lowest yield was recorded in GBGD x Cochin China (37.1 nuts) (Table 14).

Table 14: Growth and yield performance of new location specific hybrids of coconut at Ambajipeta (Year of planting 2012)

Hybrids	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm	Leaf length (cm)	Petiole length (cm)	No. of leaf scars in 1m	Age at first flowering (months)	Nut yield/ palm/ year
ECT x Cochin China	382.2	112.2	11.7	31.0	616.5	175.1	11.3	52.0	57.1
GBGD x Cochin China	271.0	94.9	12.9	28.5	547.3	153.6	13.2	46.0	37.1
ECT x PHOT	396.5	123.8	12.5	28.8	584.7	163.8	11.5	53.0	59.1
GBGD x PHOT	329.5	101.3	11.7	29.7	567.3	161.6	12.8	49.0	50.4
PHOT x GBGD	341.3	94.3	11.7	30.7	577.0	154.3	14.4	45.0	56.7
ECT x GBGD	338.9	93.3	12.2	30.2	572.1	155.8	15.2	48.0	65.5
SE d±	**23.5**	**3.3**	**0.7**	**0.7**	**21.1**	**4.0**	**0.7**	**--**	**4.4**
CD (P=0.05)	**70.9**	**10.1**	**NS**	**NS**	**NS**	**12.0**	**2.2**	**--**	**13.4**

Arsikere

In Arsikere centre, six hybrid cross combinations along with one variety were planted during September, 2012 in RBD with four replications. The experiment is in bearing stage. **(Table 15).** Among the five hybrid combination, the hybrid TPT x MOD and LCOT x MOD were observed to be earliest to start flowering 60 months. The maximum number of nut per palm (76.8) was recorded in hybrid TPT x MYD (76.8 nuts/palm) followed by TPT x MOD hybrid (65 nuts/palm).

Table 15: Growth and yield characters of new location specific hybrids of coconut at Arsikere (Year of planting 2012)

Hybrids	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	Age at first flowering (months)	Inflorescence / palm/year	Nut yield/ palm/year
TPT x PHOT	647.3	129.0	12.3	62	7.0	44.3
TPT x LCOT	679.7	141.9	12.8	65	7.5	61.8
LCOT xMYD	639.4	133.3	12.0	64	8.4	33.3
LCOT x MOD	674.7	133.7	12.4	60	9.3	43.0
TPT x MYD	623.9	123.0	12.1	68	7.4	76.8
TPT x MOD	685.0	143.4	13.1	60	8.8	65.0
TPT	631.3	131.2	12.6	75	5.6	32.3
Mean	33.87	5.88	0.68	3.27	0.12	2.31
SE d±	100.6	17.47	2.01	9.70	0.37	6.87
CD (P=0.05)	10.35	8.80	8.55	10.07	3.25	9.08

Field view of Gen2. Expt. 2 at Arsikere

Bhubaneswar

In Bhubaneswar centre, a field experiment was conducted by taking five location specific cross combinations in RBD with four replications in February, 2008. All the palms in the trial were severely affected by last cyclonic storm "FANI" held on 3rd May, 2019. The current year result revealed that among the different cross combinations tried, the shortest plant height (3.16 m) was recorded in the cross GBGD x Guam followed by the cross combination SKL x COD (3.53 m).Whereas, the maximum plant height (4.18 m) and girth at bole (140.25 cm) were recorded in the cross combination, SKL x GBGD. However, other parameters like no. of functional leaves, annual leaf production rate, leaf length, petiole length, no. of bunches, no. of female flowers and no. of nuts per palms were found statistically non-significant.

Kahikuchi

This field trial was initiated with five location specific cross combinations of coconut along with a check (AGT) during April, 2009 in RBD with six palms per replication. Analysis of the data indicated that the highest plant height (2.9 m), plant girth (161cm) were recorded in AYT x PHOT whereas, maximum leaf production/ year (12 nos), functional leaves/palm (32.6 nos) were observed AGT x PHOT. On the other hand, cross combination AGT x CCNT recorded highest leaf length (480 cm) and petiole length (126 cm). Significantly the highest fruit yield (68.4 nuts) was recorded in AGT x PHOT followed by AGT x MYD (61.8 nuts) whereas, the lowest nut yield (45.6 nuts) was found in local check AGT. The cross combination AGT x PHOT also recorded highest number of inflorescences (10.2 nos) per palm as well as highest number of buttons (25.8 nos) as compared to other crosses (Table 16).

Table 16: Growth and yield characters of new location specific hybrids of coconut at Kahikuchi (Year of planting 2009)

Hybrids	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm	Leaf length (cm)	Petiole length (cm)	Inflorescence / palm	Nut yield/ palm/year
AGT x CCNT	2.3	152	10.9	28.1	480.0	126.0	9.0	56.0
AGT x PHOT	2.7	156	12.0	32.6	463.4	121.6	10.2	68.4
AGT x MYD	2.2	150	11.4	28.0	435.0	110.4	9.1	61.8
Bengal Hazari x AGT	2.5	154	11.7	27.0	460.2	119.6	9.0	57.0
AYT x PHOT	2.9	161	11.9	30.0	470.1	120.0	8.9	53.6
AGT (Local check)	2.7	154	11.9	27.0	452.0	122.5	7.2	45.6
SE d±	0.09	1.15	0.2	0.53	4.17	1.72	0.29	2.50
CD (P=0.05)	**0.19**	**2.41**	**NS**	**1.12**	**8.75**	**3.62**	**0.61**	**5.24**

Mondouri

At Mondouri centre, five location specific hybrid cross combinations were planted along with ECT as local check under RBD in four replications with six palms per replication during 2009. The maximum plant height (469 cm) was recorded in ECT x Java Tall and minimum plant height (189.3 cm) was recorded in LCOT x PHOT. Maximum collar girth (171.7 cm) was recorded in ECT x Jamica. Annual leaf production/palm was recorded maximum (10.7 nos) in ECT x Bengal Hazari, PHOT x LCOT, ECT x Jamica and ECT x Java Tall. Highest (40.0 nos) number of functional leaves per palm was recorded in ECT x Java Tall and minimum (32 nos) was recorded in LCOT x PHOT. It was observed that ECT x Bengal Hazari recorded maximum (8.0 nos) number of inflorescence/palm/year followed by ECT x Java (7.7 nos). Number of female flowers per palm were recorded maximum (85.7 nos) in ECT x Jamica whereas, minimum (27 nos) were recorded in LCOT x PHOT. Maximum nut yield (26.3 nuts) per palm per year was recorded in PHOT x LCOT followed by ECT x Bengal Hazari (25 nuts) whereas, minimum (9.7 nuts) were recorded in LCOT x PHOT.

Ratnagiri

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

among the new coconut hybrids under evaluation. The data reveled that the hybrid CRP-513 x COD recorded maximum plant height (570.4 cm) whereas the lowest plant height (381.33 cm) was in hybrid COD x Pratap. The hybrid CRP-513 x COD recorded maximum plant girth (101.5 cm) whereas the lowest plant girth (78.54 cm) was in hybrid COD x Pratap. The highest annual leaf production (12.5 nos.) was recorded in hybrid CRP-514 x COD. The maximum no. of functional leaves (26.92 nos.) were observed in hybrid CRP-513 x COD. The maximum leaf length was in hybrid CRP-513 x COD (386.2cm) and maximum petiole length was recorded in COD x CRP- 514 (151.2cm) among all the new coconut hybrids under evaluation. Hybrid COD x CRP-514 recorded maximum no. of inflorescence (11.3 cm) whereas lowest in the hybrid COD x Pratap (8.5 nos.). Hybrid COD x CRP-514 recorded maximum no. of buttons (202.8 nos.) whereas the lowest was in COD x Pratap (152.3 nos.). Highest nut yield was recorded in hybrid COD x CRP-513 (86.50 nuts) followed by COD x CRP-514 (81.69 nuts) whereas the lowest was in hybrid CRP-513 x COD (53.7 nuts). Maximum whole nut weight (1318.7g) was recorded in hybrid COD x Pratap and maximum copra weight (169.25 g) was in hybrid COD x Pratap among all the new coconut hybrids under evaluation. Rhinoceros beetle incidence was maximum in hybrid COD x Pratap (9.52%) whereas lowest in the hybrid CRP-514 x COD (7.69%). The generally 1-7 % palms are infected by Rugose Spiralling Whitefly among all the new coconut hybrids of location specific cross combinations under evaluation (Table 17).

Table 17: Yield performance and pest incidence of new location specific hybrids of coconut at Ratnagiri (Year of planting 2006)

Coconut hybrids	No. of inflorescence/ palm/year	Nut yield (nuts/ palm/ year)	Whole nut weight (g)	De-husked nut weight (g)	Copra weight (g)	Rhinoceros beetle incidence (%)	Eriophyid mite incidence (%)	Rugose Spiralling Whitefly	
								% incidence	% intensity
COD x CRP-513	11.0	86.5	1274.3	788.0	163.0	8.7	4.3	8.0	7.9
COD x Pratap	8.5	75.9	1318.8	754.6	169.3	9.5	3.2	6.4	7.9
COD x CRP-514	11.3	81.7	963.8	537.8	94.3	9.1	3.1	5.1	8.2
CRP-513 x COD	9.1	53.8	1151.3	735.0	132.5	8.0	3.7	3.5	5.4
Pratap x COD	9.2	62.3	1247.5	761.3	163.8	8.7	9.3	2.9	5.4
CRP-514 x COD	8.7	65.3	1260.0	790.0	149.3	7.7	23.9	2.9	5.3
Mean	**9.6**	**70.9**	**1202.6**	**727.8**	**145.3**	-	-	-	-
SE d±	**0.7**	**1.4**	**49.4**	**47.7**	**2.8**	-	-	-	-
CD (P=0.05)	**2.2**	**4.3**	**148.9**	**143.6**	**8.6**	-	-	-	-

Veppankulam

At Veppankulam centre, six location specific cross combinations were planted with four replications during 2008. Analysis of data revealed that the cross MOD x WCT beared higher number of nuts which was followed by ADOT x COD (24 nut). Among the five cross combinations, ADOT x COD registered maximum whole nut weight and copra content (940 g and 149 g) (Table 18).

Table 18: Growth and yield characters of new location specific hybrids of coconut at Veppankulam (Year of planting 2008)

Hybrids	Palm height (cm)	palm girth (cm)	No. of functional leaves/palm	Nut (yield/ palm/year)*	Copra content (g/nut)
WCT x Kenthali	535	136	23	30	130
WCT x MOD	650	197	26	34	135
MOD x WCT	640	177	28	45	145
ADOT x COD	550	186	24	38	149

WCT x MGD	643	190	23	28	142
VHC -2 (Local check)	550	173	23	28	144
Mean	**594.7**	**176.5**	**24.5**	**35.5**	**140**
SE d±	**5.24**	**3.90**	**3.29**	**3.67**	**8.32**
CD (P=0.05)	**10.48**	**7.80**	**7.11**	**7.28**	**NS**

Expt. 3: Evaluation of released varieties in coconut

Centers: Ambajipeta and Bhubaneswar

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

Varieties and hybrids under evaluation

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

Ambajipeta

Among the different hybrids and varieties evaluated, Chandra Laksha and VHC-1 produced more number of bunches (13.4 nos). Maximum oil content was recorded in Kera Ganga (68.3 %) which was significantly at par with Godavari Ganga and Chandra Kalpa with 66 % and 67.1% respectively. Double Century recorded minimum oil content (61.3 %) among the varieties evaluated. Total number of functional leaves per palm was more in VHC-2 (34 nos). Godavari Ganga recorded best for yield parameters compared to other varieties with 138.6 nuts/palm/year. Maximum copra content per nut was recorded in Double Century with 230.7g/nut (Table 19).

Table 19: Growth and yield performance of released varieties and hybrids in coconut at Ambajipeta (Year of planting 2002)

Varieties/ hybrids	No. of functional leaves/ palm	No. of spadices / palm	Nut yield/ palm /year	Tendernut water content (ml)	Whole nut weight (gm)	Oil content (%)	Copra content (g/ nut)
Chandra Sankara	31.6	12.0	103.8	340.4	1328.3	65.0	143.3
Chandra Laksha	32.8	13.4	110.7	372.8	1199.5	65.0	217.3
VHC-1	33.3	13.4	121.7	318.0	821.7	61.6	200.3
VHC-2	34.0	13.3	119.5	386.8	1231.0	68.3	179.3
Kera Ganga	32.3	12.7	105.8	339.2	1149.5	64.3	301.3
Laksha Ganga	33.8	12.6	82.6	334.4	1041.0	62.3	163.3
Double Century (C)	31.6	11.7	75.6	375.5	1450.5	61.3	230.7
Godavari Ganga	31.3	11.5	138.6	382.5	1316.3	66.0	225.3
Chandra Kalpa	32.0	11.2	81.8	286.9	1107.8	67.1	152.7
SE d±	**1.0**	**0.4**	**10.6**	**10.9**	**124.2**	**2.3**	**27.1**
CD (P=0.05)	**NS**	**1.3**	**31.7**	**32.7**	**NS**	**N.S**	**81.2**

Field view of released varieties in coconut at Ambajipeta

Bhubaneswar

At Bhubaneswar, this experiment was initiated with three hybrids, two promising varieties and one local check (Sakhigopal-IND 041) in RBD with four replications in August, 2004 **(Table 20).** Among the different hybrids and varieties evaluated, the hybrid, Kera Sankar (WCT x COD) recorded significantly maximum plant height (4.6 m) and number of functional leaves (33.2 nos.). Maximum plant girth (152 cm) was recorded in local check (IND 041), whereas, maximum annual leaf production (12.8 nos.) was observed in Kera Ganga. The hybrid, Kera Sankar (WCT x COD) registered maximum no. of inflorescences (12.4 nos.), no. of buttons (297.2 nos.) and nut yield (97.4 nuts). However, there was no significant variation among different germplasm with respect to leaf length and petiole length.

Table 20: Growth characters of released varieties and hybrids in coconut at Bhubaneswar (Year of planting 2004)

Varieties/ hybrids	Plant height (m)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/palm (nos.)	No. of inflore scences /palm	Nut yield/ palm /year
Kera Ganga (WCT x GBGD)	3.7	131.9	12.8	32.5	12.4	95.5
Chandra Sankara (COD x WCT)	3.3	122.1	12.7	32.6	12.4	93.9
Kera Sankara (WCT x COD)	4.6	140.1	12.7	33.2	12.4	97.4
Kera Chandra(PHOT)	3.6	145.8	12.4	32.2	12.1	76.9
Chandra Kalpa(LCOT)	3.9	149.3	12.5	31.7	12.2	71.6
Sakhigopal (IND 041)(Check)	3.5	152.0	12.6	32.5	11.9	73.8
Mean	**3.8**	**140.2**	**12.6**	**32.5**	**12.2**	**84.9**
CD (P=0.05)	**0.6**	**19.11**	**0.2**	**0.7**	**0.4**	**5.4**

Expt. 4: Evaluation of Tall x Tall coconut hybrids

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

This experimentwas started with the objective to assess five Tall x Tall hybrids, *viz*., LCOT x ADOT, ADOT x ECT, BGR x ADOT, ECTx LCOT and WCT x TPT at various agro-climatic regions. The hybrids were produced at CPCRI, Kasaragod and supplied to eight AICRP (Palms) centres for evaluation in RBD with three replications and six palms per hybrid per replication.

Aliyarnagar

This experiment was initiated at Aliyarnagar during 2011. The data revealed that the cross, WCT x TPT was significantly observed as short statured one with minimum palm height (405.4 cm) with more number of leaves (27.1 nos), high rate of annual leaf production (11.5 nos), more number of spikelets (34.8 nos), number of buttons (20.5 nos) and nut yield (62.3 nuts). The cross BGR x ADOT recorded highest whole nut weight (1924.8 g), de-husked nut weight (739.0g) and copra content (186.5 g) (Table 21).

Table 21: Yield performance and pest incidence of Tall x Tall coconut hybrids at Aliyarnagar (Year of planting 2011)

Hybrids (T x T)	Nut yield/ palm/ year	Whole nut weight (g)	De-husked nut weight (g)	Kernel thickness (cm)	Copra weight (g)	Rhinoceros beetle leaf damage (%)
LCOT x ADOT	52.5	1652.3	657.5	1.3	173.0	18.3
ADOT x ECT	59.4	1519.0	601.5	1.3	152.8	21.5

BGR x ADOT	51.9	1924.8	739.0	1.3	186.5	16.8
ECT x LCOT	58.7	1497.0	692.8	1.2	171.5	12.9
WCT x TPT	62.3	1500.0	547.5	1.4	147.8	11.8
WCT (c)	40.3	1127.5	576.3	1.2	162.5	10.5
Kalpatharu (c)	38.3	967.8	483.3	1.1	139.8	14.6
Mean	**51.9**	**1455.5**	**614.0**	**1.3**	**162.0**	**15.2**
SE d±	**8.8**	**59.1**	**30.5**	**0.1**	**9.1**	**--**
CD (P=0.05)	**NS**	**125.1**	**64.5**	**NS**	**19.3**	**--**

Yield of BGR x ADOT

Ambajipeta

The experiment was initiated during 2011 in RBD with four replications and six palms per hybrid per replication and due to Helen and Philin cyclones in 2013; some of the hybrids were severely damaged and gap filling has been carried out during February, 2014 and the palms are in bearing stage. Significant difference was recorded for palm girth. Lowest plant height was recorded in ECT x ECT cross combination with 387.7 cm while the highest plant height was recorded in ECT x LCOT (454.7 cm). However, the maximum stem girth was recorded in the cross combinations ADOT x ECT (126.7 cm) and BGR x ADOT (124.3cm). Hybrid LCOT x ADOT recorded highest number of inflorescences/palm (8.6 nos) followed by WCT x TPT (8.4 nos). LCOT x ADOT cross combination recorded 72.4 nuts) followed by WCT x TPT (67.7 nuts) respectively (Table 22).

Table 22: Growth and yield performance of Tall x Tall coconut hybrids at Ambajipeta (Year of planting 2011)

Hybrids (T x T)	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	No. of functional leaves/ palm	Leaf length (cm)	Petiole length (cm)	Inflores cence/ palm/ year	Nut yield/ palm/ year
LCOT x ADOT	432.1	110.8	12.7	31.0	602.0	165.5	8.6	72.4
ADOT x ECT	407.6	126.7	12.2	29.4	603.9	168.8	7.5	46.7
BGR x ADOT	401.3	124.3	12.2	30.8	640.3	183.0	7.9	51.5
ECT x LCOT	454.7	120.7	12.5	29.1	583.5	165.9	7.2	47.5
WCT x TPT	453.3	104.6	11.7	30.3	629.4	173.7	8.4	67.7
ECT (c)	387.7	113.7	12.9	28.2	598.8	165.6	8.4	44.1
SE d±	**21.2**	**3.3**	**0.8**	**0.8**	**12.4**	**5.3**	**0.4**	**5.6**
CD (P=0.05)	**NS**	**9.8**	**NS**	**NS**	**NS**	**NS**	**NS**	**16.9**

Arsikere

The trial was initiated during 2012 at Arsikere. Analysis of data on morphological parameters revealed that, the hybrid cross combination LCOT x ADOT has significantly recorded highest in plant height (664 cm), plant girth (156 cm) , total leaf length (302.6 cm) , petiole length (201 cm), annual leaves per palm (14.0), functional leaves (15.6) as compared to other combination. Among the 5 hybrids cross combination with local check under evaluation, the cross combination LCOT x ADOT has produced significantly higher number of inflorescence (8.5 no/palm), number of bunches per inflorescence (6.3) and number of nuts per palm (78.3 nuts/palm) followed by BGR x ADOT.

Table 23: Growth characters of the Tall x Tall coconut hybrids during 2019-20

Treatments	Plant height (cm)	Plant girth (cm)	Annual leaf production/ palm	Total leaf length(cm)	No. of bunches/palm	No. of Nuts / palm
WCT x TPT	590.5	133.8	13.1	300.5	4.8	27.3
LCOT x ADOT	664.0	156.0	14.0	302.6	6.3	78.3
BGR x ADOT	564.0	141.3	12.7	285.5	5.1	40.9
ECT x LCOT	569.0	152.5	13.3	291.1	4.4	30.6
ADOT X ECT	558.3	130.6	12.9	294.1	3.8	27.0
Check (TPT)	601.5	142.3	13.7	293.3	4.3	39.9
S. Em±	20.9	5.7	0.23	7.48	0.69	10.48
CD @ 5%	63	17.18	0.7	22.55	2.09	31.59
CV%	7.07	7.99	3.51	5.08	4.8	27.3

Bhubaneswar

The experiment was initiated to evaluate five different Tall x Tall cross combinations along with one local check (Sakhigopal Tall-IND 041) in RBD with four replications in June, 2013. (Table 24). The result revealed that the minimum plant height (6.8 m) and plant girth (150.6 cm) were recorded in ECT X LCOT cross. The maximum number of leaves (30.6 nos.) as well as the annual leaf production (12.6 nos.) was recorded in BGRT x ADOT cross. But the crosses under evaluation did not differ significantly with respect to leaf length, petiole length, rate of production of inflorescence, no. of buttons and nut yield.

Table 24: Growth and yield performance of Tall x Tall coconut hybrids at Bhubaneswar (Year of planting 2013)

Hybrids (T x T)	Plant height (m)	Plant girth (cm)	Annual leaf production (nos.)	Leaf length (m)	Petiole length (cm)	No. of inflorescences/ palm	Nut yield/ palm/ year
WCT x TPT	8.5	150.0	12.1	5.1	141.4	8.9	35.6
LCOT x ADOT	7.3	145.8	12.5	4.8	142.6	9.3	33.9
BGRT x ADOT	7.8	145.7	12.6	4.8	143.8	7.0	42.3
ECT x LOCT	6.8	150.6	12.5	4.8	142.1	6.8	23.4
BENT x ADOT	7.2	139.3	12.3	5.0	112.7	6.6	28.2
IND 041	7.3	137.9	11.8	4.9	140.5	8.6	28.6
Mean	**7.5**	**144.9**	**12.3**	**4.9**	**137.2**	**7.9**	**32.0**
C.D (P=0.05)	**0.6**	**7.6**	**0.42**	**NS**	**NS**	**NS**	**NS**

Kahikuchi

Field experiment on Tall x Tall cross combinations was initiated at Kahikuchi during June, 2013 and designed as RBD with four replications. Among the different crosses, the highest plant height (590 cm), plant girth (129.8 cm), functional of leaves (26 nos), petiole length (122 cm) and leaf length (326 cm) were observed with LCOT x ADOT whereas, the hybrid ADOT x ECT recorded the lowest values for the above characters. With regard to age of first flowering, minimum months (65 months) was recorded by BGR x ECT and the maximum months (73 months) was taken by ADOT x ECT. Some of the crosses are now started bearing and hence fruit yield in the range of 10-15 nuts/palm/year were recorded (Table 25).

Table 25: Growth characters of Tall x Tall coconut hybrids at Kahikuchi (Year of planting 2013)

Hybrids (T x T)	Plant height (cm)	Plant girth (cm)	No. of functional leaves/palm (nos.)	Leaf length (cm)	Petiole length (cm)	Age at first flowering (months)
LCOT x ADOT	590.0	129.8	26.0	326.0	122.0	72
ADOT x ECT	467.0	120.0	20.3	286.0	108.0	73
BGR x ADOT	473.0	124.5	21.0	317.0	114.7	65
ECT x LCOT	577.0	124.0	22.4	297.0	116.5	70
WCT x TPT	561.0	121.6	22.6	298.0	110.4	71
Kamrupa (c)	566.0	122.4	20.6	306.0	113.8	72
SE d±	**7.91**	**1.10**	**0.37**	**3.39**	**1.38**	**0.78**
CD (P=0.05)	**16.62**	**2.31**	**0.77**	**7.12**	**2.83**	**1.63**

Field View of T x T hybrids at Kahikuchi

Navsari

The field experiment on Tall x Tall cross combinations was laid out under RBD with four replications during July, 2013 at Navsari. The result revealed that, significantly minimum plant height (194.5 cm) was recorded in WCT x TPT whereas, maximum collar girth (199.5 cm) with highest leaf length (539.5 cm) were recorded in (ADOT x ECT). Functional leaves on crown were recorded maximum (25.5 nos) in ECT x LCOT and at par with BGR x ADOT (24.5 nos). The BGR x ADOT were counted minimum age at first flowering (39 months) with maximum numbers of inflorescence per annum (10.3 nos), nut yield/palm/year (41.3 nuts). Regarding to reaction of biotic stresses, 3-3.30% and 25-31% palms of all genotypes are infected by rhinoceros beetle and eriophyid mite respectively moreover, there is no any other infestation of pests and diseases was observed in the experimental plot (Table 26).

Table 26: Growth and yield performance of Tall x Tall coconut hybrids at Navsari (Year of planting 2013)

Hybrids (T x T)	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	Leaf length (cm)	Petiole length (cm)	Age at first flowering (months)	Inflore scence / palm	Nut yield/ palm/ year	Rhinoceros beetle incidence (%)	Eriophyid mite incidence (%)
BGR x ADOT	257.8	176.0	9.0	495.0	149.0	39.3	10.3	41.3	3.1	25.1
LCOT x ADOT	213.0	178.8	8.8	473.3	144.8	50.3	8.3	19.3	3.3	31.0
ECT x LCOT	317.8	184.0	8.0	495.3	146.5	39.0	9.3	36.5	3.0	26.1
WCT x TPT	194.5	109.3	8.3	474.3	141.8	41.3	10.1	40.0	3.3	28.1
ADOT x ECT	299.5	199.5	8.0	539.5	148.8	42.3	10.0	28.3	3.2	26.3
Mean	**256.5**	**169.5**	**8.4**	**495.5**	**146.2**	**42.4**	**9.6**	**33.1**	**3.2**	**27.3**
SE d±	**3.2**	**3.1**	**0.4**	3.2	2.0	1.1	0.4	2.3	-	-
CD (P=0.05)	**9.8**	**9.4**	**NS**	9.6	6.1	3.3	1.3	7.0	-	-

Ratnagiri

The field experiment on five different Tall x Tall cross combinations along with one local check Pratap was laid out under RBD with four replications during August, 2011 at Ratnagiri.The observations growth parameters showed significant differences among the Tall x Tall coconut hybrids. Data showed that the local check (Pratap) recorded maximum plant height (460 cm) whereas among the hybrid the ADOT x ECT showed highest plant height (409.7 cm). The hybrid ECT x LCOT recorded maximum plant girth (119.50 cm) whereas the lowest plant girth (104.4 cm) was in local check (Pratap). The highest annual leaf production (12.7 nos.) was recorded in hybrid ECT x LOCT. The maximum no. of functional leaves (26.3 nos.) was observed in hybrid BGR x ADOT. The maximum leaf length was in local check (Pratap) (367.5 cm) and maximum petiole length was recorded in local check Pratap (157.7 cm). Hybrid WCT x TPT recorded maximum no. of inflorescence (12.5 cm), maximum no. of buttons (200.28 nos.), highest nut yield (64 nuts), maximum whole nut weight (1495 g) and maximum copra weight (182.2 g) among all the among the Tall x Tall coconut hybrids under study. Percentage of Rhinoceros beetle incidence was maximum in hybrid ADOT x ECT (4.54 %) whereas lowest in BGR (Pratap) x ADOT (3.84 %). The percentage of Eriophyid mite incidence was maximum in hybrid ECT x LOCT (38.57 %). The generally 1-5 % palms are infected by Rugose Spiralling Whitefly among all the among the Tall x Tall coconut hybrids under evaluation (Table 27).

Table 27: Yield performance and pest incidence of Tall x Tall coconut hybrids at Ratnagiri (Year of planting 2011)

Coconut hybrids (T x T)	Inflorescence/ palm/ year	Nut yield (nuts/ palm/ year)	Whole nut weight (g)	De-husked nut weight (g)	Copra content (g)	Rhinoceros beetle incidence (%)	Eriophyid mite incidence (%)	Rugose Spiralling Whitefly	
								% incidence	% Intensity
LCOT x ADOT	11.5	55.0	1227.5	702.5	165.8	4.2	-	5.6	4.4
ADOT x ECT	9.3	42.5	1185.0	705.5	142.3	4.5	6.7	3.6	5.7
BGR x ADOT	8.2	45.5	1040.0	548.8	120.0	3.8	-	5.1	5.8
ECT x LCOT	7.3	41.2	1298.8	733.8	162.0	4.0	38.6	3.9	4.6
WCT x TPT	12.5	64.0	1495.0	845.0	182.3	4.2	10.5	4.4	4.5
Pratap (check)	8.1	32.2	1061.3	552.5	113.3	4.0	13.3	5.1	5.0
Mean	**9.5**	**46.7**	**1217.9**	**681.3**	**147.6**	-	-	-	-
SE d±	**0.4**	**2.2**	**30.6**	**30.6**	**3.5**	-	-	-	-
CD (P=0.05)	**1.1**	**6.6**	**92.4**	**92.4**	**10.6**	-	-	-	-

Veppankulam

Five new Tall x Tall cross combinations were planted in RBD during 2011. Among the five new crosses and local check (VHC3), LCT x ADOT expressed the dwarf stature (510 cm) and BGR x ADOT recorded higher number of inflorescence/palm (8 nos) and nut yield (38 nuts). LCT x ADOT recorded higher whole nut weight (950 g and copra content (172 g) (Table 28).

Table 28: Growth and yield performance of Tall x Tall coconut hybrids at Veppankulam (Year of planting 2011)

Hybrids (T x T)	Plant height (cm)	Plant girth (cm)	No. of functional leaves/palm	No. of Inflorescence /palm	Nut yield (nuts/ palm/ year)	Whole nut weight (g)	Copra weight (g)
LCOT x ADOT	510	185	31	7	29	950	172
ADOT x ECT	585	194	33	7	32	930	168
BGR x ADOT	580	236	32	8	38	940	157
ECT x LCOT	725	184	30	6	32	790	145
WCT x TPT	620	233	26	7	32	760	152
VHC -3 (c)	562	245	28	9	28	790	140

Mean	**614**	**218**	**30**	**7**	**31.83**	**842**	**152**
SE d±	**10.38**	**5.04**	**6.74**	**2.54**	**3.01**	**9.74**	**4.05**
CD (P=0.05)	**20.73**	**10.09**	**NS**	**NS**	**6.10**	**19.49**	**8.11**

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

Centers: Ambajipeta, Ratnagiri and Veppankulam

The experiment was laid out in RBD with three replications at six palms per genotype per replication for evaluation of yield and reaction to biotic and abiotic stresses.

List of location specific Tall x Tall coconut hybrids under evaluation

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

Ambajipeta

In Ambajipeta centre, seven location specific Tall x Tall hybrids were planted during 2011. Due to Helen and Philin cyclones in the year 2013, there was mortality in some of the hybrids. Gap filling has been taken up during the month of February, 2014 and the experiment is in bearing stage. Maximum plant height was recorded in ECT x Fiji (392.3 cm) followed by Java Tall x ECT (389.1 cm) while, the lowest plant height of 297.6 cm was recorded in check (ECT x ECT). Maximum girth was recorded in Cochin China x ECT (120.2 cm) minimum plant girth was recorded in ECT x Fiji Tall (104.9 cm). Average number of buttons/bunch was noted maximum in ECT x Fiji Tall (17.8 nos) which was significantly on par with ECT x PHOT (17.6 nos) and LCOT x ECT (15.0 nos). A significantly higher nut yield (63.2 nuts) was recorded in ECT x PHOT followed by ECT x ECT (50 nuts) and ECT x Fiji Tall (48.4 nuts) (Table 29).

Table 29: Growth and yield performance of location specific Tall x Tall coconut hybrids at Ambajipeta (Year of planting 2011)

Hybrids	Plant height (cm)	Plant girth (cm)	Annual leaf production (nos.)	Leaf length (cm)	Petiole length (cm)	Inflore scence / palm	Nut yield/ palm/ year
Java Tall x ECT	389.1	111.6	11.8	565.4	151.9	7.4	39.2
PHOT x ECT	362.6	119.3	10.5	607.7	152.8	7.3	40.1
Fiji Tall x ECT	353.5	110.0	10.9	585.9	141.5	5.5	32.2
LCOT x ECT	346.3	106.3	10.6	579.2	155.2	7.8	55.3
ECT x PHOT	351.2	107.7	10.2	600.5	149.2	7.0	63.2
Cochin China x ECT	375.0	120.2	10.6	620.5	158.6	8.5	47.7
ECT x Fiji Tall	392.3	104.9	11.6	600.8	150.3	8.9	48.4
ECT (C)	297.6	109.2	11.8	566.9	142.4	6.5	50.0
SE d±	**31.2**	**5.6**	**0.7**	**12.6**	**4.0**	**0.6**	**3.7**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**1.9**	**11.3**

Ratnagiri

In Ratnagiri centre, seven location specific Tall x Tall hybrids were planted during 2009 for evaluation. The observations growth parameters showed significant differences among the location specific Tall x Tall coconut hybrids. Data showed that the hybrid PHOT x BGR recorded maximum plant height (474.50 cm) whereas minimum (339.50 cm) was observed in Pratap (local check). The hybrid PHOT x BYR recorded maximum plant girth (115.44cm) whereas the lowest plant girth (81.22 cm) was in local check (Pratap). The average annual leaf production (12.09 nos.) was recorded in all the hybrids. The maximum no. of functional leaves (25 nos.) was observed in hybrid BYR x PHOT. The maximum leaf length was in PHOT x BGR (400 cm) and maximum petiole length was recorded in hybrid PHOT x BGR (164.50 cm). Hybrid BGR x PHOT recorded maximum no. of inflorescence (12.55 cm), maximum no. of buttons (212.50 nos.), highest nut yield (83.07 nuts) among all the location specific Tall x Tall coconut hybrids. The maximum whole nut weight (1453.33 g) was recorded in hybrid LCOT x BGR. The maximum copra weight (175 g) was recorded in hybrid BGR x PHOT. Percentage of Rhinoceros beetle incidence was maximum in hybrid LCOT x BGR (9.52 %) whereas lowest in the hybrid BGR x PHOT (14.70 %). The generally 2-7 % palms are infected by Rugose Spiralling Whitefly among all the location specific Tall x Tall coconut hybrids under evaluation (Table 30).

Table 30: Yield performance and pest incidence of location specific Tall x Tall coconut hybrids at Ratnagiri (Year of planting 2009)

Coconut hybrids (T x T)	No. of inflorescence/ palm	Nut yield (nuts/ palm	Whole nut weight (g)	De-husked nut weight (g)	Copra weight (g)	Rhinoceros beetle incidence (%)	Eriophyid mite incidence (%)	Rugose Spiralling Whitefly (%)	
								% incidence	% intensity
PHOT x BGR	9.2	45.7	1201.7	601.7	150.0	8.7	31.8	7.8	9.6
BGR x PHOT	12.5	83.1	1158.3	750.6	175.0	4.5	13.7	7.4	10.2
PHOT x BYR	11.2	57.7	1108.3	596.6	125.0	4.3	6.6	6.1	9.3
BYR x PHOT	12.2	68.0	1301.7	608.4	141.0	8.7	12.7	5.3	9.1
BGL x PHOT	10.5	60.2	1406.7	565.6	121.0	8.0	22.4	4.6	7.4
PHOT x BGL	9.0	40.4	1385.0	551.7	138.7	9.1	11.5	3.8	4.5
LCOT x BGR	9.7	45.1	1453.3	645.0	137.3	9.5	18.3	2.8	2.5
Pratap (C)	10.9	52.9	1343.3	533.3	110.3	5.3	12.4	3.0	2.5
Mean	**10.7**	**56.7**	**1294.8**	**606.6**	**137.3**	-	-	-	-
SE d±	**0.4**	**1.4**	**20.8**	**20.8**	**3.3**	-	-	-	-
CD (P=0.05)	**1.1**	**4.4**	**63.2**	**63.2**	**9.9**	-	-	-	-

Veppankulam

Seven location specific Tall x Tall cross combinations were planted during, 2009 for evaluation. Among the seven new crosses and local check (VHC-3), the performance of ECT x PHOT was superior in terms of palm height (< 420 cm) i.e. dwarf stature with higher annual nut (41 nuts).

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

Centres: Ambajipeta, Mondouri, Pillcode, Ratnagiri and Veppankulam

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

Ambajipeta

This experiment was initiated at Ambajipeta during 2011. Due to Helen and Philin cyclones in 2013, some of the hybrids were severely affected. Gap filling was done with planting material received from CPCRI, Kasaragod in March, 2014. However, initiated production of COD x MYD seed nuts in 2015 and seed nuts were harvested in 2016. These seedlings were raised in polybags during 2017 and the selected seedlings were planted in experimental plot in 2018. These seedlings were established in the field and are in vegetative stage. Further, the other crosses combinations of the experiment are in bearing stage. Data pertaining to growth attributes and nut yields showed that the mean lowest plant height was recorded in GBGD (217.8 cm) and the maximum was recorded in CGD x MGD (316.6 cm) while the maximum plant girth

was recorded in MYD x CGD cross (104.3 cm). The maximum nut yield (80.4 nuts) was recorded in CGD x MGD cross combination followed by GBGD x MOD (44.9 nuts) whereas, minimum nut yield was recorded in GBGD (27.5 nuts). The number of inflorescences per palm was recorded more in CGD x MGD (7.62 nos) and less was recorded in GBGD x MOD (6.1 nos). Tender nut water content was recorded maximum in CGD x MGD (378 ml) followed by COD x MGD (334 ml) **(Table 31).**

Hybrids (D x D)	No. of inflorescence/ palm/year	Tender nut yield/palm	Quantity of tender nut water (ml/nut)	TSS (°B)	Sweetness of water	Taste of tender nut endosperm
COD x MYD*	-	-	-	-	-	-
COD x MGD	5.0	33.9	334.0	6.3	Good	Good
MYD x CGD	5.4	35.7	313.0	6.2	Good	Good
GBGD x MOD	6.1	44.8	253.0	7.9	Good	Good
CGD x MGD	7.6	80.4	378.0	6.1	Good	Good
GBGD (c)	4.8	27.5	316.8	8.0	Good	Good

Note: * indicates the seedlings damaged due to Helen and Philin cyclones (2013) were replanted during 2018.

Mondouri

The trial was established during 2012 and the palms are nine years old. Analysis of data on morphological parameters revealed that the GBGD X MOD recorded maximum plant height (254.7 cm) and CGD x MGD recorded minimum plant height (149 cm) followed by COD x MYD (154.3 cm). GBGD x MOD recorded maximum collar girth (157 cm), whereas minimum collar girth (83.3 cm) was recorded in COD x MYD. Annual leaf production per palm were recorded maximum (10.7 nos) in COD x MGD whereas minimum (9.0 nos) numbers per palm were recorded in GBGD x MOD. Number of functional leaves per palm were recorded maximum (40 nos) in COD x MGD and minimum (26.7 nos) were recorded in COD x MYD and GBGD x MOD respectively. During this period, no inflorescence, female flowers and nuts were recorded irrespective of any combinations

Pilicode

The trial was initiated during 2014 with a set of five D x D hybrids viz., COD x MYD, COD x MGD, MYD x CGD, GBGD x MOD, CGD x MGD and GBGD as a local check. It is establishment phase. Apart from these five crosses, one more hybrid combination of RARS, Pilicode namely GBGD x CGD was also included. The plot was intercropped with banana. There was no significant difference found between hybrids for the traits, plant height, average number of leaves, plant girth and length of third leaf and fifth leaf. When the hybrid MYD x CGD and check variety GBGD started flowering during fifth year of planting, the hybrids COD x MYD and CGD x MGD started flowering during this 6th year of planting. Regarding pest scoring for rhinoceros beetle, MYD x CGD showed the least infection followed by COD x MGD **(Table 32).**

Table 32: Growth attributes of Dwarf x Dwarf coconut hybrids at Pilicode (Year of planting 2014)

Hybrids (D x D)	Plant height (m)	Plant girth (cm)	No. of functional leaves/palm	Details of flowering	Rhinoceros beetle incidence (%)
COD x MYD	2.88	0.82	11.0	Started flowering	29.9^{ab}
COD x MGD	3.10	1.08	14.7	-	22.6^{bc}
MYD x CGD	3.0	1.07	12.3	Started flowering	18.7^{c}
GBGD x MOD	3.10	0.91	14.0	-	31.0^{a}
CGD x MGD	2.20	0.80	10.3	Started flowering	22.9^{bc}
GBGD x CGD	3.27	0.95	13.3	-	22.5^{bc}
GBGD (c)	2.73	1.09	12.00	Started flowering	29.0^{ab}
C.D. (P=0.05)	NS	NS	NS	-	7.938

Ratnagiri

At Ratnagiri centre, the trial was initiated during 2011 with five D x D hybrids and one check variety (COD). The growth characters showed significant difference among the D x D hybrids under study. The data revealed that the hybrid COD x MYD recorded maximum plant height (340.2 cm) whereas minimum (237.5 cm) was observed in COD. The hybrid MYD x CGD recorded maximum plant girth (80.5 cm) and maximum annual leaf production (12.4 nos.). Maximum no. of functional leaves (25.2 nos.), maximum leaf length in COD x MYD (355 cm) and maximum petiole length in COD x MGD (132.38 cm) among the Dwarf x Dwarf coconut hybrids. Hybrid GBGD x MOD showed early flowering after planting (27.83 months) followed by COD x MGD (28.8 months). Hybrid COD x MYD recorded maximum no. of inflorescence (12.5 cm) and maximum no. of buttons (213.2 nos.). Hybrid GBGD x MOD is a promising cross for the earliness. The hybrid COD x MYD recorded highest tender nut yield (76.7 nuts) followed by the hybrid GBGD x MOD (68.3 nuts) among the entire Dwarf x Dwarf coconut hybrids. Regarding to the quantity of tender nut water (ml/nut), the hybrid COD x MYD recorded maximum volume of tender nut water (602.75 ml/nut). Regarding the Total soluble solids (TSS), the maximum score was recorded in the hybrid GBGD x MOD (5.7 ^{o}Brix). Percentage of Rhinoceros beetle incidence was maximum in MYD x CGD (16.61 %) whereas the lowest was in the hybrid GBGD x MOD (10.56%). The generally 6-19 % palms are infected by Rugose Spiralling Whitefly among the entire Dwarf x Dwarf coconut hybrids under evaluation (Table 33).

Table 33: Yield performance of Dwarf x Dwarf coconut hybrids at Ratnagiri (Year of planting 2011)

Hybrids (D x D)	Age at first flowering (months)	No. of inflorescence/ palm/year	Tender nut yield/ palm	Quantity of tender nut water (ml/nut)	TSS (^{o} B)	Rhinoceros beetle incidence (%)	Rugose Spiralling Whitefly	
							% incidence	% intensity
COD x MYD	32.3	12.5	76.7	602.8	5.2	13.0	19.7	23.4
COD x MGD	28.8	12.0	68.3	395.0	4.9	14.5	17.1	22.0
MYD x CGD	31.6	10.7	69.4	498.8	4.5	16.6	16.0	23.0
GBGD x MOD	27.8	12.2	73.9	426.3	5.7	10.6	10.3	18.0
CGD x MGD	30.0	10.8	58.7	431.3	5	14.9	9.6	10.4
COD (C)	29.5	10.1	53.3	421.3	4.7	11.5	6.5	6.5
Mean	30.0	11.4	66.7	462.5	-	-	-	-
SE d±	0.7	0.3	1.3	9.8	-	-	-	-
CD (P=0.05)	2.1	0.8	3.8	29.4	-	-	-	-

Veppankulam

This trial was started during 2011 at . Among five crosses being evaluated, the cross MYD x CGD stared flowering on 22nd month after planting, which is a promising cross for the earliness. Based on morphological characters recorded, it is revealed that, GBGD x MOD expressed the dwarf stature with less girth (462 cm and 150 cm, respectively) and COD x MGD recorded maximum volume of tender nut water (480 ml). Total Soluble Solids recorded maximum in cross MYD x CGD (6.2^{o} Brix) with higher tender nut yield (40 nuts). Regarding the pest and disease incidence, CGD x MGD has less incidence of both Rhinocerous beetle and Red palm weevil as compared to other crosses (Table 34).

Table 34: Yield and quality attributes of Dwarf x Dwarf coconut hybrids at Veppankulam (Year of planting 2011)

Hybrids (D x D)	Age at first flowering (months)	No. of inflorescence/ palm/year	Tender nut yield (Nuts/palm)*	Quantity of tender nut water (ml/nut)	TSS (°B)	Organoleptic score
COD x MYD	33	5	32	380	5.6	3
COD x MGD	32	5	26	480	5.4	3
MYD x CGD	22	6	30	350	6.2	4
GBGD x MOD	26	6	32	340	5.4	3
CGD x MGD	28	7	31	345	5.6	3
COD (c)	36	7	30	320	6.1	4
Mean	**29.5**	**6.0**	**30.7**	**369.2**	**5.7**	
SE d±	**2.64**	**1.98**	**2.82**	**8.94**	**-**	**-**
CD (P=0.05)	**5.29**	**NS**	**5.65**	**17.88**	**-**	**-**

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

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

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

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

Aliyarnagar

The demonstration block consisting of ten coconut varieties and hybrids namely Kalyani coconut hybrid 1, Gautami Ganga, Konkan Bhatye hybrid, Kerakeralam, Kera Bastar, Kalpa Prathiba, Kalpa Mitra, Kalpa Raksha and Kalpa Dhenu released by different AICRP centres and CPCRI, Kasaragod was established during 2011 . The primary aim of this demonstration block to showcase the performance of released cultivars in different agro-climatic situations. The demonstration block comprised of ten genotypes and one local check with ten palms per genotype.

Ambajipeta

The observations on growth parameters revealed that the minimum plant height (267.4 cm) was recorded in Gautami Ganga and the maximum plant height (502.7 cm) was recorded on Kera Bastar. The Kalpa Mitra recorded highest nut yield (75 nuts) followed by Kalpa Samrudhi (70.7 nuts) and Konkan Bhatye Coconut Hybrid-1 (67.2 nuts) .

Bhubaneswar

This experiment was laid out in June, 2013 by taking ten released varieties with one local check as un-replicated trial. It was observed that among the ten cultivars, Cochin China performed better in growth parameters. It recorded maximum plant girth at base (168.50 cm), number in functional leaves (19.25/palm), no. of leaves/ palm/year (6.50), leaf length (5.27 m) and petiole length (155.33 cm). Whereas, the shortest plant height (2.20 m) was recorded in Fiji Tall followed by MGD (2.26 m). In case of yield contributing characters, the genotype Fiji Tall performed better by producing maximum numbers of bunches/palm (6.00) and nuts/palm (22.00). However, maximum number of female flowers (145.40/palm/year) was observed in GBGD x ECT. All the palms in the trial fail to perform as per their potency due to cyclonic hit "FANI" on 3rd May, 2019.

Jagdalpur

The perusal of data revealed that the Kalyani Coconut hybrid 1 recorded maximum plant height, petiole length,

leaf length and plant girth. The number of leaves was at par in Gautami Ganga, Konkan Bhatye coconut hybrid-1, Kalpa Mitra and Kalyani coconut hybrid 1 (18.8 nos, 16.1 nos, 15.9 nos, 15.9 nos respectively) whereas the petiole length (161 cm, 157 cm, 151.5 cm and 149.4 cm respectively) and plant girth (130.5 cm, 139 cm, 137 cm and 138.7 cm) of Kera Bastar, Kalpa Mitra, Kalpa Dhenu and Kalyani coconut hybrid 1 were at par .

Kahikuchi

Planting of all the ten coconut varieties/hybrids at Kahikuchi was completed during July, 2013. Morphological characters of the varieties hybrids were recorded. Highest values in respect of plant height (549cm), plant girth (127 cm), no.of functional leaves (25.8 nos) and leaf length (371 cm) were recorded in Kera Baster. While the lowest values for the above characters were observed in Kalpa Raksha. Among the varieties/hybrids, hybrid Kalpa Samrudhi recorded early first flowering which was 68 months from date of planting .

Mondouri

The trial was initiated with ten released varieties of coconut and one local check as un-replicated observational trail in 2012. Out of 10 released varieties, the five varieties were planted in 2012 and rests of five were planted in 2014. From the data revealed that the Kera Keralam recorded maximum plant height (278.7 cm) followed by Kera Baster (274 cm) whereas, Gautami Ganga recorded minimum plant height (121.7 cm). and Kalpa Rakshak both are recorded maximum (10.7 nos) number of annual leaf production per palm. Kera Bastar recorded maximum (7.3 nos) numbers of inflorescence/ year followed by Konkan Bhatye coconut hybrid 1 and Kalpa Dhanu recorded minimum (1.7 nos) number of inflorescence during this time.

Navsari

Experiment was laid out during July, 2013 as a demonstrational trial on different released varieties/ hybrids at Navsari. Minimum plant height (155.7 cm) and collar girth (82.3 cm) was recorded in Konkan Bhatye Coconut Hybrid 1 while, annual leaf production (10.3 nos), functional leaves on crown (34.3 nos), inflorescence/palm (11 nos) and nut yield/palm/year (46.3 nuts) were recorded maximum in Kalpadhenu. However, the maximum leaf length (511.7 cm) and petiole length (127.7 cm) was measured in Kalpa Prathiba. The Kalpa Samrudhi flowered at the age of 40th months after planting as compared to other released varieties/hybrids of coconut.

Ratnagiri

The field trail was initiated with ten released varieties of coconut as un-replicated observational trail in 2011. The maximum plant height recorded in Kera Bastar (401.11 cm) whereas minimum in Gauthami Ganga (194 cm), maximum plant girth was in Kerakeralam (108.20 cm) and the average no. of annual leaf production were (12.25 cm) among the different nationally released coconut varieties/hybrids. The maximum total no. of functional leaves/palm was in Kalpamitra (27.70 nos.). The coconut variety Gauthami Ganga recorded maximum no. of inflorescence (13 nos.) and no. of buttons in Konkan Bhatye hybrid 1 (178.33 nos.). The variety Konkan Bhatye hybrid 1 recorded maximum nuts yield (67.5 nuts), maximum whole nut weight in Kalpadhenu (1637 g) and maximum copra weight in Kalpadhenu (161 g) among the different nationally released coconut varieties/hybrids under study. Percentage of Rhinoceros beetle incidence was highest in Kalpamitra (10.71 %). The highest Rugose Spiralling Whitefly incidence was in Kalyani hybrid 1 among the entire varieties/hybrids under evaluation.

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

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

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

Varieties for large scale multiplication

Centre	Genotypes
Aliyarnagar	ALN (CN) 1, Tiptur Tall, Kalpa Pratibha, Kerakeralam, COD, KTD, MYD, GBGD, MGD and San Raman
Ambajipeta	Gautami Ganga, Kalpa Pratibha and Kera Bastar
Arsikere	COD, GBGD, MYD, MOD, Fiji Tall, Kulashekaran Green, MGD, ECT and Kalpatharu
Jagdalpur	Kera Bastar
Kahikuchi	MYD and Kamrupa

Mondouri	Kalyani coconut hybrid 1,Kalpamitra, Kerakeralam
Pilicode	Existing dwarf varieties: MYD, MGD, MOD, GBGD, COD, CYD, CGD, SSA, Gudanjali New collection dwarf varieties: Chulliyode, Mannukusumbil 2, Azheethala, Nirvaram, Thonnooran, Chakkittapara local, Sannagi, Pulpally
Port Blair	CARI - Annapurna,CARI- Omkar, CARI-Surya, CARI-Chandan
Ratnagiri	Gautami Ganga,East Coast Tall, Kera Bastar
Veppankulam	Kerakeralam, Kalpa Pratibha

Aliyarnagar

The quality seed nuts were harvested from the mother palms of West Coast Tall in a phased manner and sown in the nursery regularly and elite seedlings produced are distributed to the farmers. The nucleus seed gardens Kalpa Prathiba, Kalpa Shatabdi, Tiptur Tall, MGD, MYD, MOD and were planted in this are in establishment stage. During 2020, 6520 seedlings of WCT, 4870 seedlings of ALR 1, 5290 seedlings of COD and MYD, 2640 seedlings of Kenthali dwarf and 1352 seedlings of Chandra Sankara hybrids were distributed to the farmers from the mother palms and crossing blocks maintained at the centre.

Mother block of Kenthali Dwarf (Aliyarnagar)

Ambajipeta

Under this project multiplication of Gautami Ganga, Kera Bastar and Kalpa Prathiba was allotted for Ambajipeta. During 2013-14, the *inter se* crossed seedlings of Gauthami Ganga (300nos.) and Kalpa Prathibha (150 nos.) were planted at Horticultural Research Station, Ambajipeta for future production of quality planting material. However, instead of Kera Baster, variety Double century plantation was maintained to take up the production of newly released coconut hybrid Vasishta Ganga (GBGD x PHOT) and Vainateya Ganga (PHOT x GBGD) and large scale production of Godavari Ganga (ECT x GBGD) and Gautami Ganga (a selection of GBGD).

Arsikere

The coconut nucleus seed garden block consisting of varieties viz., COD (50 nos.), GBGD (50 nos.), MYD (40 nos.), MOD (40 nos.), Fiji Tall (10 nos.), Kulashekaran Green (25 nos.), MGD (15 nos.), ECT (15 nos.) and Kalpatharu (50 nos.) have been established at Arsikere. The demonstration block consist of 6 variety was established during 2013 and with the objective is to production of improved variety of coconut and distribution to Karnataka farmers.

Mother block of COD (Arsikere)

Jagdalpur

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

Kahikuchi

As the female parent for the hybrid MYD x WCT is limited at the centre, a mother block of MYD with 25 palms has been planted in the field. Simultaneous hybridization programme of the above cross is also being done to produce planting materials. Inter-*se*

crossed seedlings of Kamrupa (150 nos.) were planted at the Kahikuchi centre during 2010 for establishment of nucleus seed garden. Growth of the seed garden is satisfactory. Most of the palms have already been started flowering.

Mondouri

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

Pilicode

A six years old seed garden of dwarf coconuts comprising 20 dwarf genotypes which include 10 existing dwarf genotypes namely, MYD, MGD, MOD, GBGD, COD,CYD,CGD, SSA, Sannagi and Gudanjali and 10 new dwarf ecotypes collected from various districts of Kerala namely, Chulliyode, Mannukusumbil-2,Azheethala, Nirvaram, Thonnooran, Chakkittapara local, Pulpally, Kanichikulangara, Achankollyand Thondupali were established in 2017.

Port Blair

With the objective to reproduce the improved varieties of coconut for distribution to island farmers, nucleus seed garden was established in the Garacharma farm of the Institute. For production of quality planting material of improved varieties of coconut viz., CARI-Annapurna, CARI-Omkar, CARI-Surya and CARI-Chandan were planted at Port Blair during 2017 and the mother palm blocks are in establishment phase.

Ratnagiri

For large scale multiplication of newly released coconut hybrids and varieties, the mother palms of released varieties are planted on large scale in the orchard. About 175 seedlings each of ECT and GBGD and 290 seedlings of Fiji Tall have been planted for establishment of mother palm garden.

Mother block of GBGD (Ratnagiri)

* * * * *

4.2 CROP PRODUCTION

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

Sabour

Treatments details:

T_1: No fertilizer; T_2: 25% Recommended dose of fertilizer (RDF) (NPK) through drip system; T_3: 50% RDF (NPK) through drip system; T_4: 75% RDF NPK through drip system; T_5: 100% RDF (NPK) through drip system; T_6: 100% RDF (NPK) through soil application; Recommended dose of fertilizer (g): N: P: K- 500:320:1200; No. of split doses: 8; No. of replications: 4; No. of plants/treat./replication: 4.

Variety: Shakhigopal

Experiment was comprised of six fertigation level with four replications. The fertigation with different doses of fertilizers were found significant with respect to plant growth parameters of palms. The maximum collar girth (220.0 cm), number of functional leaves (28.0/ plant) and annual leaf production (11.0 per plant) was recorded in T_5 (100% RDF fertigation) followed by T_4 (fertigation at 75 % RDF) having collar girth of 200.0 cm, 25.8 number of functional leaves and annual leaf production of 10. It was noted that plant under T_5 (75 % RDF through fertigation) produced maximum number of inflorescences (10 /plant) during the year which was at par with T4 (100% RDF fertigation). The minimum inflorescence was noted in control i.e. T_1 (without fertigation). Similarly number of fruit per bunch and nut yield per plant was also found highest with T_5 (100% RDF fertigation) with 9.2 nuts per bunch and nut yield of 58.2 nuts per palm. It was followed by T_4 (75 % RDF through fertigation) and significantly minimum yield was recorded in T_1 (without fertigation) with 5.3 inflorescence production /palm with yield of 7.2 nuts per bunch and 32 nuts a yield per palm.

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

Objectives:

1. To develop location specific Coconut - Livestock integrated farming system models
2. To study the effect of integration of livestock on the productivity of coconut
3. To assess the impact of integration of livestock on soil fertility and plant nutrient content in coconut.
4. To workout the economics of the model

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

Arsikere

Treatment details:

T_1: Coconut + fodder crops – cows

T_2: Monocrop of coconut

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

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

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

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

The experiment was laid out during September 2013 on 0.40 ha area. The rooted slips of Napier grass (Co-3) were planted in the inter space of coconut at a spacing of 90 cm × 60 cm. Fodder legume- *Stylosanthes hamata* was sown in the interspaces of coconut on during 2013. The fodder trees- Drumstick and *Sesbania grandiflora* 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 (Table 35).

The integrated farming system with coconut, fodder and cows has recorded number of nuts 7,056/- per acre and higher copra content 150.6 g per nut as compared to monocrop during 2019-20. A total 2 calves were produced during this year. The coconut based integrated farming system has found remunerative over monocrop of coconut. The IFS model has recorded a highest net return Rs. 2,93,696/- per acre compared to monocrop (Rs. 81,640/-per acre).

Table 35: Growth and yield of coconut in the Coconut - Livestock integrated farming system (Arsikere)

Parameter	Pre-expt. Period (2011-13*)	2019-20	
		IFS	Monocrop
No. of leaves on the crown	31.3	30.4	31.0

No. of bunches per palm	12.3	12.7	12.8
No. of buttons per palm	250.4	248.9	240.3
Nut yield per palm	103.8	100.8	97.0
Copra content (g/nut)	143.0	150.6	148.3
Copra yield per palm (kg)	14.85	15.18	14.3
Oil content (%)	65.4	67.50	66.0
Oil yield per palm (kg)	9.73	10.26	9.52

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

Arsikere

Treatment details:

T_1: Coconut + pasture crops – sheep

T_2: Monocrop of coconut

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

The experiment was laid out during May 2014 on an area of 0.40 ha. The pasture crops were sown in the interspace of coconut during May 2014. The establishment and growth of pasture is satisfactory. The sheep were allowed to graze the pasture from November 2014. The production of pasture, sheep and sheep manure have been quantified.

Integrated farming system with coconut, fodder and sheep recorded more number of nuts during the period. A total of 18 lambs were produced during this year. Integrated farming system with coconut recorded higher net returns of Rs. 1,30,916/- per Acre when compared with Rs. 36,060/- per Acre in coconut monocropping.

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

Centres: Aliyarnagar and Veppankulam

Treatment details:

T_1: Coconut + fodder trees + pasture crops – goat

T_2: Monocrop of coconut

Aliyarnagar

The experiment was initiated in 2015. Annual leaf production, total number of leaves and total number of inflorescence per palm were higher in IFS (T_1) plots compared to monocrop of coconut (Table 36). Total of 18,780 nuts per ha per year and 7,200 kg of fodder were realized from one ha coconut (Table 37). Six lambs were laid by the goats during this period. Goat droppings were collected periodically and applied to coconut. Integration of coconut with pasture crops (*Cumbu Napier hybrid* + *Desmanthus*), fodder trees (*Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia)* and Telicherry breed of goats recorded gross income of Rs. 3,18,400/- per ha as compared to Rs. 2,03,400/- per ha in the monocrop of coconut (Table 37).

Table 36: Growth and yield of coconut on integration of goat in coconut based cropping system (Aliyarnagar)

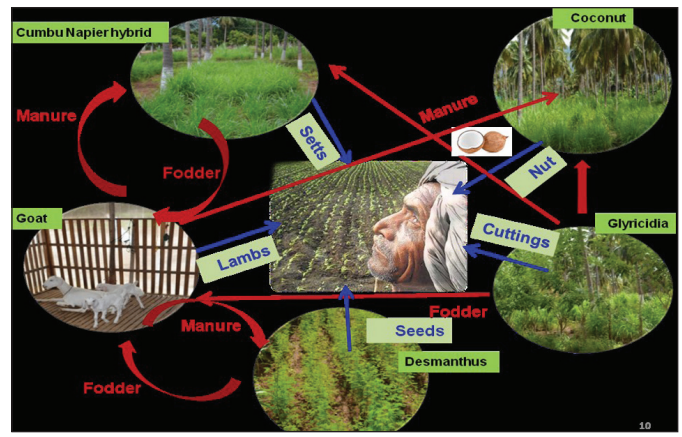
Parameter	Pre-expt. period	Experimental period	
	2015-16	2020	
		IFS (T_1)	Monocrop (T_2)
Annual leaf production	12.0	12.0	11.0
Total leaves (Nos.)	34.9	35.0	34.4
Total Inflorescence (Nos.)	10.5	12.0	11.0
Mean Nut yield (Nut/Palm/Year)	130	138	124

Table 37: Output from the Coconut based Integrated Farming System with goat (Aliyarnagar)

Output (ha)	2020	Remarks	Gross Returns (Rs./ha)	Net Returns (Rs./ha)
IFS (T_1)				
Coconut nut yield	19,780	Avg. sale price @ Rs. 12/ nut	2,37,360/-	-
Pasture production	11,300	Grazed by goats	--	-
Goat manure	7,200	Applied manure in coconut basins.	21,600/-	-
Lamb production (Does -3, Bucks -9)	12	Weight 160 kg (Rs. 250/- per kg)	40,000/-	-
		Total	**2,98,960/-**	**2,05,420/-**
Monocrop (T_2)				
Coconut nut yield	18,820	Avg. sale price @ Rs. 12/ nut	**2,25,840/-**	**1,25,640/-**

Field view of IFS Trial

Stall feeding of goats



Resource Flow in IFS Trial

Veppankulam

The fodder crops were raised under irrigated condition. The goat manures are used to partly supplement the nutrient requirement of coconut palms and grasses. The nut yield recorded in IFS model was 11,638 nuts per ha per year, whereas in monocrop it was 10,745 nuts per ha per year (Table 38). The nut yield recorded in IFS was 8.2% higher than that in monocrop. Minor differences in functional leaves / tree were noticed between IFS and monocrop plots. However, with respect to number of inflorescence / tree, IFS plot recorded 9.6% higher values

than those palms under monocropping. In goat rearing, 15 goats with live weight of 286.3 kg were sold out and 9 lambs were produced during the period.

Table 38: Growth, nut yield and output production of coconut in integration of goat in coconut based cropping system (2019-2020) (Veppankulam)

Parameters	IFS model plot (T_1)	Coconut monocrop (T_2)
No. of functional leaves / tree	27.5	28.0
No. of inflorescences / tree	10.3	9.4
Mean nut yield (nos./ tree/ year)	66.5	61.4
Coconut nut yield (nos./ ha/year)	11,638	10,745
Pasture production (kg)	1,820	-
Goat manure (kg)	2,960	-
No. of new born lambs	9	-
No. of goats sold	15 (379 kg live weight)	-

In the Integrated farming system, fodder and pasture crops had a total fodder yield of 5,400 kg during the reporting period, which was used to feed the goats reared in the IFS component of this treatment. Due to sale of goats, an additional revenue of Rs. 1,25,070/- was realized. The cost of maintenance of goat along with additional feed was Rs. 40,380/- and hence a net income of Rs. 1,13,996/- was realized. This is totally an additional income in this treatment over monocrop of coconut (Table 39).

Table 39: Economics of coconut based integrated farming system with goat (2020) (Veppankulam)

Treatment	Quantity	Gross income (Rs.)	Cost of cultivation (Rs.)	Net income (Rs.)	Remarks
IFS (T_1)					
Coconut nut yield (No./ha)	11,638	1,39,656/-	1,10,350/-	29,306/-	Average sale price of Rs.12/- per nut
Pasture production (kg)	5,400				Used as feed for the goats reared in IFS
Goat manure (kg)	2,960				Used for coconut as organic input
Goat sale	15 nos. (379 kg live wt.)	1,25,070/-		84,690/-	Sale price of goat @ Rs. 330/- per kg of live weight
Goat feed and maintenance			40,380/-		
Total		**2,64,726**	**1,50,730/-**	**1,13,996/-**	
Mono crop (T_2)					
Coconut nut yield (No. ha)	10,745	1,28,940/-	1,08,850/-	20,090/-	Average sale price of Rs.12/- per nut

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

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

Centres: Kahikuchi and Mondouri

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

Kahikuchi

The trial was initiated during September 2009 with five pepper varieties *viz*., IISR- Thevam, IISR- Shakti, IISR- Malabar Excel, Sreekara and Panniyur-1. Planting material of the above varieties was planted in main field under coconut garden on 10th September, 2009 following randomized block design replicated four times. Six numbers of palms were taken for each variety in each replication.

Pre-experimental yield data of coconut for last three years was recorded, which ranged from 50 to 55 nuts/ palm/ year. Results of the experiment showed that the highest vine length of 6.5 m and vine girth of 8.2 cm were observed in Panniyur-1, whereas lowest vine length (5.6 m) and vine girth (7.0 cm) was observed in IISR- Sakthi. With regard to number of laterals per vine among the varieties, the highest number of laterals (32.0 at one m column) was recorded in Sreekara followed by Panniyur-1 (29.1) and the lowest of 26.4 laterals was found in IISR- Malabar Excel. Among the varieties/ hybrids, Panniyur-1 recorded significantly higher number of spikes (115.0 in one meter column height), spike length (15.0 cm), number of berries per spike (72.0), dry recovery (35.6%) and yield of 1.60 kg/vine (pooled over 6 years) compared to other varieties/ hybrid.

An assessment of economics of pepper varieties as mixed crop in coconut garden revealed that Panniyur-1 gave the highest net returns (Rs. 2,50,903/- per ha) as well as B:C ratio of 3.73 followed by Sreekara (Rs. 2,21,776/- per ha, B:C = 3.30) and the lowest net returns (Rs. 1,84,846/ ha) and B:C ratio (2.72) was observed in IISR- Malabar Excel (Table 40).

Table 40: Economics of black pepper varieties as mixed crop in coconut garden

Pepper varieties	Yield of coconut (nuts/ha)	Gross income (Rs.)	Cost of production (Rs.)	Net income (Rs.)	Benefit-cost ratio
IISR-Thevam	9,625	2,57,775/-	68,024/-	1,88,701/-	2.79
IISR-Sakthi	9,975	2,61,825/-	68,024/-	1,93,801/-	2.85
IISR- Malabar Excel	9,538	2,52,870/-	68,024/-	1,84,846/-	2.72
Sreekara	9,100	2,93,100/-	68,024/-	2,21,776/-	3.30
Panniyur-1	10,238	3,21,570/-	68,024/-	2,50,903/-	3.73

Rate: Coconut: Rs. 15/- per nut, black pepper: Rs. 600/- per kg

Mondouri

Five black pepper varieties were evaluated under West Bengal condition. Overall performance of Panniyur-l was superior as compared with other four varieties studied. Panniyur-1 recorded the highest fresh yield of berries (2.91 kg/plant) followed by Sreekara (2.14 kg/ plant), while the lowest yield (1.55 kg/plant/year) was recorded in IISR Sakthi. Similarly, maximum dry weight of berries (1.13kg/ plant) was recorded in Panniyur-1 followed by Sreekara (0.83kg/ plant). Lowest dry yield of 0.57kg/ plant was recorded in IISR-Sakthi. Thus, in the Gangetic Alluvial Zone of West Bengal with irrigation facilities, black pepper can be successfully as an intercrop in coconut and varieties Panniyur-1 and Sreekara could be promoted for this purpose.

Expt. 5: Evaluation of coconut based cropping system models

Centres: Goa and Port Blair

Experimental details: Goa

T_1: Coconut + Black pepper + Papaya + Drumstick
T_2: Coconut + Black pepper + Heliconia
T_3: Coconut + Black pepper + Banana + Lemon
T_4: Coconut + Black pepper + Passion fruit + Pineapple

T_5: Coconut + Black pepper + Annona

T_6: Coconut + Black pepper + Crossandra

T_7: Coconut monocrop

Goa

Pre experimental coconut yield in the experimental plot was 47 nuts/ year/ palm during July 2014 to June 2015. Coconut yield after intercropping was observed to be 69 nuts/ palm/ year. Yields and economic returns of treatments recorded during January to December 2020 are presented in Table 41.

Table 41: Yield and economic returns of intercrops recorded during January to December 2020

Treatment	Crop	Yield (kg/ha)	Gross returns (Rs./ha)	Net return (Rs./ha)
T_1	Papaya fruits	1,040	1,52,896/-	87,296/-
T_2	Heliconia Flower	14,080 stems/ha	1,45,460/-	79,860/-
T_3	Banana-Lemon	-	1,17,300/-	51,700/-
T_4	Pineapple fruits	1,092	1,50,071/-	84,471/-
T_5	Sour soup fruits	141	1,59,492/-	93,892/-
T_6	Crossandra flowers	13	1,22,652/-	57,052/-
T_7	Monocrop	-	1,17,300/-	67,700/-

Port Blair

Experiment was initiated during 2018-19 to evaluate performance of improved varieties/ hybrids of black pepper as intercrop in a coconut (ADOT) plantation. Experiment was set up on glyricidia standards spaced at 2 m × 2 m in RBD with eleven pepper varieties (Panniyur 1, Panniyur 2, Panniyur 5, Panniyur 6, IISR- Girimunda, IISR- Malabar Excel, Panchami, IISR- Sakthi, Sreekara, Subhakara and IISR-Thevum). Due to severe water shortage, death of pepper vines and standards was observed. Hence, replanting was undertaken in both standards as well as pepper during the period. Trenches have been made for soil and moisture conservation in the experimental garden. Pre-experimental soil samples were collected, analysis of which revealed the following characteristics. pH (4.76), EC (177.4 µS/cm), organic carbon (1.32%), total N (0.24%), available P (2.44 ppm) and available K (73.0) Pre-experimental yield of coconut was found to be 20.1 nuts/ palm/ year.

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

Mondouri

Treatment details:

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.

Data presented in below indicated that under coconut based cropping system, among the seven treatments studied, highest nut yield of 18,568 nuts /ha was recorded in the treatments T_2 and T_3. Treatment T_3 recorded maximum B: C ratio of 2.34 with a maximum net returns of Rs. 4,55,107/- per ha of available land. Coconut + black pepper + onion + potato model (T_6) recorded the lowest B:C ratio of 1.65 (Table 42), while the lowest net returns of Rs. 1,05,400- per ha was recorded in coconut monocrop (T_7).

Coconut + sapota+ Pineapple at Bhubaneswar

Table 42: Yield, economics of different tuber crops and spices under coconut based integrated farming system model

Treatment	Yield/ha of available land	Gross returns/ ha (Rs.)	Cost of Production /ha (Rs.)	Net returns /ha (Rs.)	B:C ratio
T_1	Coconut (17,346 nuts), black pepper (90.75 kg), sweet potato (6.96 t) and onion (6.12 t)	4,06,281/-	1,90,452/-	2,15,829/-	2.13
T_2	Coconut (18,568 nuts), black pepper (113 kg), turmeric (8.88 t) and EFY (27.55 t)	7,47,628/-	3,29,861/-	4,17,767/-	2.27
T_3	Coconut (18,568 nuts), black pepper (112 kg), ginger (8.75 t) and colocasia (8.21 t)	7,93,669/-	3,38,562/-	4,55,107/-	2.34
T_4	Coconut (17,523 nuts), black pepper (91 kg), coriander (0.66 t) and sweet potato (6.96 t)	3,75,423/-	1,68,966/-	2,06,457/-	2.22
T_5	Coconut (17,523 nuts), black pepper (101 kg), chilly (2.31 t), sweet potato (6.96 t)	4,35,509/-	2,02,914/-	2,32,595/-	2.15
T_6	Coconut (17,523 nuts), black pepper (92 kg), onion (6.12 t) and potato (7.8 t)	3,54,829/-	2,14,871/-	1,39,958/-	1.65
T_7	Coconut (18,054 nuts)	1,98,594/-	93,194/-	1,05,400/-	2.13

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

Centres: Bhubaneswar, Kasaragod and Ratnagiri

Experimental details:

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

Bhubaneswar

Table 43: Growth and yield of palms in the cropping system in littoral sand.

Treatment	Number of leaves/palm	Number of leaves/palm /year	Number of inflorescences/ palm/year	Number of female flowers/ palm/year	Number of nuts/ palm/yr
CS1	26.8	7.6	6.8	120.2	17.02
CS2	28.1	7.9	7.2	126.5	18.39
CS3	26.3	7.5	6.60	105.4	17.56
CD (0.05)	**1.15**	**NS**	**NS**	**NS**	**NS**
N1	25.9	7.3	6.4	102.9	15.04
N2	28.2	8.0	7.1	130.3	20.08

N3	27.2	7.7	7.0	118.7	17.86
CD (0.05)	**0.60**	**0.21**	**0.22**	**17.94**	**2.04**
CS1N1	26.2	7.3	6.5	97.6	18.83
CS1N2	28.1	8.1	7.2	147.4	24.56
CS1N3	26.3	7.6	6.8	115.6	22.67
CS2N1	26.3	7.5	6.8	111.1	21.31
CS2N2	29.0	8.3	7.4	135.9	25.28
CS2N3	28.9	8.1	7.3	132.3	23.58
CS3N1	25.1	7.2	5.9	100.2	19.98
CS3N2	27.4	7.8	6.8	107.5	25.39
CS3N3	26.3	7.5	7.0	108.4	22.31
CD (0.05)	**1.21**	**NS**	**NS**	**NS**	**NS**

Kasaragod

A field study was conducted to develop coconut based fruit intercropping system under coastal sandy soil. Coconut var. Kera Keralam (WCT) 41 years old spaced at 7.5 x 7.5 m and Sapota var. DHS 2 was studied. Nutrient management practices were tried *viz.* Green manuring + biofertilizers + organic recycling + FYM @10t/ha+ 50% RDF (N1), Green manuring + biofertilizers + organic recycling + FYM@10t/ha+ 100 % RDF (N2) and Green manuring + biofertilizers + organic recycling + FYM@10t/ha + 150 % RDF (N3). The fifth year fruit yield data of sapota revealed that the treatment T3 recorded significantly higher yield (47 kg per tree and 7.3 t/ha) and differed from the treatment T1 (43 kg per tree 6.7 t /ha) and T2(38 kg per tree 5.9 t /ha).

Coconut based multispecies cropping system under coastal sandy soil

Ratnagiri

The planting of kokum has been done as per treatment details and soil samples were analyzed for determining their initial nutrient contents. The average number of functional leaves was maximum (30.03 Nos.) in CS1N3. The maximum nut yield (88.83 nuts) was recorded in CS3N1. The vegetable yield was maximum (97.30 kg/plot) in CS1N3. The maximum pineapple yield (227 Kg) was recorded in CS2N3 and maximum *Garcinia indica* height (174.33 cm) was recorded in CS2N3.

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

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

Aliyarnagar

Treatment details:

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

T_2: Bio-manures and biofertilizers (green leaf manuring @ 10 kg with Glyricidia loppings + organic recycling of coconut waste through vermicompost @ 10 kg + coconut frond mulching + *Azospirillum* @ 100 g + *Phosphobacteria* @ 100 g + VAM @ 100 g + green manuring with sunn hemp twice a year)

T_3: T_2 + soil test based NPK and micronutrient application

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

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

Growth attributes recorded after four years of experimentation although registered a numerical increase,

statistical parlance was witnessed among the treatments whilst significantly higher tender nut yield (159 nuts per palm per year) was witnessed in the treatment T_3 followed by 148 nuts per palm in T_2. Lowest nut yield of 135 per palm was recorded in T_1 (Farmer's Practice) (Table 44). Quality parameters *viz.,* concentration of sodium, potassium and total soluble solids in tender nut water were maximum in T_3 compared to T_2 and T_1. An improvement in soil fertility status was evinced compared to the year of inception irrespective of the treatments but the quantum of increase in soil nutrient availability was higher in treatments T_2 and T_3. Net returns was higher in T_3 (Rs. 2,51,610/- per ha) followed by T_2 (Rs. 2,29,840/- per ha) and T_1 (Rs. 1,95,120/- per ha). Adoption of integrated nutrient management in coconut (T_3) resulted in increased tender nut yield by 15.5 % and net returns by 28.9 % compared to farmer's practice (T_1) (Table 45).

Table 44: Effect of INM on growth, yield attributes and nut yield of dwarf coconut

Treatments	Plant height (cm)	Plant girth (cm)	Number of leaves	Annual leaf production (no./ palm)	No. of inflorescence/ palm/ year	Nut yield (nuts/ palm/ year)
T_1	492.2	97.2	30.0	10.9	11.2	135
T_2	494.5	98.1	32.1	11.3	11.8	148
T_3	498.6	97.4	32.9	12.4	12.0	156
Sed	**19.2**	**1.84**	**0.98**	**0.10**	**0.67**	**12.7**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**13.1**

Table 45: Economics of different nutrient management practices in dwarf coconut

Treatments	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)
T_1	182880	378000	195120
T_2	184560	414400	229840
T_3	215640	467250	251610
SEd	**8412.2**	**9435.4**	**6431.6**
CD (P = 0.05)	**10129.1**	**13743.4**	**23352.1**

Expt. 3: Organic farming in coconut based farming system

Centres: Aliyarnagar, Ambajipeta and ArsikVere

Treatment details:

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

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

T_3: T_1 + 50% recommended K_2O through the application of sulphate of potash

T_4: T_2 + 50% recommended K_2O through the application of sulphate of potash

T_5: Conventional method (chemical fertilizer application)

T_6: Shredded coconut waste application

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

Cropping system to be followed at different centres:

Aliyarnagar: Coconut + cocoa

Ambajipeta: Coconut + cocoa + banana

Arsikere: Coconut + sitaphal + lime + drumstick

Kasaragod: Coconut+ cocoa + vegetables+ cover cropping system

Aliyarnagar

Experiment was laid out during 2015 comprising of five treatments. A trench of 15 m length and 1.3 m width was excavated amidst six coconut palms for the treatments $T_1 - T_4$. PGPR consortia, organic manure, husk burial and 50% recommended K_2O (600 g K_2O) as Sulphate of potash were applied as per the treatments. Daincha seeds were sown @ 30 kg /ha in the interspaces of the coconut palms in the treatments T_1 to T_4 and was incorporated *in situ* at 50 days after sowing. Daincha biomass incorporated in the soil was 6.2 t/ ha.

Although differential effect of treatments was not

conspicuous on the growth of the palm, nut yield showed spectacular variation, with T_4 registering the highest nut yield (183 nuts per palm per year) followed by T_3 (174 nuts) and the lowest was witnessed in T_1 (145 nuts) (Table 46). Although soil reaction and electrical conductivity did not vary among the treatments, the available macronutrients were higher in T_4 and lower in T_5. Treatments receiving sole application of organic manures (T_1 and T_2) helped in increasing the soil organic carbon pool compared to the rest of the treatments. Physical properties *viz.* bulk density, porosity and soil moisture content enhanced on addition of organic manures compared to sole chemical fertilization.

Table 46: Differential effect of treatments on the growth and yield of coconut (Aliyarnagar)

Treatments	Palm height (m)		Plant girth (cm)		Leaves (nos./palm)		Nut yield (Nos./palm/year)	
	2014-15	2019-20	2014-15	2019- 20	2014-15	2019-20	2014-15	2019-20
T_1	13.4	19.7	85.1	93.4	34	35	157	150
T_2	14.7	19.5	86.0	95.1	33	36	145	152
T_3	15.4	19.8	85.3	96.2	38	36	160	174
T_4	13.2	19.9	88.2	96.8	35	36	148	183
T_5	13.1	19.1	82.2	91.1	36	35	149	145
S.Ed	**0.48**	**0.98**	**5.42**	**3.12**	**1.11**	**0.76**	**12.4**	**8.62**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**10.3**

Recycling of residues in the trenches (Aliyarnagar)

Ambajipeta

The trial was initiated during 2015 in 30 years old East Coast Tall variety coconut plantation with four replications. Cocoa cv. Forestero and banana cv. T. C. Keli were planted as intercrops. Initial soil samples were collected and sent to CPCRI, Kasaragod for analysis of soil physicochemical properties and microbial analysis. Cocoa crop is four years old and is in bearing stage and the growth characters of cocoa were recorded.

With respect to coconut, no significant differences were noticed for total number of functional leaves/palm. However, nut yield per palm differed significantly among the treatments. Treatment T_5 recorded significantly highest yield (124.19 nuts/palm/year), which was on par with T_4 (121.43 nuts/palm/year). With regards to banana, there was no significant variation for bunch weight, number of fingers per bunch and total number of hands per bunch. However, higher bunch weight (5.55 kg) was recorded in T_4 treatment followed by T_3 (5.49 kg), T_2 (5.21 kg) and T_5 (5.13 kg).

Field view of organic farming at Ambajipeta

Arsikere

Experiment on effect of different organic nutrient on component crops as influence by different treatment levels was initiated during 2015-16. The morphological parameters *viz.* plant height, plant girth, number of branches, canopy spread were significantly higher in T_4 followed by T_3 and T_2. The lowest morphological data were recorded in T_6 with chemical fertilizer application. The yield of coconut (78.9 nuts/ palm/year), lime (4.8 kg/ plant/year), Drumstick (6.70 kg/ plant) were recorded significantly maximum in treatment T_4 (application of *in situ* organic matter, PGPR, green manure. husk burial, FYM and 50 percent SOP) followed by T_3 and T_2.

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

Aliyarnagar

Locations: 3 farmer's plots

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

Year of start: 2015-16

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

Package practices proposed based on the soil test results:

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

Management practices as per the package of treatments were initiated in root wilt affected garden at three locations based on soil nutrient status (Manakkadavu village of Coimbatore district, Kanakkapillaivalasai village of Tirunelveli district and Melagudalur village of Theni district. The pH of samples from the all sites is in the alkaline range. The organic carbon content is extremely low and Zn was found to be low in all three locations. Based on the soil nutrient status, the above mentioned packages of practices were followed and treatments were imposed during last year. Disease assessment was done based on the disease grades assigned to flaccidity, yellowing and necrosis symptom in the second or third spiral as per the score chart.

Regular agronomical management practices reduced the average root wilt disease index from 15.86 (2015-16) to 5.58 (2019-20) in Coimbatore district and 16.34 (2015-16) to 7.23 (2019-20) in Tirunelveli district, respectively. In control plot, root (wilt) index increased from 16.35 (2015-16) to 18.20 (2019-20) in Coimbatore district and 18.57 (2015-16) to 20.50 (2019-20) in Tirunelveli district. The disease index was higher in control plot compared to demonstration plot. Nut yield in demonstration plot was higher (86 nuts /palm /year) in Manakkadavu village (Table 47) compared to control plot (60 nuts/palm/year). In Kanakkapillaivalasai (Table 48.), nut yield was higher (98 nuts/ palm/ year) compared to control (63 nuts/palm/year).

Table 47: Root (wilt) disease index in Manakkadavu village, Coimbatore Dist. (Aliyarnagar)

Particulars	Demonstration plot		Control plot (Farmers practice)	
	2015-16	2019-20	2015-16	2019-20
	Pre treatment	Post treatment	Pre treatment	Post treatment
Range of disease index	4 to 44	0-30	2 to 46	4-47
Average disease index*	15.86	5.58	16.35	18.20
Nut yield	80	86	83	60

Table 48: Root (wilt) disease index in Kanakkapillaivalasai, Tirunelveli Dist. (Aliyarnagar)

Particulars	Demonstration plot		Control plot (Farmers practice)	
	2015-16	2019-20	2015-16	2019-20
	Pre treatment	Post treatment	Pre treatment	Post treatment
Range of disease index	0 to 40	0-30	6 to 42	2-45
Average disease index*	16.34	7.23	18.57	20.50
Nut yield	84	98	96	63

* * * * *

4.3 DISEASE MANAGEMENT

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

Centres: Aliyarnagar, Ambajipeta, Arsikere and Veppankulam

Expt. 1: Roving survey of coconut diseases

Aliyarnagar

Roving survey was carried out in six districts of Tamil Nadu *viz.,* Coimbatore, Tirupur, Dindigul, Theni, Tirunelveli and Kanyakumari to assess the incidence of major diseases of coconut *viz.*, bud rot, basal stem rot, stem bleeding, leaf blight and leaf spot during month of February 2020 and September 2020. The maximum bud rot incidence of 12.5 per cent was recorded in Gomangalampudur village of Pollachi (South) block followed by Kollarpatti (10.5%) village of Pollachi (North) block in Coimbatore district. The block average of bud rot incidence was found to be high (3.8%) in Pollachi (South) followed by Pollachi (North) block of Coimbatore district which recorded the bud rot incidence of 3.8 and 3.01 per cent respectively. The district mean incidence of 2.13 and 1.19 per cent was observed in Coimbatore and Tirupur district respectively (Table 49). Basal stem rot was found to be high in Udumalai, Udumalaipet block followed by Pulavadi village of Gudimanagalam block, Tirupur district which respectively recorded 20.0 and 12.5 per cent disease incidence. The basal stem rot incidence of 11. 5 per cent was observed in Therichananamkoppu village of Thovalai block, Kanyakumari district. Among the blocks, Gudimanagalam block, Tirupur district recorded the highest block average of 8.30 percent followed by Udumalai block with 7.60 per cent incidence. The high district average of 5.2 per cent was recorded in Tirupur.

The highest stem bleeding incidence of 12.5 percent was recorded in Periyapatti followed by Pulavadi village (11.8%) of Gudimangalam block, Tirupur district. The mean disease incidence of the Gudimanagalam, Thovalai and Udumalai blocks were 8.10, 3.30 and 2.45 per cent respectively. The district average for the Tirupur district was 2.84 per cent. The severity of the disease was recorded high (48.90) in Gudimangalam block and district mean severity of 24.06 was observed in Kanyakumari.

The intensity of leaf spot (27.5 PDI) was more in village of Avalchinampaalyam village of Pollachi followed by Devampadivalasu (25.7PDI. Among the blocks, Periyakulam block of Theni district recorded the highest (19.06 PDI) leaf spot incidence followed by Pollachi (South) block wherein 13.94 PDI was observed. The district average was found to be high in Theni district (10.82 PDI) followed by Coimbatore district (9.1 PDI). The district mean severity of 41.25 per cent was recorded both in Coimbatore and Theni. The leaf blight intensity was maximum (27.7 PDI) in Kalliyapuram village of Anamalai block followed by Kallipalayam village of Pollachi (North), Coimbatore district The maximum district average (14.62 PDI) was recorded in Coimbatore district. The highest disease severity of 70 per cent was recorded in Anamalai block and mean maximum district severity of 64.0 was observed in Coimbatore district.

Table 49: Incidence of coconut diseases in districts of Tamil Nadu

Districts	Coconut disease status (DI/PDI)									
	Bud rot (DI)*		Basal stem rot (DI)*		Stem bleeding (DI)*		Leaf spot(PDI)**		Leaf blight (PDI)**	
	Feb'20	Sep'20	Feb'20	Sep'20	Feb'20	Sep'20	Feb'20	Sep'20	Feb'20	Sep'20
Coimbatore	2.0 ± 0.74	2.13± 0 .77	1.43±0.44	1.57± 0.47	0.68± 0.27	0.73±0.29	8.67±1.43	9.1± 1.65	13.95±0. 44	14.62± 0 .48
Tirupur	0.83± 0.30	1.10±0.18	4.91± 1.67	5.20± 1.72	2.60± 1.70	2.84± 1.82	5.56± 0.89	6.07± 0.79	9.1± 0.78	9.8± 0.79
Dindigul	0.36± 0.13	0.50± 0.17	0.73± .0.16	0.84± 0.17	0.56±0.25	0.70± 0.27	5.67± 1.53	6.68 ±1.68	9.76 ± 1.35	10.25 ± 1.42
Theni	0.60± 0.41	0.67±0.45	0.46±0.15	0.49± 0.11	0.36±0.08	0.44± 0.09	10.23± 3.30	10.82±3.35	6.9 ± 1.02	7.37 ±1.04
Tirunelveli	0.32± 0.12	0.40±.15	0.57± 0.06	0.70± 0.08	0.46± 0.06	0.54± 0.06	2.26±0.26	2.5 ± 0 .29	3.58± 0.66	4.11 ± 0.82
Kanyakumari	0.55± 0.10	0.65± 0 .11	1.85± 0.58	2.09±0.21	1.30± 0.53	1.50±0.52	3.19± 0.50	3.72 ±0.9	3.86 ± 0.69	4.47 ± 0.72

Values are mean ± Standard error

Ambajipeta

Surveys were conducted in different mandals of East Godavari, West Godavari, Visakhapatnam districts of Andhra Pradesh during 2020-2021. Major diseases observed in coconut gardens were basal stem rot, stem bleeding and bud rot along with minor incidence of grey leaf spot. Overall Mean percent incidence of basal stem rot, stem bleeding and bud rot diseases were 7.59, 1.65 and 0.74 respectively in the surveyed villages (Table 50).

Table 50: District wise disease scenario of coconut in Andhra Pradesh during 2020

S. No	District	Mean Percent disease incidence		
		Basal stem rot	Stem bleeding	Bud rot
1	East Godavari	9.54±0.59	1.39±0.22	0.77±0.09
2	West Godavari	9.01±1.03	1.50±0.09	0.71±0.10
3	Visakhapatnam	4.21±1.17	2.07±0.31	0.73±0.19

The survey was conducted in three districts of Andhra Pradesh *viz*., East Godavari, West Godavari and Visakhapatnam district for assessing the incidence of coconut diseases. The high basal stem rot disease was noticed in Pedavegi (12.33 percent disease incidence) mandal of west Godavari district, Sakhinetipalli mandal (11.07 PDI) and Mamidikuduru (10.03 PDI) of East Godavari district. The stem bleeding disease is more severe in (2.60 PDI) Actchrapuram mandal of visakhapatnam district and lowest in Mallikipuram and mamidikuduru mandal (1.00 PDI) of East Godavari district. Further, the highest bud rot disease incidence observed in Bheemili mandal (1.17%) of Visakhapatnam district.

Arsikere

The Roving survey on major coconut diseases *viz*., basal stem rot, stem bleeding, bud rot, leaf blight and leaf spot was conducted in major coconut growing districts of Karnataka namely Hassan and Tumkur, during February, 2020. The basal stem rot disease was noticed in all the four districts and the disease incidence ranged from 0.28 to 6.11 per cent. The maximum incidence of 6.11 per cent was recorded in Chikkanaykanahalli of Tumkur district. However, the incidence of stem bleeding ranged from 3.17 to 21.04 per cent. Maximum incidence of 21.04 per cent was recorded at Channarayapatna taluk of Tumkur district. With respect to bud rot disease incidence, the incidence ranged from 0.00 to 2.42 per cent. Maximum disease incidence of 2.42 per cent was noticed in Belur of Hassan taluk during February, 2020 (Table 51).

The foliar diseases of coconut namely leaf blight and leaf spot were separately recorded. The incidence of leaf blight ranged from 4.26 to 14.40 per cent and maximum incidence was recorded at Thuruvekere taluk (Tumkur District). The leaf blight disease incidence ranged from 3.15 to 21.13 per cent during February, 2020 and maximum incidence was recorded at Thuruvekere taluk.

Table 51: Disease status of coconut in major growing districts of Karnataka during 2020

District	Basal Stem Rot	Stem Bleeding	Bud rot	Leaf blight	Leaf spot
Hassan	2.166±0.862	7.026±2.602	1.156±0.554	10.50±4.79	9.622±2.556
Tumkur	3.958±1.088	13.824±02.756	0.234±0.254	9.176±3.55	12.464±1.792

*Mean of three locations in three villages in each taluk

Data presented is mean ± standard deviation

Veppankulam

Roving survey was conducted in Thanjavur district block villages to assess the incidence of major coconut diseases *viz.,* basal stem rot, stem bleeding and bud rot in 2020. The results revealed that the mean incidence of basal stem rot disease was 2.61% and the maximum incidence of basal stem rot disease was recorded as 12 % in Karupur (Madukur block), 12% in Kallikadu (Pattukkottai block) and 12% Karambayam (Orathanad block). The mean incidence of bud rot disease was 2.61% and the maximum incidence of bud rot disease was recorded as 12 % in Andami (Madukur block), 12% in Thamarankkottai (Pattukkottai block) and 11% in Solagankudikadu (Orathanad block). The incidence of leaf blight, leaf spot and lethal wilt and stem bleeding diseases were not recorded in any of the places where survey was undertaken.

Expt. 2: Fixed plot survey of coconut diseases

Aliyarnagar

Fixed plot survey was carried out at quarterly intervals from January 2020 to December 2020 in two villages' *viz*., Uliankandi and Aliyarnagar, Anamalai block, Coimbatore district. Observations were recorded on leaf blight and leaf spot diseases and the per cent disease incidence and percent disease index were calculated. Data recorded on weather parameters *viz*., Temperature and Relative Humidity. The intensity of leaf blight and leaf spot diseases were high in Puliyankandi when compared

to Aliyarnagar. The leaf blight severity of 68.75 and 62.2 per cent were observed in Puliamkandi and Aliyarnagar, respectively and the leaf spot severity of 41 and 35 per cent were recorded in the above villages (Table 52). The leaf blight incidence was positively correlated with temperature and negatively correlated with RH. The leaf spot severity was negatively correlated with the temperature (Table 53).

Table 52: Incidence of coconut diseases in fixed plot survey

Month	Puliyankandi				Aliyarnagar			
	Leaf blight		*Pestalotia* leaf spot		Leaf blight		*Pestalotia* leaf spot	
	PDI	% incidence	PDI	% incidence	PDI	% incidence	PDI	% incidence
Jan'20	18.70	65.0	9.5	40.0	17.00	60.00	7.50	30.00
April'20	24.50	72.0	8.30	38.0	19.0	65.00	8.10	35.00
July'20	20.50	70.0	11.8	42.00	18.20	62.00	10.20	37.00
Oct20	19.30	68.0	12.5	44.00	17.40	62.00	11.30	38.00
Mean	**20.75±1.3**	**68.75**	**10.52±0.95**	**41.00**	**18.07±0.044**	**62.2**	**8.60±0.88**	**35.00**

Table 53: Correlation between weather parameters and leaf blight and leaf spot diseases

Puliyankandi				Aliyarnagar			
Correlation coefficient							
Leaf blight		Leaf spot		Leaf blight		Leaf spot	
Temperature	RH	Temperature	RH	Temperature	RH	Temperature	RH
0.97	-.0.77	- 0.78	0.32	0.86	- 0.92	- 0.48	0.54

Ambajipeta

Fixed plot survey was taken up for stem bleeding and bud rot diseases at Horticulture Research station, Ambajipeta and for basal stem rot disease (*Ganoderma*) disease in farmer's field at Gudapalli village in East Godavari District at quarterly intervals from April 2020 to October 2020. Percent disease incidence of basal stem rot during April 2020 was 35.23% which was increased to 36.89% by the end of October 2020. Percent incidence of stem bleeding disease varied between 2.62 to 3.90% during 2020-2021 year. Bud rot disease incidence was observed from September 2020 to October 2020. 2.20% of bud rot was observed during October 2020.

Arsikere

The Fixed plot survey on major coconut diseases was undertaken to assess the disease spread. The experiment was conducted at HREC, Arsikere. The plot is managed as per general management practices and no disease management measures are taken. The observations on basal stem rot, stem bleeding and leaf blight were recorded at quarterly interval (Table 54). The incidences of 40.33 per cent BSR, 24.25 per cent stem bleeding, 10.24 per cent leaf blight was recorded during January 2020. At the end of the October, 2020, the incidences of BSR and stem bleeding diseases increased to 41.53 and 25.1 per cent, respectively. However, the incidence of leaf blight disease increased to 11.05 per cent.

Table 54: Fixed plot survey of coconut diseases at HRES, Arsikere

Month	Disease Index/Disease Incidence		
	Basal Stem Rot	Stem Bleeding	Leaf blight
January -20	40.33	24.25	10.24
April – 20	40.51	24.47	10.56
July- 20	41.04	24.99	10.88
October – 20	41.53	25.10	11.05

Veppankulam

The periodical survey of fixed plot survey was done at Mangadu village in Alangudy taluk of Pudukottai district in 2020. The total number of palms in the field is 85. The initial disease incidence of basal stem rot was recorded as 28 per cent in 2012. The per cent incidence

of basal stem rot was increased to 91.76 per cent (PDI of 25.13%) during November, 2020.

Coc./Path. 2: Basal stem rot disease

Centres: Ambajipeta, Arsikere and Veppankulam

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

Ambajipeta

Four isolates of *Ganoderma* spp. representing varied geographical locations were collected and their variations with respect to morphological and cultural characters were documented. The radial growth of isolates was around 90mm in 8 days in almost all the isolates and statistically there was no difference among the isolates with respect to growth. The colony characters of all isolates were white in colour and most of them were cottony growth and a few produced leathery growth (Table 55).

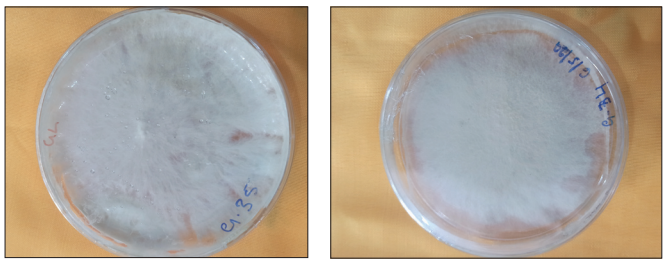
Table 55: Morphological and cultural variations of *Ganoderma* isolates from Andhra Pradesh

Ganoderma isolate	Part of collection	Mycelial growth (mm) of *Ganoderma*				Morphological character
		3 DAI	5 DAI	7 DAI	9 DAI	
Peddapatnamlanka	Root	5.00	40.00	60.00	90.00	White cottony
Antervedipalem	Root	15.00	50.00	70.00	90.00	White cottony
Gudapalli	Root	10.00	40.00	60.00	90.00	leathery
Vanapalli	Root	10.00	40.00	70.00	90.00	leathery

*Mean of four replications; DAI- Days after inoculation

Arsikere

The roots samples from *Ganoderma* infected coconut palms were collected during roving survey. The isolation of pathogen from these samples was done under laboratory using PDA medium. The totals of two isolates (G34 and G35) were isolated from the samples of Belur and Thuruvekere region. The variations with respect to morphological and cultural characters were documented. The radial growth of isolates was around 90.00 mm in 9 days in almost all isolates and statistically there was no difference among the isolates with respect to growth. The colony characters of all isolates were white in colour with cottony growth.



Isolates of *Ganoderma* collected from Karnataka

Veppankulam

The two sporophores of *Ganoderma spp.* were collected from surveyed village's *viz.,* Veppankulam and Karikadu for the isolation of fungi and morphological studies during 2020. *In vitro* growth of the fungus was not obtained after inoculation into the PDA medium.

Expt. 2: Epidemiology and disease forecasting

Influence of weather parameters on BSR disease incidence

Ambajipeta

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

The study was initiated in November 2010 to study the impact of other palms and intercrops in coconut on occurrence and spread of basal stem rot disease. Fifty palms in the field with sole coconut and field with coconut + banana were selected in Gannavaram village of East Godavari District. Horizontal and vertical spread of the disease in sole coconut as well as coconut intercropped with banana during the time period is being recorded. In sole coconut plot, the PDI of 34.27% during January 2020 was increased to 36.02% by the end of December 2020. Mean vertical spread in sole coconut crop was recorded as 116.52 cm in January 2020 and as 119.25 cm in December 2020. Over a period of 6 years, the percent disease incidence of 2 (Nov, 2010) in sole coconut was increased to 36.02% (December 2020).

In the new plot selected for coconut and banana, the 24.08% PDI during January 2020 was increased to 25.08% by the end of December 2020. Mean vertical spread of the disease in coconut + banana plot was recorded as 128.26 cm in January 2020 and as 135.28 cm in December 2020. (Table 56).

Table 56: Impact of intercrops on occurrence and spread of the disease in coconut (2020)

Sl. No	Month	Temp °C		Relative Humidity (%)		Rain fall (mm)	No. of rainy days	Percent disease incidence (PDI) (Horizontal spread)		Mean vertical spread (cm)	
		Min.	Max.	Min.	Max.			Sole coconut	Coconut + Banana	Sole coconut	Coconut + Banana
1	Jan'20	19.8	29.4	63.5	98.5	-	-	34.27	24.08	116.52	128.26
2	Feb'20	19.9	29.5	63.5	98.5	-	-	34.27	24.08	116.52	130.58
3	March'20	21.6	33.7	52.5	98.0	-	-	34.27	24.08	116.52	130.58
4	April'20	23.5	35.4	55.2	98.6	60.3	2	34.27	26.22	116.52	133.26
5	May 20	26.1	36.9	53.0	96.7	12.3	1	35.46	26.22	117.36	133.26
6	June 20	26.3	34.6	65.4	97.2	126.0	9	35.46	26.22	117.36	133.26
7	July'20	25.4	32.8	74.2	99.6	419.5	14	35.46	26.22	117.36	133.26
8	Aug'20	25.6	31.5	77.4	98.3	177.3	14	35.46	26.22	117.36	133.26
9	Sep'20	25.5	32.7	75.8	99.3	408.5	12	35.46	26.22	117.36	133.26
10	Oct'20	24.5	31.4	77.9	99.2	297.5	10	35.46	28.02	117.36	133.26
11	Nov'20	22.3	30.9	67.3	96.8	191.0	4	35.46	28.02	117.36	133.26
12	Dec'20	18.5	29.6	60.5	96.6	-	-	36.02	28.02	119.25	135.28

Arsikere

The study was continued with 76 palms to record the disease incidence at monthly interval. The weather parameters such as atmospheric temperature, relative humidity, rainfall, and rainy days were recorded to correlate the vertical and horizontal spread of the disease. The results revealed that the vertical spread of the disease ranged from 183.5 to 184.6 cm and horizontal spread from 11 to 12 palms (14.47 to 14.98 %) during twelfth months.

Correlation of weather parameters with disease incidence

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

Veppankulam

The vertical and horizontal spread of basal stem rot disease of coconut was recorded in the plots of sole coconut and intercropped coconut at CRS, VPM, at quarterly basis Table-18. The weather parameters such as relative humidity, atmospheric temperature, rainfall and soil temperature were recorded to correlate the vertical and horizontal spread of disease during 2020 (Table 57). The results revealed that the vertical spread of basal stem rot disease (BSR) in sole coconut crop ranged from 65.4 cm to 72.45 cm and the horizontal spread of basal stem rot disease from 33.46% to 35.74 % in sole coconut crop.

The temperature and relative humidity (RH) has positive correlation with the horizontal spread of the basal stem rot disease (BSR) both in sole coconut crop and intercropped coconut. The relative humidity (RH) and rainfall has negative correlation with the vertical spread of the basal stem rot disease (BSR) intercropped coconut. The soil temperature has positive correlation with the vertical spread of the basal stem rot disease (BSR) intercropped coconut.

Table 57: Correlation of weather parameters with Horizontal and Vertical spread of BSR in Intercropped coconut and Sole coconut crop during 2020 (Veppankulam)

Weather parameters	Horizontal Spread of BSR		Vertical Spread of BSR	
	Sole Crop	Inter Crop**	Sole Crop	Inter Crop**
Temp-Max	0.11	0.20	-0.01	0.03
Temp-Min	0.40	0.48	0.29	-0.20
Morning-RH(%)	0.30	0.31	0.21	-0.24

Evening-RH(%)	0.48	0.48	0.37	-0.36
Rainfall (mm)	0.83	0.82	0.72	-0.70
Morning-Soil temp.	-0.03	0.19	0.07	0.16
Evening-Soil temp.	-0.77	-0.70	-0.85	0.87

Table 57: Correlation of weather parameters with Horizontal and Vertical spread of BSR in Intercropped coconut and Sole coconut crop during 2020 (Veppankulam)

Weather parameters	Horizontal Spread of BSR		Vertical Spread of BSR	
	Sole Crop	Inter Crop**	Sole Crop	Inter Crop**
Temp-Max	0.11	0.20	-0.01	0.03
Temp-Min	0.40	0.48	0.29	-0.20
Morning-RH(%)	0.30	0.31	0.21	-0.24
Evening-RH(%)	0.48	0.48	0.37	-0.36
Rainfall (mm)	0.83	0.82	0.72	-0.70
Morning-Soil temp.	-0.03	0.19	0.07	0.16
Evening-Soil temp.	-0.77	-0.70	-0.85	0.87

Coconut + Pepper + Banana + Cocoa, **BSR-Basal Stem Rot

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

Ambajipeta

Field experiment: The bacterial bioagent named *Bacillus amyloliquefaciens* was found to be promising in arresting the growth of *Ganoderma* sp. under in vitro conditions. The same isolate was taken to field conditions to test field efficacy of *Bacillus amyloliquefaciens* against Basal stem rot disease in coconut. The talc based formulation was applied in soil along with FYM 50 kg, where as bacterial broth was fed through roots and root feeding of Hexaconazole was used as standard check. The results revealed that among all the treatments, there was no significant variation with respect to disease index at three months after treatment. At 6 months after treatment, treatment with root feeding of bacterial strain 50 ml broth (10^8 cfu/ml) in 100 ml water resulted in reduced disease index 34.83 to 33.27 (Table 58).

Table 58: Influence of bacterial bio-agents on basal stem rot disease of coconut

Treatments	Disease index			
	Before treatment	3 MAT	6 MAT	9 MAT
T_1- Soil application of 100g talc formulation of *Bacillus amyloliquefaciens* along with 50kg FYM	38.48 (38.28)	38.48 (38.28)	38.09 (38.05)	38.48 (38.28)
T_2 -Root feeding of bacterial strain 50 ml broth (10^8 cfu/ml) in 100 ml water	34.69 (35.68)	34.69 (35.68)	34.69 (35.68)	33.26 (34.83)
T_3 - Root feeding of Hexaconazole 3 ml in 100 ml water	41.46 (39.88)	42.25 (40.39)	42.25 (40.37)	42.25 (40.39)
T_4 – Control	52.37 (49.57)	53.54 (50.25)	54.25 (50.07)	54.32 (50.66)
S.Em	6.14	6.01	5.75	5.60
CD (P=0.05)	NS	NS	17.73	17.27

Arsikere

The bacterial bioagent named EP10 was found to be promising in arresting growth of test pathogen *Ganoderma* sp. under *in-vitro* conditions. The same isolate was taken to field conditions to test efficacy

against BSR disease in coconut. The talc based formulation was applied to soil along with FYM 50 kg whereas the bacterial broth was fed through roots and root feeding of Hexaconazole was used as standard check. Each palm constituted one replication and six replications were maintained under each treatment. The result revealed that among the all the treatments there was no significant variation (Table 59) with respect to disease index at 18 month after treatment.

Table 59: Influence of bacterial bio-agents on basal stem rot disease of coconut

Treatments	*Disease Index at different month				
	Oct,19	Jan 20	April 20	July 20	Oct, 2020
T1- SA of 100g Talc formulation of EP10 along with 50 Kg FYM	34.05	33.92	34.04	34.26	35.98
T2- Root feeding of bacterial strain 50 ml broth (10^8CFU/ml) in 100 ml water	37.27	37.87	37.98	38.68	39.03
T3- Root feeding of Hexaconazole 3 ml in 100 ml water	36.79	37.51	37.79	38.55	38.91
T4- Control	38.11	38.46	39.04	39.63	39.87
SEm±	0.72	0.85	0.71	0.82	1.07
CD@5 %	2.21	2.63	2.76	2.52	3.30

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

Veppankulam

Based on the *in vitro* evaluation of biocontrol agents, effective bacterial strain *Bacillus subtilis* EPC5 was selected for the management of basal stem rot under field condition. The trial was laid out in randomized block design with following four treatments and five replications. For each replication, four coconut palms were selected. The trial was initiated during October, 2018 at Coconut Research Station, Veppankulam. The effective bacterial strain EPC5 was given as soil application and root feeding at quarterly intervals and compared with fungicide (Hexaconazole). Among the treatments, root feeding of 50 ml of *Bacillus subtilis* EPC5 (nutrient broth)/100 ml of water at 3 months interval was found superior in containing the disease by registering 24.81 per cent reduction over initial as compared to other treatments. The per cent increase of annual nut yield/palm was recorded as 61.43% in T3- Root feeding of Hexaconazole 3ml/100 ml of water at 3 months interval over control and followed by T_2.

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

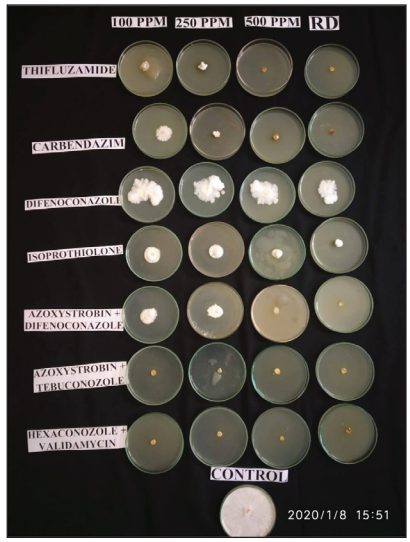
Centres: Ambajipeta, Arsikere and Veppankulam

Ambajipeta

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

Under *in vitro* screening of latest systemic fungicides *viz*., Thifluzamide 24 SC, Mancozeb 50% + Carbendazim 25% WS, Zineb 68% + Hexaconazole 4% WP, Myclobutanil 10% WP, Dodine 65% WP, Pyraclostrobin + Fluxapyroxad 250 SC, Kresoxymethyl 44.3% SC, Isoprothiolone 40% EC against *Ganoderma* sp. at different concentrations (100 ppm, 250 ppm, 500 ppm and recommended concentrations), except Kresoxymethyl 44.3% SC (12.96%), all chemicals showed cent per cent inhibition at recommended concentration. Due to Zineb fungicide is under banned list, *In vitro* screening of different single fungicides and combi products against *Ganoderma* sp were tested. Among the fungicides, Azoxystrobin 11% + Tebuconazole 18.30% SC and Hexaconazole 5% + validamycin 2.5% SC showed 100 percent at lower concentration *i.e.* 100 ppm.

For field evaluation of fungicides, Azoxystrobin 11% + Tebuconazole 18.30% SC and Hexaconazole 5% + validamycin 2.5% SC, were selected. An experiment on field evaluation of Azoxystrobin 11% + Tebuconazole 18.30% SC and Hexaconazole 5% + validamycin 2.5% SC fungicides at different combinations were initiated in the farmer's coconut garden at Peddapatnamlanka village of East Godavari district during the month of October, 2020.



In vitro* screening of different single fungicides and combi products against *Ganoderma spp

Arsikere

In vitro* evaluation of fungicide molecules against *Ganoderma

The New fungicide molecules with combi-products were tested against mycelial growth of *Ganoderma lucidum* at three concentrations (100,250 and 500 ppm) under *in-vitro* condition. Fourteen new systemic fungicides *viz*., Famoxadone 16.6% + Cymoxanil 22.1% SC, Cyazafamid 34.5% SC, Difenoconazole 250 EC, Thifluzamide 24% SC, Kitazin 48% EC, Hexaconazole4% + Carbendazim 16% SC, Azoxystrobin 11%+ Tebuconazole18.3% SC W/W, Carbendazim 50% WP, Carbendazim 12% + Mancozeb 63% WP, Mancozeb 75% WP, Hexaconazole 5% EC, Hexaconazole 4% WG + Zineb 68% and Hexaconazole 5% + Validamycin 2.5% SC tested against *Ganoderma lucidum* under *in vitro* by poisoned food technique. Among the fourteen new systemic fungicides tested Hexaconazole 4% WG + Zineb 68% (100) Hexaconazole 5% + Validamycin 2.5% SC (100%), Hexaconazole 5% EC (98.15)and Azoxystrobin 11%+ Tebuconazole18.3% SC W/W (88.89 %) were found superior recording inhibition of *Ganoderma lucidum* and showed superior over the other fungicides tested under *in vitro* in 500 ppm concentration . In untreated control It was 90mm growth was recorded after 9days of inoculation.

Field evaluation of fungicides molecules against *Ganoderma*

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

Veppankulam

Thirteen new systemic fungicides *viz*., Famoxadone1 6.6%+Cymoxanil22.1%SC, Cyazafamid 34.5% SC, Mancozeb35%SC, Kitazin 48% EC, Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W, Thifluzamide24%SC, Carbendazim 46.27% SC, Isoprothiolone 40% EC, Difenoconazole 25% EC, Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC, Hexaconazole 5% + validamycin 2.5%SC, Hexaconazole 5% + validamycin 2.5%SC and Pencycuron 23.9 % SC tested against *Ganoderma lucidum* under *in vitro* by poisoned food technique. Among the thirteen new systemic fungicides tested, Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W and Hexaconazole 5% + validamycin 2.5%SC were found superior recording 100 per cent inhibition of *Ganoderma lucidum* and showed superior over the other fungicides tested under *in vitro* (Table 60).

Table 60: *In-vitro* evaluation of new fungicides molecules against *Ganoderma* sp.

Sl. No	Fungicides	Mycelial growth of *Ganoderma spp.* 9 days after inoculation (in mm)			% Inhibition over control
		100ppm	250ppm	500ppm	
1	Famoxadone16.6%+ Cymoxanil22.1%SC	90.00	90.00	89.68	0.361
2	Cyazafamid 34.5% SC	90.00	90.00	90.00	00.00
3	Mancozeb35%SC	68.75	68.13	66.38	26.25
4	Kitazin 48% EC	15.38	11.20	10.39	88.46
5	Hexaconazole 4% + Carbendazim 16% SC	00.00	00.00	00.00	100.00

6	Azoxystrobin 11% + Tebuconazole-18.3% SC W/W	1.50	00.00	00.00	100.00
7	Thifluzamide24%SC	18.06	10.31	12.31	86.32
8	Carbendazim 46.27% SC	6.13	4.13	0.81	99.10
9	Isoprothiolone 40% EC	35.13	23.43	15.19	83.13
10	Difenoconazole 25% EC	56.44	46.49	35.50	60.56
11	Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC	25.19	21.00	3.78	95.81
12	Hexaconazole 5% + validamycin 2.5%SC	00.00	00.00	00.00	100.00
13	Pencycuron 23.9 % SC	90.00	90.00	90.00	00.00
14	Control	90.00	90.00	90.00	00.00
	CD@5%	**5.465**	**0.391**	**0.437**	

Based on the *in vitro* evaluation of new systemic fungicides, effective combination fungicides *viz.*, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W and Hexaconazole 5% + validamycin 2.5%SC were selected and compared with Hexaconazole 5% for the management of basal stem rot under field condition in 2020. The trial was laid out with the following treatments in randomized block design with three replications. For each replication, four coconut palms were selected. The effective fungicides were given as root feeding and soil drenching at quarterly intervals. The disease index of basal stem rot of coconut was recorded before imposing the treatments and post treatment at quarterly interval. The experiment is in progress.

Coc./ Path 3: Stem bleeding disease

Centres: Ambajipeta and Arsikere

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

Ambajipeta

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

Application of *T. harzianum* and *T. reesei* cake formulation completely recovered the diseased palms when compared to the paste application of copper oxychloride against stem bleeding disease of coconut. Disease index of 7.96 and 6.95 at HRS farm, Ambajipeta was brought down to 0.00 per cent within 50 days of cake application both *Trichoderma harzianum* cake (CPCRI cake) and as well as *Trichoderma reesei* cake formulation (Native isolate, HRS, Ambajipeta). Disease index of 6.82 was reduced to 5.42 in case of paste application of copper oxychloride at Horticulture Research Station farm, Ambajipeta (Table 61). However, the treatments differ significantly at 50 DAT.

Table 61: Field evaluations of cake formulations of different *Trichoderma* species against stem bleeding disease of coconut

S. No	Treatment	At Ambajipeta	
		DI (BT)	DI (50DAT)
1	*Trichoderma harzianum* cake application	7.96 (17.21)	0.00 (0.00)
2.	*Trichoderma reesei* cake application	6.95 (15.81)	0.00(0.00)
3	Copper oxychloride paste application	6.82 (15.43)	5.42 (13.80)
4	Control	11.70 (21.07)	15.70 (23.79)
	SEm±	2.29	2.52
	CD@5 %	6.76	7.46

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

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

Ambajipeta

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

Under *in vitro* screening of different single and combi products *viz.,* Thifluzamide 24 % SC, Carbendazim 46.27%SC, Difenoconazole 25% EC, Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC, Azoxystrobin 11% + Tebuconazole 18.30% SC, , Hexaconazole 5%+validamycin2.5%SC, Isoprothiolone 40% EC against *Thielaviopsis paradoxa* at different concentrations (100 ppm, 250ppm, 500 ppm and recommended concentrations). Among all the fungicides tested, Carbendazim 46.27%SC showed 94.44 percent inhibition over control followed by Hexaconazole 5% + validamycin 2.5%SC showed 73.61% inhibition over control at recommended concentration compared to control. None of these chemicals *viz*., Thifluzamide 24 % SC, Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC, Isoprothiolone 40% EC inhibits the growth of *Thielaviopsis paradoxa.*

For field evaluation of fungicides Azoxystrobin 11% + Tebuconazole 18.30% SC and Hexaconazole 5% + validamycin 2.5% SC was selected and field selection was done at Dagalavaripalem village of East Godavari district. An experiment on field evaluation of Azoxystrobin 11% + Tebuconazole 18.30% SC and Hexaconazole 5% + validamycin 2.5% SC fungicides at different combinations were initiated against basal stem rot disease of coconut at farmer's coconut garden at Dagalavaripalem village of East Godavari district. Pre data was recorded on disease index of stem bleeding disease.

Arsikere

Influence of fungicides on stem bleeding disease of coconut

The New fungicide molecules with combi-products were tested against mycelial growth of *Thielaviopsis paradixa***.** at three concentrations (100, 250 and 500 ppm) under *in-vitro* condition. Fourteen new systemic fungicides viz., Famoxadone 16.6% + Cymoxanil 22.1% SC, Cyazafamid 34.5% SC, Difenconazole 250 EC, Thifluzamide 24% SC, Kitazin 48% EC, Hexaconazole4% + Carbendazim 16% SC, Azoxystrobin 11%+ Tebuconazole18.3% SC W/W, Carbendazim 50% WP, Carbendazim 12% + Mancozeb 63% WP, Mancozeb 75% WP, Hexaconazol 5% EC, Hexaconazol 4% WG + Zineb 68% and Hexaconazol 5% + Validamycin 2.5% SC tested against *Ganoderma lucidum* under *in vitro* by poisoned food technique. Among the fourteen new systemic fungicides tested Hexaconazol 5% + Validamycin 2.5% SC (100%), Azoxystrobin 11%+ Tebuconazole18.3% SC W/W (100%), Carbendazim 12% + Mancozeb 63% WP (100%), Carbendazim 50% WP (98.15) and Mancozeb 75% WP (97.41%) were found superior recording inhibition of *Thielaviopsis paradixa* and showed superior over the other fungicides tested under *in vitro* in 500 ppm concentration (Plate). In untreated control 90 mm growth was recorded after 9 days of inoculation.

In vitro* screening of different single fungicides and combi-products against *Thielaviopsis paradoxa

Field evaluation of fungicides molecules against *Thielaviopsis*

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

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

Centres: Aliyarnagar

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

Aliyarnagar

Twenty five healthy and 25 leaf blight infected palms were selected in Puliankandi village, Anamalai Block Coimbatore district and nut yield were recorded from June 2018 –December 2020. From the results it was found that the percent reduction in nut yield due to leaf blight disease in coconut ranged from 10.39- 20.00 per cent with an average nut yield loss of 15.28 per cent. In addition to leaf blight rugose spiralling white fly infestation was observed to an extent of 10 per cent.

Expt. 2: Epidemiology of leaf blight disease in coconut

Aliyarnagar

Observation recorded on leaf blight incidence at weekly intervals during Jan 2020 to Dec 2020. Weather data *viz.*, temperature, relative humidity and the leaf blight disease intensity were recorded regularly at weekly intervals during January 2020 to December 2020. The results revealed that the intensity of leaf blight was maximum during April 2020 and it was minimum during January 2020. The leaf blight incidence was positively correlated with temperature and negatively correlated with Humidity (Table 62).

Table 62: Correlation between leaf blight incidence and weather parameters

	Weather parameters	Correlation coefficient
Leaf blight incidence	Temperature(Maximum)	**0.75**
	Temperature(Minimum)	**0.52**
	RH (Morning)	**- 0.85**
	RH(Evening)	**- 0.71**
	Rainfall	**0.393**
	Evaporation	**0.55**

Expt. 3: Management of leaf blight disease in coconut

Aliyarnagar

A field experiment was laid out at Puliyankandi village of Anaimalai block in Coimbatore district for evaluating the efficacy of fungicides against leaf blight disease with eight treatments and three replications in Randomized Block design. The treatments were imposed at appropriate time intervals. Pre treatment and post treatment observation were recorded at 36 months after application. The results showed that root feeding with Propiconazole @ 5ml in 100 ml of water was significantly superior in reducing the leaf blight incidence from 29.95 PDI to 2.95 PDI which accounted for 27.00 per cent disease reduction. It reduced the leaf blight severity from 100 to 33.33 per cent. This treatment also recorded the highest nut yield of 138 nuts/ palm/year as against 97 nuts/ palm /year (Table 63). Root feeding with Propiconazole @ 5 ml in 100 ml of water at three months interval in reduced the leaf blight incidence by 27.0 per cent 36 months after treatment this treatment also recorded the highest nut yield of 138 nuts/ palm/ year as against 97 nuts/ palm/ year.

Table 63: Evaluation of systemic fungicides against leaf blight disease

Trt. No	Treatment details	Leaf blight intensity (PDI)			Leaf blight severity (%)			Nut yield**
		0 MAA	36 MAA	Disease reduction	0 MAA	36 MAA	Severity reduction	
1	Root feeding of tebuconazole @ 2ml + 100 ml water	32.09	20.09	12.00 (20.3)	100	55.5	44.5	112
2	Root feeding of tebuconazole @ 5ml + 100 ml water	33.42	10.42	23.00 (28.7)	100	44.44	55.6	123
3	Root feeding of tebuconazole @ 10ml + 100 ml water	33.33	18.33	15.00 (22.8)	100	55.5	44.5	106
4	Root feeding of propiconazole @ 2ml + 100 ml water	37.93	19.93	18.00 (25.1)	100	44.4	55.6	118

5	Root feeding of propiconazole @ 5ml + 100 ml water	29.95	2.95	27.00 (31.33)	100	33.3	66.7	138
6	Root feeding of propiconazole @ 10 ml + 100 ml water	36.71	17.71	19.00 (25.8)	100	44.4	55.6	117
7	Root feeding of 2 g of carbendazim in 100 ml water	23.56	9.26	14.30 (22.20)	100	55.5	44.5	115
8.	Untreated control	39.82	40.72	- 0.900 (5.44)	100	100	0	97
	SEd	-	-	0.93	-	-	-	1.62
	CD(P=0.05)	-	-	2.3	-	-	-	3.47

Values are mean of three replications. Values in Parentheses are arc sine transformed values treatment

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

Aliyarnagar

In vitro evaluation of systemic fungicides against _Lasiodiplodia theobromae_

Systemic fungicides *viz.*, Tebuconazole - 25.9%EC, Propiconazole - 25.9% EC, Penconazole -10% EC, Carbendazim - 50% WP, Kresoxym methyl - 44.3% SC, Azoxystrobin - 23% SC, Thiophanate methyl 70 % WG, Debacarb+Carbendazim -1.7 % +0.3 %, Myclobutanil - 10 % WP, Tebuconazole+ Zineb - 2% +75 % WP were screened against *L. theobromae* at different concentrations (50,100,250,500,750,1000 and 1500ppm) by using poisoned food technique

The *in vitro* evaluation of systemic fungicides against *L. theobromae* revealed that, cent per cent inhibition over control was recorded in propiconazole at 250 ppm concentrations onwards up to 1500 ppm, while tebuconazole at 1000 ppm onwards, Penconazole at 1250 ppm onwards .The minimum inhibitory concentration of propiconazole, tebuconazole and Penconazole was found to be 250 ppm, 1000ppm and 1250 ppm respectively. Therefore Tebuconazole and Propiconazole were selected for field evaluation as sequential application against leaf blight.

Table 64. _In-vitro_ evaluation of fungicides against _Lasiodiplodia theobromae_

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

Evaluation of sequential use of fungicides against coconut leaf blight

Based on the *in vitro* screening the effective fungicides (Tebuconazole and Propiconazole) were selected for field evaluation at different time intervals. An experiment was laid out to evaluate the efficacy of sequential application of fungicides against leaf blight with five treatments and four replications in Randomized Block Design (RBD) at Puliyankandi village of Anaimalai block in Coimbatore district .The treatment details are as presented below. The treatments were imposed as per the technical programme and the pre and post treatment observations were recorded on leaf blight incidence using 0-5 scale in the experimental plot.

The results of the field experiment revealed that root feeding with Propiconazole @ 5ml in 95 ml water during Jan, July followed by Tebuconazole @ 5ml in 95 ml water during April and October reduced the leaf blight incidence by 5.5 per cent after six months of application. This treatment recorded the highest nut yield of 130 nuts/palm/ year as against 98 nuts/palm/ year (Table 65) Systemic fungicides *viz.,* Propiconazole and Tebuconazole completely inhibited the mycelial growth of *L. theobromae* at 250 ppm and 1000 ppm respectively. Root feeding with Propiconazole @ 5ml in 95 ml water during Jan, July followed by Tebuconazole @ 5ml in 95 ml water during April and October reduced the leaf blight incidence by 5.5 per cent after six months of application.

Table 65: Evaluation of sequential use fungicides against leaf blight disease

Treatment details	Leaf blight intensity (PDI)			Leaf blight severity (%)			Nut yield**
	0MAA	6MAA	Disease reduction	0MAA	6MAA	Severity reduction	
T1 Effective fungicide A (Tebuconazole) @ 5ml in 95 ml water during Jan, April, July and October months	24.49	21.79	2.7(9.5)	100	83.3	16.7	109
T2 Effective fungicide B (Propiconazole) @ 5ml in 95 ml water during Jan, April, July and October months	27.78	24.68	3.1(10.1)	100	83.3	16.7	117
T3 Effective fungicide A (Tebuconazole) @ 5ml in 95 ml water during Jan, July and Effective fungicide B (Propiconazole) @ 5ml in 95 ml water during April and October	32.49	28.90	3.5(10.8)	100	83.3	16.7	121
T4 Effective fungicide B (Propiconazole) @ 5ml in 95 ml water during Jan, July and Effective fungicide A (Tebuconazole) @ 5ml in 95 ml water during April and October	31.95	26.45	5.5(3.6)	100	75.0	25.0	130
T5 Untreated Control	33.45	33.67	-0.22(2.7)	-	-	-	98
SEd			0.75				3.10
CD(P=0.05)			1.63				6.54

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

Aliyarnagar

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

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

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

Pre treatment (initial) and post treatment observation (6 months after application) were recorded on leaf blight intensity both in treated and untreated plots and the results presented in Table 51. The average intensity of leaf blight disease was reduced from 27. 52 PDI to 24. 50 0PDI after 6 months of application accounted for the disease reduction of 3.02 per cent. In control plot the disease incidence slightly increased from 28.08 PDI (initial) to 28.22 PDI after 6 months of application.

Integrated disease management modules *viz.*, Cutting and removal of the severely affected leaves, root feeding with Propiconazole (2ml in 100ml water), soil application of *Pseudomonas fluorescens* @ 200g/ palms and spraying of Copper oxy chloride (0.25 %) was found to be promising in controlling the leaf blight incidence.

Ambajipeta

Demonstration of integrated disease management on leaf blight, one acre coconut garden with leaf blight disease was selected in Adurru village of East Godavari district along with the control plot.

The average intensity of leaf blight disease was reduced from Pre treatmental (initial) and post treatment observations of leaf blight intensity for the month of July 2020 were recorded in demonstrated treatments and in control treatments 5.25 (initial year) to 4.28 per cent. However, in case of control plot, disease intensity was slightly increased from 11.32 (initial) to 14.53.

Arsikere

One acre garden with leaf blight incidence was selected at Boranakoppalu village in Arsikere Taluk for demonstration trail on management of leaf blight. A separate control plot was also selected in nearby place. The above treatments were imposed at appropriate time. The initial incidence of disease is 12.24 per cent in treated plot and 11.92 in untreated control (Table 66) and the incidence was decreased in treated palm (5.16%) where as increased in untreated palms (11.92) and demonstration is in progress.

Table 66:. Incidence of leaf blight disease in demonstration gardens

Treatment details	Disease Index (%)				Nut yield
	Before Initiation	Jan-20	July-20	Difference (% reduction/increase)	
Treated as per schedule	12.24	08.32	5.16	7.08 (57.84%reduced)	79.00
Untreated Control	11.92	12.16	14.40	+ 2.48 (-20.80% increased)	68.33

Plate : Demonstration on integrated management of leaf blight disease

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

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

Aliyarnagar

Roving survey was carried out during Jan 2020 – Dec 2020 to assess the incidence of root (wilt) in different villages of Coimbatore, Tirupur, Dindigul, Theni, Tirunelveli and Kanyakumari districts. The highest root wilt incidence of 55.5 per cent was recorded in Gudalore village, Cumbum block,Theni District followed by Maninagaram(54.5%) and Samiandipuram villages (53.3%).

In Coimbatore district, among the four blocks surveyed the root (wilt) incidence was observed in three blocks

viz., Pollachi South, Pollachi North and Anamalai and it was not found in surveyed villages of Kinahthukadavu block. The root wilt incidence of Coimbatore district ranged from 3.5- 52.5 per cent and the maximum incidence of 52.5 per cent was recorded in Amrapalayam village of Pollachi South block. The block average for the Anamalai and Pollachi (South) blocks were 13.25 and 11.07 per cent respectively. The district average of root wilt incidence was 6.39 per cent.

In Theni district severe incidence of root (wilt) was recorded in Gudaloore (55.5%), Maninagarm (54.5%), Samiandipuram (53.3 %) villages of Cumbum block. The mean root (wilt) incidence of Uthamapalayam block was found to be 13.12 per cent. The root (wilt) incidence was not found in surveyed villages of Periyakulam and Bodi blocks. Among the surveyed districts and blocks, the highest district average of 16.80 per cent and the highest block average of 54.07 percent were recorded in Theni district and Cumbum block respectively (Table 67).

Table 67: Incidence of coconut root (wilt) disease in different districts of Tamil Nadu 2020

Districts	Blocks	Root (wilt) incidence (%)	Root wilt severity (PDI)
Coimbatore	Pollachi North	1.25	30.0
	Pollachi South	11.07	50.0
	Anaimalai	13.2	60.0
	Kinathukadavu	0.0	0.0
	Mean	**6.39± 3.35**	**35.0**
Tirupur	Udumalpet	0.00	0.0
	Gudimangalam	0.00	0.0
	Tirupur	1.70	30.0
	Avinashi	0.0	0.0
	Mean	**0.42 ± 0.40**	**7.5**
Dindigul	Palani	0.00	0.0
	Ottenchithiram	0.00	0.0
	Reddiyarchathiram	0.00	0.0
	Nilakottai	0.00	0.0
	Mean	**0.00±0.00**	**0.0**
Theni	Cumbum	54.07	70.0
	Uthamapalayam	13.12	60.0
	Periyakulam	0.00	0.0
	Bodi	0.00	0.0
	Mean	**16.80 ± 12.80**	**32.5**
Tirunelveli	Thenkasi	31.14	60.0
	Kadayanallur	14.60	50.0
	vasudevanallur	0.00	0.0
	Shencottah	18.90	50.0
	Mean	**16.16± 6.43**	**40.0**
Kanyakumari	Rajakkamangalam	4.74	30.0
	Thiruvattaru	7.14	30.0
	Kurunthancode	19.67	50.0
	Munjerai	25.85	50.0
	Thovalai	0.00	0
	Mean	**11.53 ± 4.83**	**32.0**

* * * * *

4.4 INSECT-PEST MANAGEMENT

Coc./Ent.1: Pest surveillance in coconut

Centres: Aliyarnagar, Ambajipeta, Arsikere and Ratnagiri

Aliyarnagar

Roving survey

Roving survey was carried out in seven districts of Tamil Nadu *viz.,* Coimbatore, Tiruppur, Dindugul, Theni, Tirunelveli, Kanyakumari and Thanjavur. The extent of damage in terms of per cent incidence and intensity was recorded for major pests of coconut during these surveys (Table 68). The roving survey results revealed that the mean incidence of rhinoceros beetle was high (31.5%) in Thanjavur district followed by in Coimbatore district (28.4%). It was low in Dindugul district (15.2%). In Thanjavur district both leaf and spindle lead damage was high, it was 40.2% and 30.2% respectively. This might be due to after the Gaja cyclone 2018 the coconut stems was left out in the coconut garden which attracted adult rhinoceros beetle for egg laying. The incidence was more in seedlings. The leaf damage and spindle damage was low in Coimbatore which was 13.5 % and 16.5 %, respectively. The percent nut damage by eriophyid mite was high in Thanjavur district (60.5%) district followed by in Tirunelveli district (56.8 %). It was low in Coimbatore and Dindugul district (45.2 %) district (60.5 %). T``he intensity of eriophyid mite damage was high in Tirunelveli district which recorded 1.5 Mean Grade Index, which was rated as medium damage level. All other districts recorded mild level of damage.

The intensity of infestation due to invasive rugose spiraling whitefly was medium to low in all the districts surveyed. It was medium in Tiruppur district (1.5) and remaining districts recorded low level of damage. The percent parasitisation by *Encarsia guadeloupae* was high (75.5%) in Coimbatore district followed by in Tirunelveli (68.2%), Theni (65.5%), Tiruppur (60.5%), Kanyakumari (60.5%) and it was low in Dindugul district (52.7).

Table 68: District wise pest situation in Tamil Nadu during 2020

Districts	Rhinoceros beetle			Nut damage due to Eriophyid mite (%)	Eriophyid mite (Grade index)	RSW	
	Mean incidence (%)	Leaf damage (%)	Spindle damage (%)			Grade	% Parasitism
Coimbatore	28.4	13.5	16.5	45.2	0.5 (mild)	1.0 (Low)	75.5
Tiruppur	22.2	15.5	17.5	50.7	1.2 (Moderate)	1.5 (Medium)	60.5
Dindugul	15.2	17.5	19.4	45.2	0.9 (mild)	0.7 (Low)	52.7
Theni	20.4	16.5	17.2	47.7	0.7 (mild)	1.0 (Low)	65.5
Tirunelveli	25.5	14.2	24.2	56.8	1.7 (Moderate)	0.8 (Low)	68.2
Kanniyakumari	22.2	28.5	28.2	52.8	1.5 (Moderate)	0.7 (Low)	60.5
Thanjavur	30.5	40.2	30.2	60.5	1.0 (mild)	0.8 (Low)	60.2

Fixed plot survey

Fixed plot survey was conducted in 3 locations, viz., Nadupunni (North pollachi), Angalakuruchi (Anaimalai block) and Puliyankandi (Anaimalai block). The fixed plot at Nadupunni is of Local East Coast tall variety around 25 years old. The fixed plot survey results were revealed that the leaf damage due to black headed caterpillar was ranged from 7.5 to 20.5%, the maximum damage of 20.5% was recorded during June 2020. The maximum number of larvae (1.7/100 leaflets) were recorded during April 2020, which was low (0.2/100 leaflets) during December 2020. Mean incidence of black headed caterpillar was 14.1%.

The field at Angalakurichi is with a hybrid (GBGD X WCT) and 10 years old. The rhinoceros beetle incidence was fluctuated between 24.5 % to 35.7 % percent between February 2020 to December 2020, the maximum leaf damage (30.5 %) and maximum spindle leaf damage (33.5%%) was observed during the month of August 2020. The mean incidence of rhinoceros beetle was 28.4%. Besides the rhinoceros beetle, the field was

infested by RSWF with the low to medium intensity of infestation. During February 2020 low level of damage was observed (0.7). From March to December 2020 medium level of damage was recorded. Now the nesting whitefly damage was observed, which was high (50.5%) during June 2020 and low during August 2020 (25.0%). In this particular field, the aphililind parasitoid, *Encarsia guadeloupae* was released frequently and the *Encarsia* parasitoid started to build-up. Highest parasitisation was recorded during December which was 68.5% and parasitisation was low during April (35.5%). The mean parasitisation by *Encarsia guadeloupae* was 51.3%.

The field at Puliyankandi is of ALR 1 variety, 12 years old and yielding. The nut damage in the field varied from 50.5 to 28.5 % during different months with the maximum nut damage recorded during May 2020 (50.5%) and low nut damage was recorded during August and December 2020 (28.5%). The Mean Grade Index (MGI) fluctuated between 0.8 to 1.9 during different months and the maximum MGI (1.9) was recorded during April 2020.

The results of pest infestati on in cocoa revealed that mealy bug damage was 2.8%, RSW damage was 8.5% and leaf eating caterpillar damage was 10.5% .

Correlations of coconut pests with weather factors during 2020

Correlation studies depicted in Table 69 revealed that maximum temperature was negatively correlated with rhinoceros beetle leaf damage, spindle damage and eriophid mite nut damage, whereas the BHC leaf damage, RSWF and nesting whitefly incidence are positively correlated. However, minimum temperature and morning relative humidity was positively correlated with all the pests. Evening relative humidity was negatively correlated with all the pests except BHC leaf damage. Rainfall is positively correlated with all the pests.

Table 69: Average Per cent Infestation by Different Pests in Fixed Plot Survey in Tamil Nadu during 2020

Months	Location: Nadupunni (North pollachi)		Location: Angalakuruchi (Anaimalai block)							Location: Puliyankanti (Anaimalai block)	
	Black heated caterpillar		Rhinoceros beetle			RSWF (Scale)	RSWF incidence (%)	Nesting whitefly (%)	Parasitisation by Encarsia (%)	Damage of eriophyid mite	
	Leaf damage (%)	Larvae/ 100 leaflets	Incidence (%)	Leaf damage (%)	Spindle damage (%)					Nut damage (%)	MGI
February 2020	13.5	1.3	24.5	11.2	23.5	0.7 (Low))	33.5	33.5	48.5	38.5	0.8 (mild)
April 2020	18.5	1.7	25.5	`	33.5	1.5 (Medium)	50.5	50.5	35.5	45.7	1.9 (moderate)
June 2020	20.5	1.0	28.5	25.5	33.5	1.5 (Medium)	52.5	52.5	45.7	50.5	1.5 (moderate)
August 2020	15.0	0.7	35.7	30.5	33.5	1.2 (Medium)	25.4	25.4	50.5	48.2	1.5 (moderate)
October 2020	9.3	0.5	30.0	25.5	20.0	1.7 (Medium)	35.2	35.2	60.5	30.5	1.8 (moderate)
December 2020	7.5	0.2	26.2	25.5	16.2	1.3 (Medium)	25.7	25.7	68.5	28.5	1.3 (moderate)

Ambajipeta

Roving survey

Due to Covid 19 the roving survey was carried out only in West Godavari and East Godavari districts of Andhra Pradesh (Table 70). The rhinoceros beetle incidence was 12.50% in West Godavari with leaf damage of 19.26 % and multiple cut damage of 3.21 % while in East Godavari district 10.32% incidence with 19.26 % leaf damage and 3.21 % multiple cut damage was recorded. A high red palm weevil incidence was recorded in West Godavari district (12.45%) and coconut plantations of East Godavari district had comparatively low incidence of 6.23%. The incidence of eriophyid mite was high in both the districts and in East Godavari 89.85% infested nuts with grade index of 2.10 %, while West Godavari district recorded 78.42 % infested nut with grade index of 1.96% was recorded. The leaf eating caterpillar black headed caterpillar damage was observed in West Godavari district with 9.82 % mean incidence and low incidence of 4.23 % was recorded in East Godavari district. The rugose spiraling whitefly incidence was low in both the districts. West Godavari district recorded 14.53 % incidence and 8.25 % intensity as compared to East Godavari district which recorded 12.21% incidence and 4.23 % intensity.

Table 70: District wise pest incidence in Andhra Pradesh during the year 2020

District	Rhinoceros beetle			Red palm weevil Mean incidence (%)	Eriophyid mite		Black headed caterpillar Mean incidence (%)	Rugose Spiralling white fly	
	Incidence (%)	Intensity (%)			Infested nuts (%)	Grade index		Incidence	Intensity
		Leaf damage	Multiple cut damage						
West Godavari	12.50 ± 2.06	19.26 ± 2.26	3.21 ± 1.21	12.46 ± 1.42	78.42 ± 2.12	1.96 ± 0.3	9.82 ± 1.3	14.53 ± 2.10	8.25 ± 1.20
East Godavari	10.32 ± 1.96	16.32 ± 3.31	2.05 ± 0.23	6.23 ± 0.54	89.85 ± 4.26	2.10 ± 0.5	4.23 ± 0.75	12.21 ± 1.73	4.23 ± 0.93

(Average mean ± standard error)

Fixed plot survey

Fixed plot survey was carried out from April to December (2020) in two selected villages of East Godavari district *i.e.,* Samanthakuru of Allavaram mandal and Munganda of P. Gannavaram mandal (Table 71) to record the incidence and intensity of infestation by major pests of coconut.

Among the insect pests, rhinoceros beetle and eriophyid mite damage was observed in both the fixed plot villages where as incidence of black headed caterpillar was not observed in Munganda village. The rhinoceros beetle damage was observed to be high in Samanthakurru village and a leaf damage of 15.85 % and 17.36 % and infestation of 36 and 44 per cent was recorded during October and December months, respectively and in Munganda village a leaf damage of 15.58 % and 14.65 % and infestation of 28 and 24 per cent was recorded during the same months.

Table 71: Correlations of coconut pests with weather factors during 2020

Months	BHC leaf damage (%)	Rhinoceros beetle leaf damage (%)	Rhinoceros beetle spindle damage (%)	Eriophid mite nut damage (%)	RSWF incidence (%)	Nesting whitefly incidence (%)	Max. Temp (^{0}C)	Min Temp (^{0}C)	Morning RH (%)	Evening RH (%)	Rain fall (mm)
Feb-20	13.5	11.2	23.5	38.5	33.5	33.5	33.5	33.2	17.5	90.8	0
Apr-20	18.5	15.5	33.5	45.7	50.5	50.5	50.5	35.2	22.0	84.8	70.1
Jun-20	21.7	22.5	33.5	65.5	38.3	52.5	32.8	23.3	98.6	74.1	93.8
Aug-20	20.3	28.5	50.8	52.7	29.2	25.4	31.4	22.0	95.1	60.0	22.9
Oct-20	18.5	15.5	33.5	45.3	24.4	35.2	32.1	21.3	93.9	76.1	96.0
Dec-20	12.5	17.3	25.8	55.7	20.5	25.7	32.5	17.2	65.5	96.0	10.0
Max. Temp (^{0}C)	0.1	-0.3	-0.1	-0.3	0.8	0.6					
Min. Temp (^{0}C)	0.5	0.5	0.6	0.2	0.9	0.7					
Morning RH (%)	0.6	0.4	0.6	0.1	0.8	0.6					
Evening RH (%)	0.1	-0.8	-0.9	0.1	-0.6	-0.1					
Rain fall (mm)	0.3	0.1	0.2	0.3	0.3	0.7					

The eriophyid mite incidence was high in both the villages and incidence of 81.61 % was recorded with a grade index of 1.61, in Samanthakurru, where as in Munganda a incidence was 81.15% with an grade index of 1.57 was observed. The incidence of black headed caterpillar with 33.21 % was observed in Samanthakurru village in December month, whereas no incidence was observed in Munganda village. The incidence of red palm weevil, rugose Spiralling whitefly, bag worm and slug caterpillar was absent in both fixed plot surveyed villages.

Arsikere

Roving survey

The 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. The infestation of rhinoceros beetle was noticed mostly in all newly planted gardens in all the age group of 2 to 48 years. The highest incidence 19.8 per cent incidence was noticed in Mandya district and mean incidence of 16.2 per cent was recorded in the Mysore district. The incidence of red palm weevil was maximum (up to 1.1 %) in Chikkamagaluru district followed by 0.8 % infestation in Tumkur district. The incidence of red palm weevil was also noticed in Mandya (0.3 %) and Mysore (0.6 %) district.

The infestation by Coconut black headed caterpillar was noticed in all the 4 major coconut growing districts of Karnataka, moderate (16.5 %) incidence was noticed in Chikkamagaluru district throughout the year. The other districts where the caterpillar incidence observed include Mysore 6.3 per cent, Mandya 4.2 per cent and Tumkur 0.7 per cent. The infestation of eriophyid mite was also noticed in all major districts of Karnataka and in most cases, the incidence was as high as 100 per cent in the harvested nut samples. The highest incidence of mite incidence was recorded in Tumkur district (26.9 %) followed by 21.4 per cent Chikkamagaluru, Mysore (14.8 %) and Mandya (9.5 %) district (Table 72).

Table 72: Mean Incidence of major coconut pests in important districts of Karnataka 2020-21

District	Black headed caterpillar Mean Incidence (%)	Rhinoceros beetle Mean Incidence (%)	Red palm weevil Mean Incidence (%)	Eriophyid mite Mean Incidence (%)
Chikkamagaluru*	16.5 ± 4.7	9.2 ± 1.3	1.1 ± 0.4	21.4 ± 4.1
Mysore*	6.3 ± 0.7	16.2 ± 1.8	0.6 ± 0.2	14.8 ± 3.2
Mandya*	4.2 ± 0.3	19.8 ± 3.7	0.3 ± 0.1	9.5 ± 2.4
Tumkur*	0.7 ± 0.1	11.2 ± 2.8	0.8 ± 0.3	26.9 ± 6.5

* Values expressed are Mean ± Standard error

The per cent leaf damage by rhinoceros beetle was noticed in all the 4 major coconut growing districts of Karnataka and was ranged between 7.6 to 14.4 per cent, highest per cent leaf damage (14.4 %) was noticed at Mysore district followed by 12.6 per cent in Mandya district, Tumkur (9.1 %) and Chikkamagaluru district (7.6 %). The mean grade index of mite ranged from 1.0 to 2.7, highest MGI of 2.7 was observed at Tumkur district followed by 2.1 per cent in Chikkamagaluru district, Mysore (1.0 %) and Mandya (1.3 %).

The leaf damage by coconut black headed caterpillar was ranged between 1.9 to 9.8 per cent in all 4 different district, highest per cent leaf damage (9.8 %) was noticed at Chikkamagaluru district with a number of larvae per 100 leaflets was 2.8 (Table 73).

Table 73: Mean Intensity of major coconut pests in important districts of Karnataka 2020

	Rhinoceros beetle		Eriophyid mite	Black headed caterpillar	
Months	Leaf damage (%)	Spindle damage	Mean Grade Index	Active larvae/ leaf let	Leaf damage (%)
Chikkamagaluru*	7.6 ± 1.7	0.5 ± 0.1	2.1 ± 0.4	2.8 ± 1.3	9.8 ± 1.5
Mysore*	14.4 ± 2.9	1.5 ± 0.4	1.0 ± 0.5	1.3 ± 0.4	6.9 ± 2.2
Mandya*	12.6 ± 3.2	1.2 ± 0.3	1.3 ± 0.3	0.9 ± 0.5	5.1 ± 0.8
Tumkur*	9.1 ± 2.5	0.8 ± 0.3	2.7 ± 0.8	0.7 ± 0.2	1.9 ± 0.4

Minor pests

In addition to the major pests there were some minor pests noticed during the surveys. In Chikkamagaluru district mealybug, termite and scale was noticed as a spot occurrence , the mealybug, *Pseudococcus* spp. was observed up to 4 % and its infestation in the spindle leaf as well as in harvested bunches was observed. In Tumkur district, scale incidence was noticed in the range of 1.5 to 8.4 per cent, whereas white fly incidence was noticed up to 15 per cent.

Incidence of an invasive rugose spiralling whitefly (31 %) was noticed in coconut during December 2020 during surveys in Mangala villages of Mandya district. Observations on the natural enemy fauna in the infested gardens revealed a diverse array of coccinellids along with an aphelinid parasitoid, *Encarsia guadeloupae* and few numbers of Chrysopa were observed. Parasitisation by *E. guadeloupae* was observed to an extent of 28.7 per cent (Table 74).

Table 74: Mean Incidence of minor coconut pests in important districts of Karnataka 2020

District	Rat damaged (%)	Termite infested palms (%)	Dropped nuts (%)
Chikkamagaluru*	7.5 ± 0.6	11.4 ± 2.5	5.4 ± 1.1
Mysore*	12.2 ± 0.4	2.9 ± 1.4	1.2 ± 0.5
Mandya*	7.8 ± 0.5	1.3 ± 0.7	3.5 ± 1.2
Tumkur*	6.3 ± 1.2	5.9 ± 0.8	4.2 ± 0.7

* Values expressed are Mean ± Standard error

The infestation of rat damage was noticed mostly in all age group of 2 to 42 years. The highest incidence 12.2 per cent incidence was noticed in Mysore district and mean incidence of 7.8 per cent was recorded in the Mandya district followed by Chikkamagaluru 7.5 per cent and Tumkur 6.3 per cent . The incidence of termite was maximum (up to 11.4 %) in Chikkamagaluru district followed by 5.9 % infestation in Tumkur district. The incidence of termite was also noticed in Mandya (1.3 %) and Mysore (2.9 %) district. The per cent dropped nuts was observed in all the 4 districts the highest per cent dropped nuts noticed in 5.4 per cent in Chikkamagaluru district and mean per cent dropped nuts of 4.2 per cent was recorded in the Tumkur district followed by Mandya 3.5 per cent and Mysore 1.2 per cent.

To record the incidence and intensity of infestation of different pests of coconut fixed plot survey was carried out at two months intervals from January 2020 to December 2020 in farmer's field locations at Habbanghatta and Bendekere villages of Hassan district. The palms were fallen in the age group of 14 to 40 years. In Habbanghatta the highest incidence of rhinoceros beetle (24.3 %) was observed whereas coconut black headed caterpillar (4.2 %), where as eriophyid mite infestation (28.8 %) and red palm weevil (0.7 %) were observed at Bendekere village.

The infestation by major pests was recorded at 6 times interval in a year. Throughout the year leaf damage by rhinoceros beetle was fluctuated between 8.1 and 26.8 per cent while the spindle damage ranged from 3.6 to 10.1 per cent during different months with the maximum spindle damage of 10.1 per cent during June 2020 at Habbanghatta village. The mite infestation was also noticed in both the villages of Habbanghatta and Bendekere, the nut damage ranged from 5.3 to 31.2 per cent during different months with the highest incidence of nut damage of 31.2 % was observed at Habbanghatta village during April month while the mean grade index of mite ranged from 0.9 to 2.7, highest MGI of 2.7 was observed at Habbanghatta village during April month.

The leaf damage by coconut black headed caterpillar was ranged between 1.4 to 8.4 per cent during different months, highest per cent leaf damage (8.4 %) was noticed during April month at Bendekere with the number of larvae per 100 leaflets was 3.9.

Table 75: Extent of infestation by different pests in fixed plot surveys in Karnataka

	Rhinoceros beetle		Eriophyid mite		Black headed caterpillar	
Months	Leaf damage (%)	Spindle damage (%)	Infested Nuts (%)	Mean Grade Index	Active larvae/ leaf let	Leaf damage (%)
			I. Habbanghatta			
February-20	14.8 ± 2.1	5.7 ± 1.5	22.6 ± 2.6	2.4 ± 0.5	0.4 ± 0.1	1.4 ± 0.3
April-20	18.3 ± 3.1	8.7 ± 1.1	31.2 ± 2.1	2.7 ± 0.7	0.6 ± 0.2	3.4 ± 0.8
June-20	20.5 ± 4.6	10.1 ± 1.5	9.5 ± 2.4	0.9 ± 0.2	0.9 ± 0.2	1.5 ± 1.0
August-20	21.4 ± 2.7	6.7 ± 1.8	13.2 ± 3.1	1.2 ± 0.4	1.3 ± 0.5	2.3 ± 1.2
October-20	26.8 ± 5.9	8.4 ± 2.1	14.8 ± 1.0	1.9 ± 0.5	2.2 ± 0.9	3.1 ± 1.2
December-20	23.7 ± 3.1	7.7 ± 0.9	16.3 ± 1.6	2.2 ± 0.2	2.4 ± 1.1	4.2 ± 1.3

			II. Bendekere			
February-20	8.1 ± 1.2	3.6 ± 1.5	15.4 ± 0.8	1.4 ± 0.3	3.5 ± 0.8	8.1 ± 0.7
April-19	10.2 ± 1.8	5.3 ± 1.6	21.1 ± 0.5	2.0 ± 0.4	3.9 ± 0.3	8.4 ± 1.2
June-20	9.5 ± 1.5	4.7 ± 1.1	5.3 ± 1.2	1.1 ± 0.6	1.6 ± 0.5	3.5 ± 1.5
August-20	12.4 ± 2.2	5.1 ± 1.5	7.4 ± 1.5	1.6 ± 0.5	2.4 ± 1.1	5.3 ± 1.4
October-20	15.7 ± 2.1	6.3 ± 0.8	9.6 ± 1.5	2.3 ± 0.3	2.5 ± 1.0	6.5 ± 1.2
December-20	14.1 ± 2.5	4.5 ± 1.3	12.4 ± 2.6	2.6 ± 0.3	3.2 ± 0.7	7.6 ± 1.3

* Values expressed are Mean ± Standard error

Ratnagiri

Roving survey

Roving survey was carried out in Ratnagiri, Sindhudurg, Raigad and Palghar districts and the extent of damage in terms of incidence and intensity were recorded for major pests of coconut during these surveys. The data presented in table 76 revealed that average per cent infestation of coconut rhinoceros beetle (RB) was noticed in all age palm groups which range from 8.7 to 12.6 per cent. The maximum incidence of RB was observed in Raigad district (12.6%) with highest spindle damage (1.1%). Whereas, least spindle damage observed in Ratnagiri district (0.8%). The minimum incidence of RB and leaf damage was recorded in Palghar district which noticed 8.7 and 2.1 percent, respectively. However, maximum leaf damage was noticed in Sindhudurg district (7.7%). The red palm weevil (RPW) maximum infestation was recorded in Raigad and Palghar districts only were noticed 1.03 and 1.0 per cent, respectively. Whereas, minimum incidence of RPW was noticed in Sindhudurg (0.7%) and Ratnagiri (0.4%). The infestation of black headed caterpillar was observed in Raigad and Palghar district only were recorded 7.0 and 9.5 percent, respectively. However, average incidence of BHC was observed 8.26 percent in Konkan region of Maharashtra. The eriophyid mite infestation was recorded in the range of 28.3 to 32.8 per cent. The highest nut damage due to eriophyid mite was noticed in Sindhudurg district (32.8 %) with a mean grade index (MGI) of 0.6. The MGI was noticed mild in all the districts. The least nuts damage (28.3%) was observed in Raigad district. The Ratnagiri and Palghar district were recorded 30.2 and 28.5 percent nut damage by eriophyid mite. The rugose spiralling whitefly incidence and intensity was observed in all the districts of Konkan which ranges from 5.5 to 11.3 and 6.6 to 17.3 per cent, respectively. Maximum incidence and intensity of RSW was noticed in Raigad (11.3% and 17.3%, respectively). Whereas, minimum was observed in Sindhudurg (5.5% and 6.6%, respectively). The Ratnagiri and Palghar district were recorded 9.9, 16.1 and 8.9, 12.3 percent incidence and intensity, respectively.

Table 76: Average percent infestation of pests infesting coconut during roving survey in Konkan region of Maharashtra

Districts	Rhinoceros beetle			RPW incidence (%)	BHC (%)	Eriophyid mite		RSW	
	Incidence (%)	Leaf damage	Spindle damage			Infestation (%)	MGI	Incidence (%)	Intensity (%)
Ratnagiri	11.5	6.3	0.8	0.41	0.0	30.2	0.56	9.9	16.1
Sindhudurg	12.5	7.7	0.85	0.72	0.0	32.8	0.62	5.5	6.6
Raigad	12.6	5.7	1.1	1.03	7.0	28.3	0.56	11.3	17.3
Palghar	8.7	2.1	0.9	1.00	9.5	28.5	0.52	8.9	12.3
Mean ± SE	11.3 ± 1.0	5.4 ± 1.3	0.91 ± 0.0	0.8 ± 0.1	8.2 ± 3.3	29.9 ± 1.20	0.56 ± 0.02	8.9 ± 1.4	13.0 ± 2.7

The minor pests of coconut *viz.,* arecanut black fly, scale insect, mealy bug, termites and rats were noticed 4.0, 4.8, 3.2, 2.4 and 3.75 per cent, respectively. The data depicted in table 3 indicated that average pests incidence on cocoa were recorded stem borer (2.7%), fruit damage by squirrel (10.5%), mealy bug (2.3%), rugose spiralling whitefly (12.2%) and leaf eating caterpillar 11.1 per cent.

Fixed plot survey

The average per cent infestation of major pests of coconut of two selected garden was recorded during fixed plot survey. The average data of two fixed plots are presented in table 77 revealed that the incidence of rhinoceros beetle was recorded in the range of 9.6 to 11.9 per cent and maximum infestation (11.9 %) was observed in the month of December 2020 whereas minimum incidence was observed 9.6 per cent in August, 2020. The least leaf damage (2.9%) and spindle damage (1.1%) was noticed in August, 2020. The average incidence of rhinoceros beetle, leaf damage and spindle damage were observed

10.9, 4.0 and 1.0 per cent, respectively during the year. The infestation of red palm weevil was recorded 0.3 per cent only in December 2020. Black headed caterpillar was not observed in fixed plots during the year. The average nut damage by eriophyid mite was found in the range of 19.8 and 35.9 per cent and highest nut damage (35.9 %) was noticed in the month of April, 2020 with moderate grade index (1.0) and least incidence of eriophyid mite (19.8%) with low grade index (0.3) was observed in December 2020. The maximum incidence and intensity of rugose spiralling whitefly was recorded 38.0 and 29.6 percent in December, 2020. Whereas, the least incidence (4.0%) and intensity (3.2%) was observed in April, 2020. The average per cent incidence and intensity of RSW was observed 11.6 and 8.9 per cent, respectively in Konkan region of Maharashtra.

Table 77: Average Percent Infestation by Different Pests during Fixed Plot Survey in Maharashtra

Month	Rhinoceros beetle			RPW incidence (%)	Eriophyid mite		RSW	
	Incidence (%)	Leaf damage	Spindle damage		Infestation (%)	MGI	Incidence (%)	Intensity (%)
Feb., 20	11.5	9.0	1.1	0.0	35.5	0.80		5.5
April, 20	11.1	3.3	1.5	0.0	35.9	1.05	4.0	3.2
June, 20	11.1	3.1	1.5	0.0	35.2	1.01	0.0	0.0
Aug., 20	9.6	2.9	1.1	0.0	34.1	0.87	0.0	0.0
Oct., 20	10.7	3.1	1.1	0.0	29.6	0.71	16.0	11.8
Dec., 20	11.9	8.0	0.0	0.3	19.8	0.32	38.0	29.6
Mean ± SE	10.9 ± 0.3	4.0 ± 0.9	1.0 ± 0.2	0.07 ±0.0	30.9 ± 2.9	0.79±0.1	11.6 ±7.2	8.9 ± 5.6

Correlations of coconut pests with weather parameters

Correlation studies of coconut pest incidence with weather factors during January to December, 2020 depicted in Table 78 revealed that maximum temperature was significant positively correlated with rhinoceros beetle (RB), However, Evening humidity was significant negatively correlated with rhinoceros beetle and eriophyid mite (EM). The red palm weevil (RPW) and rugose spiraling whitefly (RSW) was significantly negative correlated with morning humidity.

Table 78: Correlations of coconut pests with weather factors during the year 2020

2020-21	Pest incidence				Weather Parameters				
Months	RB	RPW	Eriophyid Mite	RSW	Max. Temp.	Min. Temp.	Mor. Humi	Eve. Humi	Rain Fall
February	11.5	0.0	56.6	13.6	33.1	18.1	93.5	57.9	0.0
April	11.1	0.0	54.0	4.0	33.7	24.3	89.8	60.8	0.0
June	11.1	0.0	43.5	0.0	31.5	24	91.6	76.3	793.7
August	9.61	0.0	37.2	0.0	30.1	24.3	91.6	83.3	11.74
October	10.7	0.0	46.0	16.0	31	24.1	54.5	79.2	239.8
December	11.9	0.38	41.5	38.0	33.3	24.1	45.2	62	0.0
Max. Temp	**0.83**	0.39	0.68	0.44					
Min. Temp	-0.33	0.18	-0.65	-0.07					
Hum (M)	-0.36	**-0.73**	0.31	**-0.85**					
Hum (E)	**-0.80**	-0.35	**-0.73**	-0.44					
Rain	0.01	-0.26	-0.21	-0.37					
R value	**0.70**								

Ent 4 :Production and supply of parasitoids

Centres: Aliyarnagar, Ambajipeta, Ratnagiri, Arsikere

Aliyarnagar centre

The parasitoid, *Bracon brevicornis* for the management of coconut black headed caterpillar, *Opisina arenosella* is being mass cultured at the biocontrol unit of CRS, Aliyarnagar and the same is distributed to the needy farmers. The details of supply of parasitoid are as follows (Table 79).

Table 79: Production and supply of parasitoids for the management of coconut black headed caterpillar in Aliyarnagar centre during 2020

Month	No. of packets
January 2020	174
February 2020	40
March 2020	130
April 2020	5
May 2020	5
June 2020	1
July 2020	100
August 22020	140
September 2020	300
October 2020	100
November 2020	15
December 2020	0

Supply of *Encarsia* parasitoids

Coconut fronds or leaflets containing parasitized puparia were collected from the affected ecosystem and released in newer areas of infestation. The details of supply of *Encarsia* parasitoids are as follows (Table 80).

Table 80: Details on the supply of *Encarsia* parasitoids from Coconut Research Station, TNAU, Aliyarnagar during 2020

Month	No of farmers benefitted	Number of packets distributed
January 2020	1758	4468
February 2020	1981	5713
March 2020	128	1192
April 2020	0	0
May 2020	1	50
June 2020	3	65
July 2020	3	130
August 2020	5	122
September 2020	6	145
October 2020	13	286
November 2020	10	180
December 2020	17	210
Total	**3925**	**12,561**

About 12,561 packets of *Encarsia* were distributed to the farmers of all the coconut growing districts of Tamil Nadu. A consignment with 100 packets of *Encarsia* was sent to West Godavari district of Andhra Pradesh and ICAR-NBAIR, Bengaluru.

Ambajipeta

Parasitoids *viz., Bracon hebetor, Goniozus nephantidis and Pediobius imbreus* are being multiplied on large scale at Parasite Breeding Station, Horticultural Research Station, Ambajipeta. A total of 6600 numbers of *Bracon hebetor*, 1,77,050 numbers of *G. nephantidis*, 17100

numbers of *P. imbrues*, 242 Tricho cards and 32,61,100 number s of *P. astur* eggs were supplied to the farmers of East Godavari, West Godavari, Visakhapatnam and Srikakulam districts of Andhra Pradesh, Bhadradri Kothagudem, Medchal and Khammam districts of Telangana. The predator P.astur eggs were also supplied to farmers of Pollachi, Kanyakumari districts of Tamil Nadu and Navasari district of Gujarat (Table 81).

Table 81: Production and supply of natural enemies at Ambajipeta during 2020

Sl. No	Month	No. of *Bracon hebetor* purchased by farmers	No. of *Goniozus nephantidis* purchased by farmers	No. of *Pediobius imbreus* purchased by farmers	No. of *Trichogramma chilonis* cards purchased by farmers	No.of *Pseudomallada astur* eggs purchased by farmers
1	Jan' 2020	0	27000	0	10	8,53,000
2	Feb' 2020	0	41700	3000	10	442000
3	Mar'2020	0	13000	5000	6	411100
4	Apr'2020	0	0	6000	0	20000
5	May 2020	0	0	0	0	0
6	June 2020	0	34500	3000	0	96000
7	July 2020	0	16500	0	0	30000
8	Aug'2020	0	2000	0	0	0
9	Sep'2020	0	20000	0	30	127000
10	Oct'2020	2000	0	0	80	141000
11	Nov'2020	100	11750	100	41	708000
12	Dec'2020	4500	10600	0	65	4,33,000
	Total	**6600**	**177050**	**17100**	**242**	**3261100**

Ratnagiri

The mass multiplication of *Bracon hebetor* and *Goniozus nephantidis* was carried out at Bio-control laboratory of Regional Coconut Research Station, Bhatye Dist. Ratnagiri and a total of 66350 nos. of *B. hebetor* and 10040 nos. of *G. nephantidis* parasitoids were mass multiplied and supplied for released in RCRS, Bhatye farm and farmers fields. The Reduvid bugs also produced 2150 nos. at Biocontrol laboratory, RCRS, Bhatye (Table 82) for the effective management of leaf eating caterpillar and mealy bugs.

Table 82. Production and supply of natural enemies

Months	*Bracon hebetor*			*Goniozus nephantidis*			Reduvid Bug
	No. of Parasitoids mass multiplied	No. of Parasitoids released in the field	Sale	No. of Parasitoids mass multiplied	No. of Parasitoids released in the field	Sale	No. of Bugs Produced
Jan., 20	9650	5100	2000	1470	-	2000	400
Feb., 20	8300	3000	-	2700	500	-	50
Mar., 20	10500	5350	-	1100	400	-	150
April 20	7400	2700	-	1400	400	-	200
May, 20	7600	3000	-	1200	-	-	350
June, 20	4600	1700	-	700	-	-	400
July 20	2000	1000	-	400	-	-	-
Aug., 20	2350	1700	-	110	-	-	200
Sept., 20	2450	1650	-	40	-	-	100

Oct., 20	8100	1000	5500	120	-	-	-
Nov., 20	1650	1150	-	250	-	-	50
Dec., 20	1750	1150	-	550	-	-	250
Total	**66350**	**28500**	**7500**	**10040**	**1300**	**2000**	**2150**

Arsikere

Wide spread incidence of coconut black headed caterpillar infestation was recorded in Chikkamagaluru, Tumkur, Mysore, Hassan and Mandya districts. Mass multiplication of *Bracon brevicornis* and *Goniozus nephantidis* is being carried out at Biocontrol Laboratory of Horticulture Research and Extension Centre, Arsikere and a total of 5,500 *Bracon brevicornis* and 36,800 *Goniozus nephantidis* parasitoids were supplied for release in approximately 68 Palms (*Bracon*) + 460 Palms (*Goniozus*) of black headed caterpillar infested coconut palms (Table 83).

Table 83: Production and supply of parasitoids for the management of coconut black headed caterpillar in Arsikere centre (2020-21)

Months	*Bracon brevicornis*	*Goniozus nephantidis*
January 2020	500	2000
February 2020	1200	6000
March 2020	700	3000
April 2020	0	800
May 2020	0	400
June 2020	0	300
July 2020	500	2000
August 2020	600	8000
September 2020	2000	7000
October 2020	0	3000
November 2020	0	2500
December 2020	0	1800
Total	**5500**	**36800**

Table 84: Extent of infestation of rugose spiralling whitefly in coconut and their natural enemies in Aliyarnagr centre during 2020

Months	Incidence of RSW (%)	Intensity of RSW (%)	Grade of pest intensity	Live colony/four leaflets /palm			Natural enemies/ four leaflets/palm		Percent parasitization (%)
				Eggs	Nymphs	Adult	Spiders	Predators	
January 2020	18.5	17.8	0.5	28.5	33.5	12.2	0.1	0.2	45.5
February 2020	20.5	22.5	0.8	29.8	35.4	13.2	0.0	0.3	45.0
March 2020	33.5	35.2	1.0	30.8	38.2	15.8	0.0	0.0	35.5
April 2020	38.7	40.5	1.5	34.5	40.2	20.4	0.3	0.2	30.5
May 2020	50.5	42.5	2.1	37.4	45.4	25.2	0.0	0.3	28.8
June 2020	45.5	40.2	2.0	40.8	48.5	28.2	0.5	0.5	25.0
July 2020	35.2	30.2	1.5	25.2	30.2	23.2	0.2	0.2	28.5
August 2020	37.2	35.5	1.0	22.3	25.2	20.2	0.3	0.0	30.5
September 2020	42.5	42.5	1.2	28.5	20.2	23.4	0.2	0.2	48.5
October 2020	48.5	45.2	1.5	30.4	25.4	28.2	0.5	0.3	58.5
November 2020	35.3	32.5	1.3	22.3	23.2	23.2	0.3	0.5	60.5
December 2020	28.7	25.7	1.0	20.2	20.8	20.5	0.3	0.3	72.5
Mean	36.2±2.8	34.2±2.4	1.3±0.1	29.2±1.7	32.2±2.6	21.1±1.5	0.2±0.0	0.3±0.0	42.4±4.2

(Mean ± standard error)

The percent incidence of rugose spiraling whitefly was recorded in the alternates host like banana, cocoa and custard apple. In banana RSWF incidence was high (28.5%) during May 2020, after South West Monsoon it was declined and reach low incidence of 20.2% during December 2020. Similar trends were observed in cocoa and custard apple. It was observed that in banana and custard apple was more preferred host than cocoa .

Ambajipeta

The infestation of rugose spiralling whitefly was recorded from April, 2020 to December 2020. However, maximum incidence (67.5 per cent), intensity (78.3 per cent) and grade pest intensity (1.2), were noticed in April 2020 and it gradually declined from May, 2020 and December an incidence of 25.9 per cent and 27 per cent intensity and 0.5 grade pest intensity was recorded (Table 85). A low incidence (less than 10 spirals) incidence of rugose spiralling whitefly was also noticed on oil palm, banana, mango and sapota.

Table 85. Extent of infestation of rugose spiralling whitefly in coconut and their natural enemies of Andhra Pradesh during 2020

Month	Incidence of RSW (%)	Intensity of RSW (%)	Grade pest intensity	Mean no. of pest stages / four leaflets					
				Spirals	Adult	Eggs	Nymph	Pupae	Natural enemies
April 2020	67.5	78.3	1.2 (Medium)	12.60	11.10	32.00	6.50	12.60	0.05
May 2020	57.6	73.7	1.0 (medium)	9.10	7.50	29.00	5.60	6.90	0.12
June 2020	51.5	58.1	0.9 (Low)	5.00	6.70	16.10	4.90	3.00	0.16
July 2020	48.1	51.1	0.7 (Low)	3.13	1.00	11.25	1.37	1.31	0.18
August 2020	46.1	50.5	0.5 (Low)	0.56	0.00	0.15	0.15	0.00	0.00
Sept., 2020	37.2	48.9	0.5 (Low)	0.29	0.00	0.15	0.00	0.00	0.00
Oct., 2020	35.5	42.6	0.5 (Low)	0.28	1.24	0.12	0.00	0.00	0.00
Nov., 2020	28.9	34.5	0.7 (Low)	1.50	0.00	0.09	0.03	0.18	0.16
Dec.,2020	25.9	27.0	0.5 (Low)	0.50	1.00	0.06	0`	0.00	0.25

Ratnagiri

Data in Table 86 indicated that the incidence of rugose spiraling whitefly (RSW) was noticed in the range of 6.6 to 57.6 per cent. However, intensity of RSW was recorded 2.9 to 36.2 percent from January to December 2020. The maximum incidence and intensity were recorded 57.6 and 36.2 percent, respectively in November, 2020. Whereas, minimum incidence (6.6%) and intensity (2.9%) was observed in June 2020. Rugose spiraling whitefly infestation was not noticed in July, August & September, 2020 due to heavy rainfall at Konkan region of Maharashtra. The average RSW pest records *viz.*, incidence, intensity, grade index, no. of live colonies/ leaflet, *Encarsia* parasitization (%) and natural enemies were recorded 26.1, 18.7, 0.49, 2.9, 18.3 and 0.83/ leaflet, respectively. The median grade index was noticed in Jan & Nov. 2020. Whereas, low grade index was recorded in rests of the months. However, maximum *Encarsia* parasitization (46%) was observed in December, 20.

Table 86: Extent of infestation of rugose spiralling whitefly in coconut and their natural enemies in Maharashtra

Months	Incidence of RSW (%)	Intensity of RSW (%)	No. of live colonies	Grade Index	Natural Enemies (Parasitoid/ Others)	Encarsia parasitism (%)
Jan., 20	24.9	9.7	10.1	1.20	1.2	5.1
Feb., 20	10.9	4.4	1.4	0.40	0.5	8.0
Mar., 20	9.0	3.9	1.1	0.13	1.0	6.3
April 20	8.2	3.2	1.0	0.10	0.6	5.4
May, 20	7.7	3.1	1.5	0.20	0.8	5.0
June, 20	6.6	2.9	1.7	0.2	0.6	21.7
July, 20	0.0	0.0	0.0	0.00	0.0	0.0

Aug., 20	0.0	0.0	0.0	0.00	0.0	0.0
Sept., 20	0.0	0.0	0.0	0.00	0.0	0.0
Oct., 20	36.6	28.1	3.17	0.68	0.9	10.0
Nov., 20	57.6	36.2	10.0	1.15	1.8	35.8
Dec., 20	37.5	29.4	5.0	0.63	1.46	46.0
Mean ± SE	26.1 ± 7.6	18.7 ± 5.2	2.9 ± 1.0	0.4 ± 0.1	0.83 ± 0.19	18.3 ± 6.4

Average mean± Standard error

The average incidence of rugose spiraling whitefly was also noticed on banana, mango, cocoa and cashew nut which recorded 6.0, 3.7, 5.5 and 3.25 per cent, respectively. However, maximum RSW population was observed during January, 2020 which was on Banana (16%), Mango (12%), Cocoa (16%), and Cashew nut 8 per cent.

Arsikere

The infestation of rugose spiralling whitefly was gradually increased from May 2020 onwards and decline during the month of October. However, maximum incidence and intensity and grade pest intensity were recorded 42.5 per cent, 34.5 per cent and 1.4, respectively in April, 2020. The incidence of rugose spiralling whitefly was also noticed on major fruit crops like banana (18.6 %), guava (15.6 %), mango (15.7 %), jackfruit (16.7 %) sapota (17.6 %) and papaya (16.8 %). The average incidence was ranged between 15.6 to 18.6 per cent was noticed during the year 2020 (Table 94).

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

Aliyarnagar

The IPM strategies for the management rugose spiralling whitefly was started during the month of November 2018, in the COD palms (Age 15 years old). The recommended IPM strategies were followed till date as per the approved AICRP (palms) technical programmes. The results revealed that in the IPM strategies adapted plot the incidence and intensity of RSWF was significantly reduced to from 52.2% to 22.5% and 48.2 % to 20.5% respectively when compared to the natural control where the percent incidence and pest intensity was increased from 45.2 to 56.2% and 50.5% to 58.5% respectively. Similarly the live colonies of egg, nymphs and adults were also significantly reduced. The grade of pest intensity was significantly reduced from 1.5 (medium) to 0.8 (low) in IPM plot and it was 2.0 to 2.3 in natural control. In both the plots the spiders and predator population was observed. The natural control registered slow decline of incidence, intensity and grade pest intensity of RSWF compared to IPM plots.

Ambajipeta

The IPM of rugose spiralling whitefly experiment was initiated in Polytechnic college, DRYSRHU, Ramachandrapuram, East Godavari district as low pest incidence and sufficient pest population build up of RSW was not recorded in HRS., Ambajipeta farm (Table 87). The experiment was initiated in eight year old Hybrid Godavari Ganga block in the college and first spraying of neem oil spray was initiated on 17.12.2020 and pre treatment observation was recorded.

Table 87: IPM of rugose spiraling whitefly at Ambajipeta during 2020

Treatments	Pre-treatment observations							
	Incidence of RSW (%)	Intensity of RSW (%)	Grade	Mean no. of pest stages per 4 leaflets			Mean no. of natural enemies per 4 leaflets	
				Adults	Nymphs	Pupae	Spider	Predator *P. astur*
T1-IPM	91.98 ± 2.82	79.47 ± 3.09	1.30 ± 0.15	8.62 ± 1.21	12.81 ± 3.23	3.19 ± 0.81	--	0.50 ± 0.19
T2-Natural control	98.81 ± 0.73	85.64 ± 0.86	1.25 ± 0.25	8.98 ± 1.51	21.82 ± 1.16	3.89 ± 0.76	--	0.75 ± 0.37

Experiment initiated on December 17th 2020 and is in progress.

Ratnagiri

The total 25 GBGD variety palms selected for determination of IPM strategies over natural control for each treatment against rugose spiralling whitefly. The present experiment was initiated in October, 2020 and thus generated data in Table 88 indicated that the non significant results registered in pre-count observations. The integrated pest management (IPM) treatment was reduced the incidence and intensity of rugose spiralling whitefly were recorded 22.0 and 17.4 percent, respectively over pre-count (40.0 and 47.5%, respectively). The IPM treatment was found significantly superior over the natural control. The grade pest intensity was reduced in IPM 0.70 (Low) as compared to pre-treatment count 2.1 (High). Moreover, the IPM treatment was found minimum no. of RSW live colonies (4.2/leaflet) which was significantly superior over natural control (13.4/leaflet). The non significant results were observed in natural enemies (parasitoid/other) and Encarsia parasitization associated with RSW. The natural control registered the increase of incidence and intensity of RSW were recorded 56.9 and 63.9 as compared to pre-count observation were noticed 36.7 and 46.7 percent, respectively. The natural enemies (parasitoid/other) and Encarsia parasitization was recorded maximum in unsprayed plot were noticed 2.0 and 52.4 per cent over treated plot (1.4 and 40.3 % respectively).

Table 88: Impact of IPM treatment on rugose spiraling whitefly

Treatments	Pre-treatment observations					
	Incidence of RSW (%)	Intensity of RSW (%)	No. of live colonies	Grade pest Index	Natural Enemies (Parasitoid/ others)	Encarsia parasitism (%)
T1- IPM	40.0 ±2.0	47.5 ± 2.9	21.9 ± 5.1	2.1	2.6 ± 0.6	21.9 ± 5.1
T2-Natural control	36.7 ±1.6	46.7 ± 3.2	22.7 ± 3.9	2.1	2.2 ± 0.7	42.8 ± 0.1
Sig. (P= 0.05)	N.S.	N.S.	N.S	Low - < 1, Median - 1-2, High - 2-3	N.S.	N.S.
't' value	0.33	0.64	0.58		1.36	0.58
T1-IPM	22.0 ± 1.5	17.4 ± 2.5	4.2 ± 0.6	0.70	1.4 ± 0.6	40.3 ± 7.5
T2-Natural control	56.9 ± 2.4	63.9 ± 3.9	13.4 ±1.8	1.75	2.0 ± 0.5	52.4 ± 6.8
Sig. (P= 0.05)	Sig.	Sig.	Sig.	Low - < 1, Median - 1-2, High - 2-3	N.S.	N.S.
't' value	5.41	3.49	3.18		1.09	0.13

Average mean ± standard error

Arsikere

The experiment was carried out at Hulukatte village of Tiptur taluk, totally there was 25 GBGD palms selected for the study. IPM package for Rugose spiralling whitefly was implemented in the plot as per the experimental protocol. Pre data on the incidence and intensity of whitefly was recorded in the month of October 2020. Post treatment observations were recorded on an incidence and intensity of whitefly. Simultaneous observations were also made in control plot. After imposition of treatments, the whitefly infestation gradually decreased from 36.3 per cent to 10.4 per cent in treatment and in control plot the whitefly infestation increased from 35.8 to 47.6 per cent. The IPM treatment recorded minimum adult's population (2.5), nymph (2.8) and egg (0. 6) which was significantly superior over natural control. The IPM treatment also registered the highest predator population (8.9) over the control (2.6).

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V. EXPERIMENTAL RESULTS IN OIL PALM

5.1 Crop Improvement

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

Centres: Pattukkottai

Pattukkottai

Ten oil palm hybrids developed from ICAR-IIOPR, Regional Station, Palode were planted during September, 2007 by adopting RBD with 3 replications and 6 palms per treatment. Soil of the experimental field was red sandy loam. Among the 10 hybrids evaluated for growth and yield parameters, the hybrid NRCOP 4 recorded significantly the highest palm height of 5.3 m and NRCOP 7 recorded the highest girth of 3.9 m. The lowest palm height (4.7 m) was recorded in hybrid NRCOP 10. Number of leaves produced per year (25.6) was highest in NRCOP 2 and female inflorescence (12.3) was highest in NRCOP 1. Data on yield attributes of oil palm revealed that the highest bunch weight of 173.25 kg/palm and per ha yield of 24.78 t/ha was recorded in hybrid NRCOP 9 for the period of January 2020 to December 2020 (Table 89).

Table 89: Growth performance of oil palm hybrids at Pattukkottai

Name of the hybrid	Palm height (m)	Palm girth (m)	Annual leaf production (No.)	No. of female inflorescence	Bunch weight (kg)	No. of bunches/ palm	FFB yield	
							kg/palm	t/ha
NRCOP 1	5.1	3.58	24.4	**12.3**	13.72	10.1	138.84	19.85
NRCOP 2	5.2	3.87	**25.6**	10.2	16.92	8.5	144.16	20.61
NRCOP 3	4.9	3.75	24.2	10.8	16.02	9.1	145.78	20.85
NRCOP 4	**5.3**	3.86	24.8	10.2	15.35	8.8	135.85	19.43
NRCOP 5	5.1	3.78	25.3	11.2	15.50	9.5	147.25	21.06
NRCOP 6	4.9	3.76	24.1	11.6	14.25	9.8	139.65	19.97
NRCOP 7	5.2	**3.89**	24.5	11.0	14.58	**10.2**	149.45	21.37
NRCOP 8	5.1	3.62	24.8	10.7	15.90	10.0	159.32	22.78
NRCOP 9	4.7	3.61	24.8	10.8	**17.50**	9.9	**173.25**	**24.78**
NRCOP 10	4.7	3.80	23.9	10.9	16.42	9.8	160.92	23.01
S. Ed±	0.13	0.32	0.46	0.56	1.33	1.18	2.23	1.45
CD (P=0.05)	0.26	0.64	0.92	1.12	2.66	2.36	4.46	3.31

Field view of Gen 8 Trial

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

Pasighat

Ten hybrid combinations were planted during August 2010. The growth and yield attributes were furnished in table 90 and growth of the palms with respect to stem height was maximum (271.0 cm) in NRCOP-29 and at par with NRCOP-23, NRCOP-24 and NRCOP-27, NRCOP-22, whereas the palm height was minimum (208.0 cm) in NRCOP-25 closely followed by NRCOP-30 (217.0 cm). Maximum number of leaves (23.3) was produced by the cross combination NRCOP-22 which was significantly higher than any other treatment. Minimum number of leaves (19.7) was produced by NRCOP-30. Maximum

number of female flowers (10.7) were produced by the cross NRCOP-22 which was significantly higher than the female flowers produced by other cross combinations. Minimum number of female flowers (7.05) were produced by the cross NRCOP-30. The sex ratio was recorded highest (0.75) in NRCOP-22 which was statistically at par with NRCOP-30, NRCOP-27 and NRCOP-26. Sex ratio recorded was least (0.56) in NRCOP-29. Maximum number of Fresh Fruit Bunches (10.4) was produced by NRCOP-22 which was significantly higher than in any other cross combination except NRCOP- 27, and NRCOP- 21 where as the NRCOP-29 produced the least number of FFB (6.69) per palm. The average bunch weight recorded was maximum (13.4kg) in NRCOP-22 which was significantly higher than any other cross combination. The bunch weight was least in NRCOP-23 (10.3 kg). Significantly the highest yield was recorded in NRCOP-22 (20.1 t/ha), whereas it was was minimum in NRCOP-29 (11.17t/h).

Table 90: Growth and yield parameters of Oil palm

Cross Combination	Plant height (cm)	No. of leaves produced	Male flowers/ palm	Female flowers/ palm	Sex Ratio	No. of FFB/ plant	Bunch weight/ palm (kg)	Yield	
								kg/ palm	t/ha
NRCOP-21	218.7	21.7	4.7	9.5	0.7	9.4	11.7	110.2	15.8
NRCOP-22	232.0	23.3	3.4	10.7	0.7	10.4	13.4	140.3	20.0
NRCOP-23	269.3	19.7	47	9.0	0.7	8.5	10.3	89.7	12.7
NRCOP-24	261.7	20.5	4.5	7.7	0.7	7.7	11.4	89.1	12.7
NRCOP-25	208.0	20.7	4.3	8.5	0.7	8.2	12.4	101.7	14.5
NRCOP-26	217.3	22.0	4.7	9.3	0.7	9.1	12.4	114.2	16.3
NRCOP-27	259.0	22.0	4.4	9.7	0.7	9.7	11.7	113.4	16.2
NRCOP-28	227.7	21.2	4.7	8.4	0.7	8.3	12.0	100.4	14.0
NRCOP-29	271.0	19.7	5.52	7.1	0.6	6.6	11.7	77.4	11.0
NRCOP-30	217.0	19.7	3.11	7.0	0.7	6.78	11.5	78.7	11.2
CD at 5%	**36.347**	**0.834**	**NS**	**0.860**	**0.074**	**0.992**	**0.643**	**12.275**	**1.724**
CV (%)	**8.896**	**2.308**	**17.440**	**5.728**	**6.504**	**6.795**	**3.161**	**7.045**	**6.935**

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

Centres: Pasighat, Mulde, Pattukkottai and Vijayarai

Treatments details:

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

Pasighat

Hybrids were planted during August 2012-13. The growth of the plants with respect to plant height collar girth and number of leaves produced over a period of one year was found to be statically at par, in all the cross combinations. Sex ratio was highest (0.60) in NRCOP-22 and lowest (0.48) in NRCOP-39 and NRCOP-40. The number of FFB/ palm recorded was maximum (7.50) in NRCOP-31 which was at par with NRCOP-37, NRCOP-33, NRCOP-32 and NRCOP-34. The average bunch weight did not vary significantly in the cross combinations. The mean yield/palm and yield t/ha was maximum (55.30kg/palm and 7.9 t/ha) in NRCOP-33 which was at par with NRCOP-37 (Table 91).

Table 91: Growth and yield parameters of Oil palm plants (Gen. 8D) (Year of planting 2013)

Cross Combination	Stem height (cm)	No. of leaves produced	No. of male flowers/ plant	No. of female flowers/ plant	Sex Ratio	No. of FFB/ plant	Bunch weight/ palm	Yield	
								kg/palm	t/ha
NRCOP-31	62.3	19.7	5.7	7.7	0.5	7.5	6.7	52.2	7.4
NRCOP-32	70.1	19.7	4.7	7.5	0.7	7.1	7.2	52.1	7.4
NRCOP-33	70.0	20.0	5.2	7.3	0.6	7.3	7.5	55.3	7.9
NRCOP-34	70.3	19.4	6.5	6.8	0.5	6.8	7.0	45.1	6.4
NRCOP-35	70.6	19.0	6.1	6.5	0.5	6.4	7.0	45.9	6.7
NRCOP-36	70.0	19.5	6.6	6.7	0.5	6.4	7.1	45.8	6.5
NRCOP-37	70.5	20.2	6.2	7.5	0.5	7.4	7.3	53.9	7.7
NRCOP-38	71.0	19.3	5.8	6.3	0.5	5.8	7.5	43.9	6.2
NRCOP-39	69.7	18.4	6.3	5.9	0.4	5.7	7.1	40.2	5.8
NRCOP-40	68.0	19.1	6.8	6.3	0.4	6.0	6.8	41.5	5.9
CD at 5%	**NS**	**NS**	**1.063**	**1.161**	**0.063**	**1.047**	**NS**	**8.936**	**1.236**
CV (%)	**4.2**	**3.1**	**10.2**	**9.9**	**6.9**	**9.1**	**4.0**	**10.9**	**10.6**

Field view of NRCOP 21 to 30 at Pasighat

Mulde

Hybrids were planted during 2011. Ten new cross combinations of oil palm showed significant variation for average height and number of female inflorescences. Minimum height (2.9m) was recorded in NRCOP-38 and maximum girth (3.3 m) was recorded in NRCOP-40. Average leaf production ranged from 26.9 in NRCOP-38 to 29.76 in NRCOP-38 . Maximum number of female inflorescences (10.28) was produced in NRCOP-31 with sex ratio 0.70. More number of FFB (16.0) and the highest yield of FFB (23.7 t/ha) were recorded in NRCOP- 31 and NRCOP-34 recorded the lowest yield i.e. 12.2 t/ha (Table 92).

Table 92: Yield performances of different hybrid combinations at Mulde (Year of planting 2011)

Code number	No. of FFB	Weight of FFB (kg/ bunch)	Yield of FFB	
			kg/palm	t/ha
NRC NRCOP 31	10.3	16.0	165.7	23.7
NRCOP 32	6.8	14.0	94.8	13.6
NRCOP 33	5.9	14.8	87.7	12.4
NRCOP 34	5.4	16.2	85.2	12.2
NRCOP 35	5.7	16.2	90.5	12.9
NRCOP 36	6.7	14.6	97.7	13.8
NRCOP 37	7.7	13.8	106.2	15.2

NRCOP 38	8.2	14.0	114.8	16.4
NRCOP 39	7.0	14.2	100.6	14.3
NRCOP 40	6.8	12.8	87.5	12.5
S.Em±	0.8	0.5	1.2	7.8
CD (P=0.05)	2.5	**1.4**	**NS**	**NS**

Pattukkottai

Nine hybrids *viz*., NRCOP 31 to 39 were planted during 2013 in ARS, Pattukkottai. Among 9 hybrids received, only five hybrids (NRCOP 31, 32, 33, 38 and 39) had sufficient seedlings for the replicated trial. Other four hybrids *viz*., NRCOP 34, 35, 36 and 37 were planted as non replicated trial for observation. The seedlings have established well. Palms are in initial stage of bearing.

Among the replicated hybrids, NRCOP -32 recorded significantly the highest palm height (5.2 m). Palm girth was higher in the hybrid NRCOP 38 (3.55 m). Number of leaves produced per year was the highest in NRCOP 39 (24.9) and the number of female inflorescence produced (11.7) was the highest in NRCOP 38, whereas, the percentage of female flowers was high in NRCOP 32 (66.0%). Highest bunch weight was observed in the hybrid NRCOP 38 (16.8 kg). The highest FFB yield per palm of 155.4 kg and FFB yield per hectare of 22.2 tonnes was registered in the hybrid NRCOP 38 during the period from January 2020 to December 2020 (Table 93).

Among the non-replicated hybrids, the hybrid NRCOP 37 recorded highest palm height (4.9 m), palm girth (3.6m) and the number of leaves produced per year (25.9) and the percentage of female flowers was high in NRCOP 35 (66.00%). The highest FFB yield (140.6 kg/palm) and yield (20.1 t/ha) was registered in the hybrid NRCOP 35 during the period from January 2020 to December 2020.

Table 93: Yield performance of oil palm hybrids at Pattukkottai

Hybrids	No. of bunches/ palm	Average bunch weight (Kg/palm)	FFB yield (kg/ palm)	FFB Yield (t/ha)
NRCOP 31	**9.3**	12.7	118.5	16.9
NRCOP 32	9.3	14.9	138.6	19.8
NRCOP 33	9.1	15.5	140.8	20.1
NRCOP 38	9.2	**16.8**	**155.4**	**22.2**
NRCOP 39	9.2	14.5	133.4	19.0
S Ed	**0.18**	**1.33**	**4.53**	-
CD 5%	**0.36**	**2.66**	**9.06**	-

Field View of Gen 8 D Trial

Vijayarai

The trial was laid out during July, 2011. Among 10 crosses, significant differences were recorded for palm height, palm girth and number of bunches per palm per year. Significantly higher palm height was recorded in the cross NRCOP-40 (3.5 m) which was on par with the crosses NRCOP-32 (3.4m), 33 (3.3m), 35 (3.3m) and 37 (3.3m). Girth of the palm was significantly higher in the palm NRCOP-36 (3.22 m) which was on par with the crosses NRCOP-34(3.06m), 38 (3.23m) and 39 (3.15m). Number of bunches produced per palm per year was significantly higher in the cross NRCOP-37 (10.8) which was on par with the crosses NRCOP-31(8.7), 34(8.3) and 38(8.82) (Table 94).

Table 94: Performance of cross combinations of oil palm at Vijayarai

Hybrid	Palm height (m)	Palm girth (m)	No. of leaves	Sex ratio	Bunch weight (kg)	No. of bunches	FFB yield	
							kg/palm	t/ha
NRCOP 31	2.7	0.7	24.7	0.6	14.3	8.7	125.0	17.9
NRCOP 32	3.4	0.8	21.6	0.5	20.8	6.5	139.0	19.9
NRCOP 33	3.3	0.9	24.8	0.5	23.2	4.9	112.4	16.1
NRCOP 34	2.7	0.6	24.7	0.5	17.9	8.3	145.4	20.5
NRCOP 35	3.3	0.9	23.0	0.5	21.3	7.6	163.0	23.3
NRCOP 36	2.3	0.5	23.8	0.3	16.4	7.3	118.2	16.9
NRCOP 37	3.3	1.0	23.2	0.6	18.8	10.8	204.0	29.2
NRCOP 38	2.6	0.6	24.5	0.5	19.8	8.8	176.5	25.2
NRCOP 39	2.5	0.5	24.3	0.5	20.4	7.2	146.5	20.9
NRCOP 40	3.5	1.0	22.7	0.6	18.0	6.5	120.3	17.2
CD (P=0.05)	**0.461**	**0.11**	**NS**	**NS**	**NS**	**2.646**	**NS**	**NS**
S.Em ±	0.1	0.0	0.3	0.0	0.8	0.5	9.2	1.3
CV (%)	9.044	2.55	7.88	22.27	15.55	20.10	24.97	24.97

Fresh fruit bunches of NRCOP 37

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

Vijayarai

The experiment was laid out during, 2013. Among 11 crosses and one control significant differences were not recorded for palm height, palm girth, number of leaves/ palm/year, sex ratio and number of bunches produced per palm per year and fresh fruit bunch yield (Table 95). Average bunch weight recorded was significantly higher in the cross NRCOP-44 (16.57 kg) followed by NRCOP-43(13.96kg) and NRCOP-50 (13.47 kg).

Table 95: Growth and yield parameters of D x P hybrids of oil palm at Vijayarai

Name of the hybrid	Palm height (m)	Annual height increment (m)	Palm girth (m)	Number of leaves/ palm/ year	Sex ratio	Number of bunches/ Palm/year	Average bunch weight (kg)	FFB Yield	
								kg/ palm/ year	t/ha/ year
NRCOP-41	2.0	0.6	2.9	24.2	0.7	16.1	11.4	182.7	26.1
NRCOP-42	2.0	0.4	2.7	24.8	0.6	11.7	12.6	148.3	21.2
NRCOP-43	1.7	0.4	3.1	23.5	0.6	11.5	14.0	160.1	22.9
NRCOP-44	2.1	0.6	2.8	22.8	0.6	10.2	16.6	168.8	24.1
NRCOP-45	1.8	0.5	3.1	23.7	0.6	13.6	11.9	166.2	23.8
NRCOP-46	1.7	0.4	2.9	23.6	0.6	11.0	10.2	112.2	16.0
NRCOP-47	1.9	0.4	2.8	24.8	0.7	16.3	12.3	**201.6**	**28.8**
NRCOP-48	1.6	0.4	2.7	25.3	0.6	12.0	12.0	145.7	20.8

NRCOP-49	1.6	0.2	2.8	23.4	0.7	12.5	11.5	143.3	20.5
NRCOP-50	1.9	0.6	2.6	23.8	0.5	13.8	13.5	185.2	26.5
NRCOP-51	1.7	0.3	2.8	24.0	0.8	12.5	12.1	151.1	21.6
Control	1.7	0.4	2.8	24.2	0.6	13.2	11.6	151.6	21.7
CD (5%)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**2.442**	**NS**	**NS**
S.Em(±)	0.0	0.0	0.0	0.2	0.0	0.6	0.5	7.4	1.1
CV (%)	18.046	16.25	5.956	10.35	20.76	21.789	11.559	25.22	25.223

Fresh fruit bunches of NRCOP 47

5.2 Crop Production

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

Bavikere

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

Treatment details:

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

Levels of nutrients	Dosage
N levels (N_0, N_1, N_2)	0, 1200, 2400 g/palm/year
P levels (P_0, P_1, P_2)	0, 600,1200 g/palm/year
K levels (K_0, K_1, K_2)	0,1800,3600 g/palm/year

Experiment is in initial stage and analysis of soil samples was done and experiment is progressing as per the technical report.

Expt. 2: Plant geometry studies in oil palm

Treatment details:

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

1. M_1: 9m x 9m x 9m Triangular planting
2. M_2: 9m x 9m Square planting
3. M_3: 10m x 10m x 10m Triangular planting
4. M_4: 10m x 10m Square planting

Planting is done during 25-26th April, 2019

Experiment is in initial stage and analysis of soil samples was done and experiment is progressing as per the technical report.

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

Pasighat

Treatments

1. 900:450:900 g NPK/palm/year
2. 1200:600:1200 g NPK/palm/year
3. 1500:750:1500 g NPK/palm/year
4. The dose may be fixed based on the existing soil/ leaf analysis report targeting 20t/ha and the dose of different fertilizer may be modified based on the annual analysis report

   Spacing: 9 m hexagonal, Design: RBD
   Replication: 5 No. of palms/plot: 6

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

Sl. No	Treatment	Plant height (cm)	Stem Girth (cm)	No. Leaves produced
1	900:450:900 g NPK/p/y	163.6	37.6	17.6
2	1200:600:1200g NPK/ p/y	137.4	53.2	19.6
3	1500:750:1500g NPK/ p/y	171.2	55.6	20.0
4	The dose may be fixed based on the existing soil/ leaf analysis report targeting 20t/ha and the dose of different fertilizer may be modified based on the annual analysis report	146.2	37.8	15.6
	CD at 5%	**NS**	**7.655**	**1.252**
	CV (%)	**13.044**	**12.063**	**4.991**

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

Mulde

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

Treatments: 7; each treatment in 3 oil palm block

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

Replications: 3

Date of Planting: January, 2018.

It is clear from Table 103 that the seven different inter crops in oil-palm garden. The maximum yield of oil palm recorded in treatment Oil Palm + Red Ginger + Black pepper, yield of oil palm is 166.2 kg /palm while the maximum black pepper yield found Oil Palm + Heliconia + Black pepper , 0.092/kg black pepper / vine. The maximum foliage cutting from Oil Palm + Dracaena + Black pepper, 150 cutting of dracaena harvested during 2020.

Sr. No.	Treatments	Plot Size	Yield			
			Pre experimental (oil Palm kg/ palm)	2019-20 (oil Palm kg/palm)	Intercrop	Black pepper Kg/ vine
1	**Oil Palm + Heliconia + Black pepper**	3 X 2 m	73.2	120.0	45 no./plot	0.092
2	**Oil Palm + Red Ginger + Black pepper**	3 X 2 m	64.75	166.2	25 no./plot	0.045
3	**Oil Palm + Lily + Black Pepper**	3 X 2 m	129.6	140.8	18 no./plot	0.236
4	**Oil Palm + Bush Pepper + Black pepper**	3 X 3 m	108.5	110.6	0.597 kg/bush	0.321
5	**Oil Palm + Nutmeg + Black pepper**	1.0 x 3.0 m Triangular	109.4	165.4	-	0.448
6	**Oil Palm + Dracaena + Black pepper**	3 x 2 m	152.75	128.0	150 cuttings	0.083
7	**Oil Palm (sole)**	9 x 9 x 9 m	99.72	147.75	-	-

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

Pasighat

The 29 oil palm seedlings planted in the year 2006 is being taken up as the material for this "maximization plot and all the recommended crop management practices are being adopted to harvest maximum yield. The average plant height, collar girth and number of leaves produced per palm per year recorded during 2020 is 4.35 m, 2.82m and 23.1 leaves per palm, respectively. Flowering and fruiting in all the palms have been observed to be satisfactory over the years. The number of FFB produced per palm was 9.30 with an average bunch weight of 18.10 kg and the to be 24.07 t/ha.

Demonstration plot at Pasighat

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VI. EXPERIMENTAL RESULTS IN ARECANUT

6.1 Crop Improvement

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

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

Centres: Shivamogga and Wakawali

Shivamogga

Seven arecanut varieties viz., Mangala, Sumangala, Sreemangala,Mohitnagar,Swarnamangala,Madhuramangala and Sreewardhini were planted at Honnaville Station during 2015.Of seven arecanut varieties evaluated, variety Mohitnagar exhibited maximum plant height (526 cm) and plant girth (54.80cm) with an internodal length of 18.50 cm compared to other varieties. The varieties Mangala, Sumangala and Mohitnagar took around 38 months to produce first inflorescence fallowed by Sreemangala (39 months) and Swarnamangala (40 months) and Madhuramangala (55 months). Among the varieties, Mohitnagar showed maximum no. of inflorescence (3.5), no. of female flowers (125.0), along with maximum Spadix length (56.3 cm) and Spadix breadth (12.5 cm) compared to other varieties. Among the varieties, the average nut was yield ranged from 0.88 kg to 1.50 kg per plant. The variety Mohitnagar showed maximum yield (1.50 kg/plant).

General view of Tarikere local at Shivamogga

Wakawali

The growth observations were recorded at four years of planting revealed that the plant height ranged from 86.9 to 155.3 cm with mean of 115.4 cm. It is revealed that the Mohitnagar variety recorded maximum plant height (155.33 cm) which was at par with Sumangala variety (133.0 cm). Mohitnagar recorded maximum number of leaves (7.9) followed by treatment Sreemangala (7.8), and Madhuramangala (7.6), respectively.

Activity II: Nucleus seed gardens for varieties

Centres: Goa, Port Blair, Shivamogga and Wakawali

Goa

Nucleus seed garden of Hirehalli Dwarf was established in different phases and being maintained with currently 284 surviving palms of which 82 are available at reproductive stage. The vegetative characters recorded on 113 plants are given below which indicates the mean height of the plant from plant base to base of crown was only 1.19±0.07 m at 9 years of planting. Mean spadix length and breadth in 133 inflorescences of the study were 32.38±1.03 cm, 13.68±0.29 cm, respectively. Mean number of female flowers per inflorescence in the experiment was 120.07±0.22.

Foliar glucose content in the leaf sap extract was measured which significantly differed between Mangala tall (564.43±79.04 microgram/ml) and Hirehalli dwarf (855.26±67.40 microgram/ml) plants. The results for the past two years confirm the hypothesis of association of the dwarf plant habit with high foliar glucose content and suggest the use as diagnostic biochemical assay.

Port Blair

To provide quality planting material of improved variety 'Samrudhi' to the island farmers, nucleus seed garden was established at Garacharma farm of the ICAR-CIARI, Port Blair. Palms have been established well and are in juvenile phase. Paddy straw mulching was undertaken for optimum moisture conservation. To avoid soil erosion from the terraces, stem cuttings of tapioca were planted on the slopes.

Shivamogga

Hirehalli dwarf variety showed a mean collar girth (55.2 cm), plant height (162 cm) and crown length of (105 cm) with partially drooping (planted during 2015) type of crown shape. Apart from that, the plant has showed a mean collar girth of (36.40 cm) and an internodal length of 5.25 cm. A total number of functional leaves (9.8 leaves/plant), leaf length (115.0 cm), leaf breadth (42.2 cm), leaf sheath length (38.8cm), leaf sheath breadth (14.3 cm) and 68.50 number of leaflets per leaf were recorded. Only one palm has flowered so far in the block.

Wakawali

The experiment has been planted with two varieties i.e. Hirehalli Dwarf and Shriwardhani of arecanut during

2015-16. The growth observations recorded after four years of planting showed that the Hirehalli Dwarf plants showed short stature with plant height to range from 9.0 to 44.0 cm, the crown length ranged from 39.0 to 79.0 cm, however the girth of palm ranged from 33.0 to 55.0 cm. The number of leaves varied from 7.0 to 8.0, leaf length 39.00 to75.00 cm and leaf breadth 39.0 to 65.0 cm, respectively.

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

Activity III: Demonstration block of Shriwardhani variety of Arecanut

Centre: Wakawali

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

6.2 Crop Production

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

Expt. 1: Evaluation of arecanut based cropping system models

Port Blair

In order to increase the profitability of arecanut farming in the islands, arecanut based cropping systems with herbal spices *viz*. arecanut + Burmese coriander 'CARI Broad Dhaniya 1' (T_2), arecanut + coriander 'ArkaIsha' (T_3) and arecanut + mint (T_4) were established during 2019 with arecanut sole cropping as control (T_1). The intercrops were replanted again in the field.

Expt. 2: Intercropping in juvenile arecanut garden

Wakawali

The data recorded for growth performance at the time planting indicated that the plant height ranged from 46.3 to 58.5 cm with mean of 53.3 cm. It is revealed that the treatment Rose apple was found to be superior and recorded maximum plant height (58.5 cm) which was at par with treatment T_2 (55.9 cm) . The Girth of plant ranged from 1.9 to 3.3 cm with mean of 2.6 cm.

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

Shivamogga

Location: Anaveri (Bhadravathi Tq.)

Treatments

1. Providing better drainage (depth maintained 15 cm below the root zone)
2. Providing water through drip irrigation
3. Improving aeration by application of paddy/areca husk (5 kg/plant)
4. Root rejuvenation by soil application of microbial consortia (*Trichoderma harzianum* (IMI304056) + *Pseudomonas fluorescence* (NCIB9046) and *Bacillus megaterium* (NCTC 9848) @ 100g/plant along with 2 kg neem cake and 10 kg of FYM/decomposed compost.
5. Growing intercrops (such as cocoa and banana) in the arecanut garden
6. Two sprays of $ZnSo_4$ @ 0.5 % during May-June and September - October
7. Application of fertilizers based on soil and leaf analysis.

The observation on initial mean number of healthy and affected leaves/plant and healthy primary roots/sq. ft. area in crown chocking affected demonstration garden revealed that, upon imposition of treatments healthy plants produced a mean number of 51.11 primary roots/sq. ft. area, 14.2 healthy leaves and 6.1 bunches/plant. Whereas, affected plants showing partial recovery and produced a mean number of 40.62 healthy primary roots/sq. ft. area, with a mean of 7.1 healthy leaves and 4.1 infected leaves/plant. The data obtained showed that, the management practices adopted to overcome crown chocking disorder influenced better root development as well as better uptake of nutrients by the plant resulting improved root growth and reduced number of infected leaves and bunches in the affected palms.

Population dynamics of biocontrol agents (*Trichoderma harzianum, Pseudomonas fluorescence* and *Bacillus megatarium)* in the rhizosphere soils of crown chocking disorder demonstration garden showed considerable increase in their population after six months of imposition

of the treatments. However, among the biocontrol agents, *Bacillus* sp. showed comparatively higher population enumeration followed by *Trichoderma* and *Pseudomonas* species, respectively.

6.3 Crop Protection

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

Roving survey was conducted during *Kharif* and *Rabi* season of 2020-21 in all the talukas of Shivamogga district to assess the incidence of different diseases in the areca gardens with the crop age ranging between 1 to 50 years. The data revealed that, among the diseases observed Phyllosticta leaf spot, Inflorescence die back and fruit rot found to be most common in majority of gardens surveyed with a mean incidence ranging from 13.45, 12.60, 46.93, 2.42, 0.75, 58.40, 14.87, 8.11, and 2.54 percent respectively. Inflorescence die back and Fruit rot appeared to be severe in almost all the taluks surveyed. However, yellow leaf disease was not observed in any of the talukas surveyed in Shivamogga district (Table 97).

Table 97: Survey and surveillance of Arecanut diseases at Shivamogga district

Taluk	No. of gardens surveyed	Disease Incidence (%)								
		PLS	BLS	Fruit rot	Bud rot	Crown rot	IDB	Crown chocking	Leaf blight	Ganoderma wilt
Shivamogga	20	23.2	33.1	11.25	2.9	0.0	88.2	27.1	13.5	3.7
Thirthahalli	7	12.3	0.0	89.15	3.5	1.8	37.7	3.75	3.9	1.1
Hosanagara	4	8.50	0.0	93.00	4.9	1.3	45.1	2.20	9.8	1.2
Shikaripura	6	12.5	19.2	20.75	1.0	0.2	69.2	29.00	9.1	2.4
Soraba	7	9.25	6.3	28.52	1.2	0.0	47.7	15.50	6.50	2.9
Bhadravathi	16	18.1	29.6	10.15	2.0	0.0	84.2	25.05	10.7	4.5
Sagara	6	10.0	0.0	75.75	1.5	2.0	36.5	1.50	3.2	2.0
Mean	**-**	**13.4**	**12.60**	**46.93**	**2.42**	**0.75**	**58.4**	**14.87**	**8.11**	**2.54**

* * * * *

VII. EXPERIMENTAL RESULTS IN PALMYRAH

7.1. Crop Improvement

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

Centres: Killikulam and Pandirimamidi

Killikulam

Performance of palmyrah germplasm collected during 1995

Much variation is observed among the planted germplasm accessions. Among the collection of germplasm planted during 1995, accession 18 has recorded maximum values in terms of palm height (503.3 cm) and leaf length (113.7 cm). Accession 01 recorded higher number of leaves (47.9 nos). Accession 21 recorded increased values for stalk length (159.2 cm). Accession 38 recorded lower values for palm height and Accession 05 for number of leaves and leaf length. Accession 34 recorded lower values for stalk length (107.5 cm). In 1995 planted germplasm accessions the highest bunch weight (11.8kg), average number of bunches (5.0) and fruits (48) were recorded with Acc. No. 1/95 followed by Acc.no.28/95.

Performance of palmyrah germplasm collected during 1997

The data recorded from the germplasm planted in 1997 indicated that the accession 67 recorded maximum palm height (516.7 cm) and accession 58 recorded increased number of leaves (52.2 nos). The length of the leaf was found to be highest in the accession 41 (131.5 cm). The length of the stalk was found to be highest in the accession 58 (219.7 cm). Among the 26 accessions of 1997 germplasm Acc. No. 26/97 has recorded the highest number of fruit bunches (8.0) and the bunch weight (7.0 Kg) and more number of fruits (32) was followed by Acc.No. 1/97.

Performance of palmyrah germplasm collected during 1999

Among the germplasm collected during 1999, the accession 74 recorded increased plant height (263.1 cm), and leaf length (117.4 cm). The accession 88 recorded increased number of leaves (46.6).

Performance of palmyrah germplasm collected during 2001

Among the accessions planted during 2001, accession 92 showed maximum palm height (369.1 cm) and number of leaves (46.4 nos), maximum leaf length (97.7) and stalk length (164.3 cm). Accession 96 recorded lower values for all the characters.

Performance of palmyrah germplasm collected during 2003

Among the germplasm accessions planted during the year 2003, the maximum palm height (205.3 cm), number of leaves (46.5), leaf length (81.4 cm) and stalk length (95.6 cm) was recorded in accession 153.

Performance of palmyrah germplasm collected during 2004

The data collected from germplasm planted during the year 2004 showed variations for palm height, number of leaves and stalk length. the accession 160 recorded maximum palm height (159.3 cm). Accession 164 recorded lowest plant height (103.2 cm). The stalk length was found to be highest (89.8 cm) in the accession 169 and leaf length was highest (81.2 cm) in the accession 165.

Performance of palmyrah germplasm collected during 2005

Accession 176 showed the maximum palm height (175.5 cm), accession 174 for number of leaves and leaf length. The stalk length was maximum (105 cm) in the accession 180 and the lowest plant height, number of leaves and stalk length was recorded with the accession Acc 179.

Performance of palmyrah germplasm collected during 2006

The data collected from germplasm accessions during the year 2006 showed maximum palm height (174.4 cm) with the accession 196. The accession 180 has recorded lowest plant height. Accession 184 recorded more number of leaves and accession 192 recorded increased leaf length (87.3 cm).

Performance of palmyrah germplasm collected during 2007

Among the germplasm collected during 2007, the accession 204 recorded maximum palm height (161.7 cm), highest stalk length (77.3 cm) was recorded in accession 206.

Performance of palmyrah germplasm collected during 2008

Among the 2008 planted accessions, the accession 209 has recorded maximum values in terms of plant height

(110.1 cm), number of leaves (29.7), leaf length (101.2 cm) and stalk length (69.4 cm).

Performance of palmyrah germplasm collected during 2009

Among the 2009 planted accessions, palm height and number of leaves was highest with the accession 219 and was lowest in the accession 224. However the leaf length was maximum in the accession 219 and stalk length recorded maximum (37.1 cm) with accession 225.

Performance of palmyrah germplasm collected during 2010

Among the accessions collected during the year 2010, accession 256 has recorded maximum palm height, number of leaves and stalk length. Minimum palm height was recorded in the accession 249.

Performance of palmyrah germplasm collected during 2011

Among the germplasm collected during 2011, the accession 274 recorded maximum palm height (115.8 cm), leaf length (77.5 cm) and minimum palm height was recorded in the accession 263 (63.7). The number of leaves (29.2) was highest in the accession 275.

Performance of palmyrah germplasm collected during 2012

Among the germplasm collected during 2012, the accession 285 recorded maximum palm height (95.8 cm). Minimum palm height was recorded in the accession 282. However the number of leaves was maximum in the accession 279 and minimum with accession 284.

Performance of palmyrah germplasm collected during 2013

Much variation was observed among the accessions planted during 2013 The accessions planted during 2013 showed maximum palm height (61.5 cm), and leaf length (45.3 cm) with accession 290. The maximum and stalk length (34.7 cm) was also recorded in the accession 289. Accession 288 recorded lower values for palm height.

Table 98: Abstract of biometrical observations recorded during January 2020

Year of Planting	Plant Height (cm)		Number of Leaves		Leaf length (cm)		Stalk length (cm)	
	Max	Min	Max	Min	Max	Min	Max	Min
1995	[503.33] Acc.18	[199.52] Acc.38	[47.82] Acc.01	[36.65] Acc.05	[113.67] Acc.18	[101.32] Acc.05	[159.22] Acc.21	[107.46] Acc.34
1997	[516.73] Acc 67	[238.11] Acc 41	[52.23] Acc 58	[49.44] Acc 46	[131.53] Acc 41	[115.33] Acc 46	[219.67] Acc 58	[147.11] Acc 48
1999	[263.12] Acc 74	[113.62] Acc 80	[46.62] Acc 88	[41.56] Acc 79	[117.41] Acc 73	[68.37] Acc 84	[131.12] Acc 73	[49.22] Acc 86
2001	[369.12] Acc 92	[95.32] Acc 96	[46.47] Acc 92	[36.17] Acc 96	[97.78] Acc.92	[70.21] Acc 96	[164.33] Acc 92	[66.47] Acc 96
2003	[205.31] Acc 153	[101.24] Acc 149	[46.55] Acc153	[32.86] Acc 149	[81.41] Acc 153	[68.32] Acc 149	[95.67] Acc 153	[57.51] Acc 149
2004	[159.33] Acc 160	[103.21] Acc 164	[39.44] Acc168	[37.13] Acc 173	[81.22] Acc 165	[66.76] Acc 164	[89.81] Acc 169	[53.41] Acc 164
2005	[175.47] Acc 176	[102.41] Acc 179	[34.61] Acc174	[30.19] Acc 179	[98.55] Acc 174	[73.23] Acc 179	[104.94] Acc 180	[66.21] Acc 179
2006	[174.44] Acc 196	[83.27] Acc 180	[37.34] Acc184	[30.32] Acc 196	[87.33] Acc 192	[65.42] Acc 196	[75.12] Acc 186	[55.26] Acc 190
2007	[161.74] Acc 204	[103.26] Acc 208	[36.19] Acc203	[27.47] Acc 197	[83.62] Acc 207	[68.73] Acc 198	[77.33] Acc 206	[42.57] Acc 202
2008	[110.15] Acc 209	[101.84] Acc 212	[29.68] Acc209	[23.74] Acc 216	[101.17] Acc 209	[56.45] Acc 217	[69.38] Acc 209	[43.77] Acc 217

2009	[119.66] Acc 219	[75.16] Acc 248	[33.11] Acc226	[26.98] Acc 224	[71.34] Acc 219	[55.66] Acc 225	[37.11] Acc 225	[33.42] Acc 223
2010	[113.92] Acc 256	[74.42] Acc 249	[32.54] Acc257	[25.78] Acc249,	[84.23] Acc 254	[55.64] Acc 255	[67.77] Acc 256	[33.17] Acc 258
2011	[115.75] Acc 274	[63.67] Acc 263	[29.18] Acc275	[23.22] Acc 263	[77.49] Acc 274	[54.20] Acc 264	[51.42] Acc 272	[29.46] Acc 275
2012	[95.74] Acc 285	[71.26] Acc 282	[23.42] Acc279	[21.32] Acc 284	[61.32] Acc 286	[45.62] Acc 287	[39.14] Acc 285	[35.84] Acc 279
2013	[61.46] Acc.290	[47.16] Acc.288	[23.84] Acc291	[19.33] Acc.295	[45.26] Acc.290	[35.83] Acc.289	[34.65] Acc 289	[29.32] Acc 293

Palmyrah germplasm fruit data collected in the year 2020

In 1995 planted germplasm accessions the highest bunch weight (11.8kg), average number of bunches (5.0) and fruits (48) were recorded with Acc. No. 1/95 followed by Acc.no.22/95.

Among the 27accessions of 1997 germplasm Acc. No. 25/97 has recorded the highest number of fruit bunches (8.0) and the bunch weight (7.0 Kg). and more number of fruits (32) was followed by Acc.No. 1/97

Germplasm collection of Palmyrah at Killikulam

Pandirimamidi

Survey and collection of palmyrah germplasm was done to identify dwarf and superior palmyrah genotypes for high neera and nungu yield. So far 272 number of Palmyrah germplasm accessions were collected and are being maintained as separate year wise germplasm blocks at Horticultural Research Station, Pandirimamidi. The germplasm accessions are being evaluated for various biometric, yield and yield related characters. The data on biometrical observations as well as flowering and fruiting characters were recorded for all the germplasm accessions assembled. The tender fruit observations were recorded in year wise blocks is tabulated as given below.

Palmyrah germplasm fruit data collected in the year 2020

In 1991 planted germplasm accessions the highest bunch weight (14.8kg), average number of bunches (10.0) and fruits (21) were recorded with Acc. No. 12/91 followed by Acc.no.8/91. Among the 10 accessions of 1993 germplasm Acc. No. 9/93 has recorded the highest number of fruit bunches (8.8) and the maximum fruit weight (1163g). Highest fruit eye weight (226g) was recorded with Acc.No. 10/93

Among the 1994 planted germplasm accessions. The highest number of fruit bunches (9) as well as number of fruits per bunch (10) was recorded with Acc. No. 2/94 with more fruit yield of 213g. The 1995 planted germplasm accessions are showing huge variation in their growth. Among the five accessions of 1995 planted germplasm, highest number of bunches (7) and highest number of fruits per bunch (8) was recorded with Acc. 2/95.

In 1998 planted germplasm flowering and fruiting was observed in accessions 2/98, 5/98, and 7/98. Among them Acc. No. 5/98 has recorded the highest number of bunches (7.0) with a big size of fruits per bunch (8) with a highest fruit eye yield of 296g. Among all the accessions planted during 1999, Acc. No. 4/99 recorded the more number of bunches (8) as well as maximium number of fruits per bunch (11).

Among the 2000 year planted germplasm flowering was observed only in few accessions. Among them the highest bunch weight (14kg), fruit weight (1955g), more fruit length (15cm), width (15cm), Circumference (50cm), with a good quality pulp of 840g in Acc.18. This Accession is identified as bigger sized fruits among the all germplasm accessions. In the 2001 planted germplasm accessions, among them Acc. No. 44/01 have recorded

the highest number of bunches (10). The highest fruit weight (954g) was recorded in Acc. No. 36/01.

Among the accessions Acc. No15/02 has recorded the highest bunch weight (14kg) with the highest fruit weight (1006g) followed by Acc. No. 7/02. In the 2003 germplasm, Acc.no. 4/2003 observed four branched bunches with a highest bunch weight of 19kg, with 11 bunches, with 30 number of fruits, followed by Acc no.10/2003. In 2004 planted germplasm, Acc.8/04 recorded, bunches (9) (three branches) fruits number (24), with fruit weight (375g). In 2006 planted germplasm, Acc.10/06 recorded, bigger sized fruits (358g), with eye yield of (80g).

In 2008 collected germplasm, flowering initiated this year, Acc.3/08 and Acc.4/08 off season flowering is observed (female bunches in the month of July-2020) recorded, fruit weight (455g), with eye yield of (60g).

Fruit yield of palmyrah at Pandirimamidi

Growth data of Palmyrah germplasm in the year 2020

In the germplasm (E.G.dt) collected during 1991, after 29 years of plant growth the minimum plant height is 8.2m recorded in Acc.No.10/91 & Acc.No.11/91 and maximum plant height (10.3m), max stem girth (1.79m) was recorded in Acc. No. 13/91, with a maximum number of leaflets (90). In the germplasm (E.G.dt) collected during 1993, after 27 years of plant growth the minimum plant height is 6.7m recorded in Acc.No.1/93 & Acc. No.10/93 and max stem girth (1.61m) was recorded in Acc. No. 9/93 with a maximum number of leaflets (87).

In the germplasm (E.G.dt) collected during 1994, the minimum plant height (6.26m) recorded in Acc.No.01/94 and Maximum plant height (9.0m) in Acc.No.2/94, and maximum stem girth (174cm) was recorded. In the germplasm (E.G.dt) collected during 1995, the minimum plant height is 2.76m recorded in Acc.No.05/95 and maximum plant height (8.0 m) and maximum stem girth (171cm) was recorded in Acc.No1/95 with 82 number of leaflets. In the germplasm (E.G.dt) collected during 1998, the minimum plant height is 6.8m recorded In Acc.No.4/98 with maximum number of leaflets (140) and Maximum plant height (8.3m) in Acc.No.5/98, and max stem girth (178cm) was recorded in Acc. No. 6/98.

In the germplasm (E.G.dt) collected during 1999, the minimum plant height (3.53m) was recorded in Acc. No.01/99 and maximum plant height (8.41m) was in Acc.No.5/99, maximum number of leaflets (84) was in Acc.No3/99 and max stem girth (180cm) was in Acc. No.6/99. In the germplasm (E.G.dt) collected during 2000, the minimum plant height (2.6m) was recorded in Acc.No.13/00 and maximum plant height (7.6m) and maximum number of leaflets (84) was in Acc.No.17/00. In the germplasm (Nellore) collected during 2001, the minimum plant height (1.2 m) was recorded in Acc. No.28/01 and Maximum plant height (6.0m) was in Acc.No.40/01, maximum number of leaflets (81) was recorded in Acc.No29/01.

In 2001 accessions (Nellore), within the flowering palms, Acc-19 recorded lowest plant height (3.5 m) and showing the symptoms of dwarfness i.e less leaf lamina length (76cm), breadth (97cm), leaflets (66), petiole length (80cm). In the germplasm (Nalgonda) collected and planted during 2002, the minimum plant height (1.8 m) recorded in Acc.No.12/02 and maximum plant height (7.5m) in Acc.No.3/02.

In the germplasm (Nidadhavolu) collected and planted during 2003, the minimum plant height (1.9 m) recorded in Acc.No.5/03 and maximum plant height (6.9m) was in Acc.No.1/03. In 2003 accessions (Nidadhavolu) within the flowering palms, Acc-4 recorded the typical character of four branched bunches with plant height (5.9 m). In the germplasm (Tamilnadu) collected and planted during 2004, the minimum plant height (2.6 m) recorded in Acc.No.13/04. In 2004 accessions within the flowering palms, Acc-8 recorded the typical character of three branched bunches with plant height (4.5 m) and recorded leaf lamina length (179cm), breadth(248cm), more number of leaflets(78), petiole length (128cm). In the germplasm (Vizag & East Godavari) collected and planted during 2006, the minimum plant height (2.7 m) recorded in Acc.No.4/06 and maximum plant height (5.1m) was recorded in Acc.No.3/06. In 2006 accessions (Vizag & East Godavari) only in Acc-10 flowering with a plant height of 3.3m, leaf lamina length (99cm).

Palmy./Gen. 10: Survey, *in situ* characterization and conservation of palmyrah germplasm for special traits

Centres: Konda Mallepally and Sabour

Konda Mallepally

Nalgonda Dist. of Telangana state is very popular for Palmyrah palm. The tree has huge population and been

in long use by the tappers community of the region. To tap these diverse germplasm in the region a survey was undertaken for collection of palmyrah germplasm from Nalgonda district with the broad objective of collecting diverse germplasm and with specific focus on dwarf types. A total of 10 accessions were marked in the survey from Ratnavaram village of Nadigudem mandal. The data on unique traits of each accession as reported by the farmer were documented.

Ten palmyrah palm germplasm accessions were identified from Ratnavaram village and all these accessions were planted by the farmers in their fields. All the germplasm accessions were male. Among ten germplasm accessions, five were dwarf phenotypes (HRSTSK-21, HRSTSK-23, HRSTSK-26, HRSTSK-28, HRSTSK-30) and five were tall phenotypes (HRSTSK-22, HRSTSK-24, HRSTSK-25, HRSTSK-27, HRSTSK-29). Among the accessions, Acc No. HRSTSK-23 had recorded the highest neera yield (12.0 litre per palm) followed by Acc No. HRSTSK-26 and HRSTSK-29 had the highest Neera yield (10 litres per palm). The highest palm height was recorded in Acc. No. HRSTSK-29 (11.4 m) and lowest palm height was recorded in Acc. No. HRSTSK-23 (3.8 m). The highest collar girth was recorded in Acc. No. HRSTSK-22 and HRSTSK-24 (1.5 m) and the lowest collar girth was recorded in Acc. No. HRSTSK-30 (1.00 m).

Sabour

In Palmyrah palm the diversification are enormous and with reference to the special traits a survey work was undertaken for the collection of Palmyrah germplasm from different blocks of Bhagalpur district in 2019 -20 and of Patna & Nalanda districts during 20-21 with specific focus on its dwarf type was undertaken.

Different blocks surveyed in Bhagalpur district, like Nathnagar, Sabour and Goradih revealed that most of the germplasm were tall type and none of them was dwarf type. During the surrey work conducted in Biharsharif and Nalanda east and west of Nalanda district as well as Manner block of Patna districts, some dwarf type was observed, identified and numbered for record. The height of the tree in most of the cases was 18-20 ft and the age as per the local farmers, varied from 15-20 years. The collar girth was found 4-5 ft.

7.2. Crop Production

Palmy./Agron. 23: Standardization of rooting media and containers for palmyrah seedling production

Centres: Killikulam, Konda Mallepally, Pandirimamidi and Sabour

Killikulam

Objectives:

- To standardize the rooting media for multiplication of palmyrah seedling through seed.
- To standardize container for multiplication and field planting.

Treatment details:

Rooting media:

T_1: Soil (control) + Imdia 6 g/kg + GA_3 1000 mg/l

T_2: Soil + scarification against sand +Imdia 6 g/kg + GA_3 1000 mg/l

T_3: Soil, sand and FYM mixed in 2:1:1 ratio + Imdia 6 g/kg + GA_3 1000 mg/l

T_4: Soil, sand and vermicompost mixed in 2:1:1ratio + Imdia 6 g/kg + GA_3 1000 mg/l

T_5: Soil, sand and poultry manure mixed in 2:1:1 ratio + Imdia 6 g/kg + GA_3 1000 mg/l

T_6: Soil, sand and composted coir pith mixed in 2:1:1 ratio + Imdia 6 g/kg + GA_3 1000 mg/l

Container:

T_1: Black polythene bag (12.5 x 50 cm)

T_2: Bamboo tube (12.5 x 40 cm)

T_3: PVC tube (12.5 x 50 cm)

T_4: Banana pseudo stem sheath (12.5 x 50 cm)

Replication: 4; Design: Completely Randomized Block Design

Observations to be taken:

- Days taken for sprouting (days)
- Percentage of germination (%)
- Number of leaves/seedling on 219 DAS
- Seedling height (cm) on 210 DAS

The trial was initiated during the month of October, 2019. The existing media *viz*., soil, sand, farm yard manure, vermicompost and composted coir pith were selected and the four types of containers were used for sowing. The sowing was done by placing uniform seed weight of palmyrah seed as well as by dipping in Imdia 6 g/kg + GA_3 1000 mg/l as per the treatment requirement.

Sabour

Different combinations on the guidelines of the technical programme, rooting media like Sand, Soil, Vermi-compost, Poultry-manure, FYM and Composted coir were prepared and placed in different containers to see the response of germination and growth of palmyrah seeds. The seeds after scarification were also treated with GA_3 and Imidacloprid.

7.3. Post Harvest Technology

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

Centres: Pandirimamidi and Sabour

Pandirimamidi

Fresh Neera collected through CPCRI method, processing by pasteurization followed by PET bottle sterilization gives maximum shelf life of 30 days under refrigerated conditions. Palmyrah sap is rich in sugar, minerals and proteins. Shelf life of sap (neera) was observed that 5-6 hours at room temperature for fresh sap of both male and female palmyrah, but lime added neutralized sap it was about 24 hours. Under refrigerated conditions for fresh neera 12-14 days and chemical processed neera is about 15-18 days, but by adding thermal processing it can be extended up to 30 days.

Palmyrah Syrup/honey of 65^{O} Brix made from Sap collected through cooling box method stored in glass bottle having shelf life up to 6 months under ambient conditions, it can be extended more than one year under refrigerated conditions. Palmyrah syrup is most economical product with rich in nutritional values. The TSS of syrup is 65-68 degree brix and vitamin C decreased as compared to Neera The syrup can be used as sweetener and the syrup was dried at low temperature to gives palm sugar or jaggery.

	Sap(CPCRI method)	Traditional method (Lime)
Room temperature	5- 6 hrs	24 hrs
Refrigerated	12 days	15 days
Sodium Benzoate		
100 ppm	14 days	20 days
500 ppm	20 days	20 days
1000 ppm	30 days	30 days

Sabour

The observations were recorded at two hourly interval on shelf life, sensory evaluation and quality of raw neera collected in lime coated earthen-pot (traditional method) revealed that neera samples had a palatability up to 2 hrs, when kept at ambient temperature and at cool temperature (8±2°C), it was found to be palatable up to 8 hrs. However even the fresh sample of neera was found contaminated as they contained considerable amount of TPC along with the coliform and yeast and mould population.

Neera collection by CPCRI box was not possible during the year under report as the box procured from CPCRI has been designed for the erect inflorescence type of coconut tree, was not fit for palmyrah inflorescence. For making the box suitable for palmyrah inflorescence (hanging and scattered type), the box has been modified and will be used in the coming season, afterwards the performance of neera collected in CPCRI box will be studied.

Process parameters: Neera was processed at 120°C sterilization for 15 min., pasteurized at 85°C for 7 min., treated with KMS 0.01% alone and in combination with CA @ 0.1% and was compared with control. Result shows that the bottled neera without any treatment, deteriorated the next day of storage, whereas neera sterilized at 120°C for 15 minutes, had a better shelf life, but lost its flavor and attractive colour. Neera pasteurized in other treatments had slightly better shelf life at ambient and cold storage condition as compared to control.

Syrup/honey was prepared with 60°B, 65°B and 70°B. The result showed that the honey prepared from neera at different brix level had a good palatability at preparation and at room temperature storage. It was also found to maintain its quality up to six months of storage. The microbial analysis was also found to be satisfactory at preparation and after six months of storage.

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

Pandirimamidi

Technology developed for dehydrated tuber and flour, same was transferred to tribal community groups through an NGO and support given for export market. Palmyrah tuber (apicolon) flour blended with tapioca and banana flour with proportion of tapioca with tuber flour (1:1) gave best results for development of cookies, the nutritional values also rich as compared to other combinations.

Palmy./PHT.4: Standardization of preservation technique for palmyrah tender fruit endosperm (*Nungu*)

Pandirimamidi

This simple hand operated machine was developed earlier and same tested for nungu extraction. The machine useful for all sizes of tender fruits and manually placing the fruit in the machine and putting little pressure from top by handle achieves the fruit breaking into three parts. The machine contains three blades with an angle of 120 degrees between two bales and having sharp edge to cut the hard tender fruit, with no damage of endosperm, but it cuts two pieces of endosperm and losses water in the endosperm (as in case of sickle cutting, whole endosperm will be available). With this machine one

person can perform the endosperm extraction activity with less stress as compared to the traditional method and useful for value added products. Shelf life of tender fruit endosperm was evaluated in palmyrah inflorescence with various brix of sap. Nungu kept in brix of 20 %, and 30 % under refrigeration condition can store up to 2 months except slight colour change.

Palmy./PHT. 5: Popularization of climbing device

Centres: Pandirimamidi and Sabour

Pandirimamidi

The climbing device (Joseph model) was evaluated with skilled and unskilled persons for palmyrah palm climbing. From the results, it was observed that skilled climbers not showing interest to use climbers as they felt that it is time taking as compared to traditional practice, young people and unskilled persons shown interest to use the same, and they felt that training is needed to use the same along with little modification to suit the girth of palmyrah. Also expressed that not suitable for palms which is having leaf scares. Overall, it was observed that 20 % people satisfied who are not regular climbers, further more studies is going on to improve the climber to suit for palmyrah palm.

Sabour

The Joseph model of climber was used for climbing palmyrah tree during a farmer's meeting organized in collaboration with KVK Sabour with about 25 local farmers. It was found that the farmers failed to climb the tree with the Joseph model climber. They mentioned that it was easier for them to climb palmyrah palm by traditional method. The difficulty in climbing was due to the girth of the tree at the base which was more up to 7-8 feet height from the ground, most of the trees were found highly tapering as compared to the even surface upwards, and it was the main hindrance in climbing.

Palmy./PHT. 6: Evaluation of palmyrah tender fruit processing machine developed by CIAE centre

Centres: Konda Mallepally and Pandirimamidi

Konda Mallepally

The processing machine will be procured from CIAE, Coimbatore for evaluation of its potential in palmyrah tender fruit processing.

Pandirimamidi

Palmyrah Endosperm Remover was received from CIAE regional centre, Coimbatore in the month of June 2020 and evaluated for endosperm removal for consumption. The machine was compared with manual extraction of endosperm. Palmyrah Endosperm Remover is manually operated with one person. The young fruits of 50 numbers collected from germplasm block of HRS Pandirimamidi and endosperm was collected both manual of traditional practice as well as manual operated Palmyrah Endosperm Remover.

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

Time taken for Endosperm removal from fruit was 43.76 second for using CIAE manually operated machine and in case of traditional practice it was 37.7 second. Endosperm damage or cutting is less by using machine as compared to traditional practice. It is also observed that drudgery was reduced by using the machine. Safety is 100 percent as compared traditional practice and unskilled person can operate the machine, where as traditional practice only skilled person can do. Recovery of whole endosperm is 2.26 using CIAE machine where as only 1.10 for traditional practice.

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VIII. EXPERIMENTAL RESULTS IN COCOA

8.1 Crop Improvement

Cocoa/Gen. 5: Evaluation of cocoa clones/hybrids

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

Centres: Ambajipeta, Kasaragod, Navsari and Veppankulam

Experiment details:

Cocoa variety/hybrid: 6; VTLC-1, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3 and VTLCH-4 (Ambajipeta and Veppankulam centres)

Design: RBD; Replications: 4;

No. of plants per treatment: 6

Spacing: coconut: 7.5 m x 7.5 m; cocoa: 3.0 m × 7.5 m

Ambajipeta

Year of start: 2008-09

Experimental area: 0.80 ha

Data pertaining to growth characteristics like girth, height at first branching, and canopy spread for the year 2020 recorded no significant differences (Table 99). Stem girth was recorded maximum in VTLCH-4 (38.5 cm). With respect to yield for the year 2019-20, VTLCH-2 recorded significantly higher dry beans yield (2.02 kg/tree/year) and it was followed by VTLCH-4 (1.90 kg/tree/year). Further number of beans per pod was also highest in VTLCH-2 (39.1) followed by VTLCH-4 (39.0). VTLC-1 recorded less no. of beans per pod (31.88) and less dry bean yield 1.45 kg/tree/year. Single dry bean yield recorded was maximum in VTLCH–2 (1.22 g).

Table 99: Performance of cocoa clones for growth and yield characteristics

Treatments	Stem girth (cm)	Height at 1st branching (cm)	Pod weight (g)	No. of beans per pod	Dry bean yield/tree/year (kg)
VTLCC-1	35.7	63.02	427.60	33.6	1.62
VTLCH-1	38.4	80.76	346.14	34.1	1.54
VTLCH-2	37.7	77.00	494.84	39.1	2.02
VTLCH-3	37.2	70.24	415.33	36.9	1.69
VTLCH-4	38.5	65.25	364.78	39.0	1.90
VTLC-1	37.6	51.92	457.61	31.9	1.45
S. Em±	0.87	8.43	28.22	2.17	0.12
CD (P=0.05) 5%	NS	NS	85.05	NS	0.38

Kasaragod

Cocoa variety/ hybrid: 13; VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4, VTLCC-1, VTLC-61, VTLC-66, VTLC-11, VTLC-5, VTLC-19A, VTLC-30A, VTLC-1A and MH-1.

Design: RBD; Replications: 2; No. of plants per treatment: 6

Spacing: coconut: 7.5 m x 7.5 m; cocoa: 3 m x 7.5 m. Year of start: 2007-08.

The performance of thirteen clones was evaluated in the 52 year old coconut WCT coconut garden in RBD with two replications. Clones were planted during 2008. The yield data was analysed and there was significant difference was observed. Dry bean weight recorded was in the range 0.80 g 1.97 g to among the clones.

Veppankulam

Year of start: 2008-09

Among the cocoa clones and hybrids evaluated, the VTLCH 1 has performed well in terms of plant height (3.12 m), stem girth (34.50 cm), canopy spread East West (2.20 m) and North South direction (2.70 m). VTLC 1 as control registered lesser plant height (2.70 m), stem girth (23.60 cm), canopy spread in East West and North South direction *viz*, 1.70 and 1.90 m. Regarding yield attributes, the pod set was null during this period due to 'Gaja' and also the following trees in the trial were affected and the level of damage is furnished. Plants are in rejuvenation stage.

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

Centres: Aliyarnagar, Kahikuchi, Ratnagiri and Vijayarai

Aliyarnagar

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

Design: RBD; Replications: 2; No. of plants/treatment: 6; Spacing: coconut: 7.5 m x 7.5 m; cocoa: 3.75 m x 7.5 m; Year of start: 2013-14

A total of 13 numbers of cocoa clones/hybrids along with one check variety (VTLC-9) were planted at 3.75 m × 7.50 m spacing during 2013-14 with two replications and six plants per genotype at Aliyarnagar centre. Observations recorded on vegetative and yield parameters registered significant variations across the traits studied. Among the genotypes the maximum plant height (275.6 cm) was observed in VTLC-9 followed by VTLCP-16 (272.5 cm). Highest stem girth was recorded in VTLCP-10 (39.4 cm) followed by VTLCP-14 (36.1cm). The maximum canopy area (9.6 m^2) and number of branches per plant (3.7) were registered by VTLCP-16. Regarding the pod characters concerned, higher number of pods per tree (32.3), maximum average single pod weight (482.6g), pod yield (15.8 kg /plant), number of beans per pod (51.6) and dry bean weight per plant (1.20 kg) were also recorded in VTLCP-16. Followed by VTLCP-16 the maximum dry bean weight per plant (1.00 kg) was recorded by VTLCP-15 (Table 100).

Table 100: Growth and yield attributes of cocoa clones under palms (Aliyarnagar)

Clones	Plant height (cm)	Stem girth (cm)	Height at first branch (cm)	Canopy area (m^2)	Number of branches /plant	No of pods/ tree	Weight/ pod (g)	Pod yield (kg / plant)	No. of beans/ pod	Single dry bean weight (g)	Dry bean weight / plant (kg)
VTLCP-1	252.6	34.6	66.5	8.3	2.9	29.9	423.1	12.8	42.3	1.1	0.98
VTLCP-3	211.9	31.1	52.6	6.9	2.7	30.5	415.8	12.7	44.6	1.0	0.96
VTLCP-5	249.3	29.4	73.4	7.0	3.1	28.4	408.9	11.7	40.6	1.1	0.98
VTLCP-6	266.1	35.6	55.9	8.2	3.3	26.6	425.4	11.6	41.3	0.9	0.97
VTLCP-8	225.7	32.4	74.2	5.9	2.2	24.3	429.5	10.7	39.9	1.1	0.96
VTLCP-9	216.4	31.6	58.4	5.1	2.1	26.2	435.8	11.6	46.9	1.2	0.95
VTLCP-10	259.2	39.4	59.8	8.1	3.2	24.9	476.5	12.0	47.3	1.1	0.98
VTLCP-11	248.1	35.1	76.2	6.8	3.5	31.5	462.1	14.8	49.3	1.2	0.99
VTLCP-12	229.6	32.4	66.9	5.6	2.3	28.3	454.8	13.1	47.9	1.1	0.96
VTLCP-13	232.4	33.6	53.1	6.4	2.6	27.9	459.4	12.9	43.0	1.1	0.98
VTLCP-14	245.9	36.1	71.8	6.7	2.4	25.1	432.2	11.2	44.9	1.0	0.96
VTLCP-15	271.6	34.9	70.9	8.8	3.2	23.5	445.2	10.6	46.3	1.1	1.00
VTLCP-16	272.5	35.4	68.4	9.6	3.7	32.3	482.6	15.8	51.6	1.2	1.20
VTLC-9 (Control)	275.6	33.9	62.8	8.0	2.6	25.6	426.3	11.2	39.6	1.0	0.90
CD (P=0.05)	2.57	0.31	0.50	0.16	0.03	0.43	0.99	0.14	0.57	1.35	0.014

MLT of cocoa clones in Aliyarnagar

Kahikuchi

Cocoa clones: 16; VTLC-13, VTLC-15, VTLC-17, VTLC-18, VTLC-20, VTLC-23, VTLC-25, VTLC-28, VTLC-36, VTLC-38, VTLC-39, VTLC-40, VTLC-128, VTLA-4A, EYT, and VTLCH-1(hybrid).

Year of start: 2015-16

The highest plant height (228.7 cm), stem girth (36.0 cm), Jorquette height (0.6 m) plant, plant spread

(E-W and N-S) and canopy area (8.44 m^2) were recorded in VTLC-20 followed by VTLC-18 and the lowest values for the above characters were observed in EYT. Cocoa clone VTLC-20 also registered maximum no. of pod/tree (38.8), no. of bean/pod (43.0) and dry bean yield/tree/year (2.34 kg) as against the lowest under EYT (Table 101).

Table 101: Growth and yield attributes of cocoa clones under palms

Clones	Plant height (cm)	Stem girth (cm)	No. of pods/ tree/year	Weight of pod (g)	Weight of single dry bean (g)	No. of beans/pod	Dry bean yield (kg/ tree)
VTLC-13	195.0	31.0	32.6	398.2	1.1	34.8	1.25
VTLC-15	217.4	32.6	30.0	392.5	1.1	33.0	1.09
VTLC-17	221.0	33.0	31.4	408.0	1.2	37.6	1.42
VTLC-18	224.6	33.8	33.7	464.5	1.2	38.6	1.56
VTLC-20	228.7	36.0	38.8	485.0	1.4	43.0	2.34
VTLC-23	206.0	30.5	30.1	378.0	1.2	32.0	1.16
VTLC-25	208.7	29.6	28.0	367.6	1.1	30.0	0.92
VTLC-28	178.4	29.0	25.2	352.0	1.1	34.6	0.96
VTLC-36	175.6	27.4	29.8	372.1	0.95	37.0	1.04
VTLC-38	189.0	28.3	27.0	332.5	1.0	33.2	0.90
VTLC-39	199.2	28.0	30.0	327.0	0.96	35.6	1.03
VTLC-40	196.7	31.6	33.6	389.0	0.97	32.6	1.06
VTLC-128	176.5	27.0	35.4	415.2	1.0	30.6	1.08
VTLC-4A	178.2	27.8	29.6	401.5	1.1	31.2	1.02
VTLCH-1	188.6	29.0	31.5	390.0	1.1	33.8	1.17
EYT	168.0	25.7	24.6	320.0	0.98	29.0	0.70
CD (P=0.05)	**3.92**	**0.88**	**1.08**	**9.82**	**0.05**	**0.82**	**0.15**

Ratnagiri

Cocoa clones: 21; VTLCP-1, VTLCP-3, VTLCP-5, VTLCP-6, VTLCP-8, VTLCP-9, VTLCP-10, VTLCP-11, VTLCP-12, VTLCP-13, VTLCP-14, VTLCP-15, VTLCP-16, VTLC-1, VTLC-13, VTLC-15, VTLC-17, VTLC-18, VTLC-25, VTLC-37 and VTLC-128.

Year of start: 2013-14

The experiment was initiated under coconut (D x T) garden with spacing of 3.0 x 7.5 m. The growth and yield attributing characters of cocoa and coconut are recorded and result revealed that at the age of 7th year the clone VTLC-17 has recorded highest plant girth 23.67 cm with height 2.45 m. with 6.67 m^2 canopy area, the same clone recorded highest pod yield. The weight of single dry beans is 1.26 g and numbers of beans per pod were 55.60. The dry bean weight recorded was 760 g/ plant. This was followed by VTLCP-16 which has recorded 630 g dry beans /plant with 1.05 single dry bean weight.

Vijayarai

Cocoa clones/ hybrids: 14; VLTC-1, VLTC-9, VLTC-13, VLTC-17, VLTC-18, VLTC-20, VLTC-25, VLTC-36, VLTC-37, VLTC-57, VLTC-65, VLTC-128, VTLCH-3 and VTLCH-4.

Year of start: 2012-13

The evaluation was carried out in adult oil palm garden. Among the 12 varieties and 2 hybrids evaluated, there were no significant differences for all growth and yield characters (Table 102).

Table 102: Growth and yield parameters of clonal varieties and hybrids of cocoa intercropped in oil palm

Variety/ hybrid	Stem girth (cm)	No. of pods/ plant	Average pod weight (g)	Pod yield (kg/ plant)	No. of beans/ pod	Average bean weight (g)	Dry bean yield (kg/plant)
VTLC-1	33.8	9.51	286.66	2.70	43.50	0.97	0.41
VTLC-9	36.6	20.60	483.33	10.75	36.25	1.37	1.06
VTLC-13	40.0	24.45	443.33	10.17	41.75	1.17	1.29

VTLC-17	32.4	18.08	512.50	9.22	38.50	1.35	1.05
VTLC-18	33.4	27.33	332.50	9.34	37.25	1.24	1.25
VTLC-20	33.4	15.16	473.33	7.12	47.25	1.27	0.91
VTLC-25	33.5	18.87	470.83	8.15	48.50	1.43	1.34
VTLC-36	34.6	7.80	420.00	3.31	45.50	1.35	0.49
VTLC-37	33.8	14.41	292.50	4.19	40.75	1.02	0.61
VTLC-57	40.2	42.67	360.83	15.31	37.50	0.95	1.51
VTLC-65	35.2	25.37	315.00	8.22	39.00	1.03	1.17
VTLC-128	35.9	17.66	372.50	6.79	40.75	1.32	1.07
VTLCH-3	30.5	10.62	439.16	4.62	41.50	0.91	0.40
VTLCH-4	31.6	11.96	505.00	5.69	39.00	1.26	0.6
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
S.Em(±)	**0.89**	**2.87**	**25.20**	**1.07**	**1.19**	**0.05**	**0.11**

Yield of VTLC-17 varieties at Vijayarai

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

Thrissur

Establishment of clonal garden

Clonal gardens are established by planting better combiners in a specified manner for the mass production of genetically improved seeds. Ninety percent of India's cocoa plantations are established with seed material produced from Cocoa Research Centre, Kerala Agricultural University, Vellanikkara. KAU maintains one biclonal garden and nine poly clonal gardens. Details are given in Table 103.

Table 103: Cocoa clonal gardens of KAU, Thrissur

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

Establishment of clonal garden with six superior varieties

A polyclonal garden was established with six superior varieties. Based on the economic and biochemical characters they were scored and ranked. Yield was also included under economic character to score the genotypes. Besides, superiority in economic and biochemical characters these selected hybrids also exhibited biotic stress tolerance. Earlier researches revealed that hybrid P II 12.11, VSD I 33.4, VSD I. 29.9 and PIV 59.8 showed resistance to *Phytophthora* pod rot and tea mosquito bug attack. The characteristics of selected hybrids are listed in Table 104. Total of 139 plants were planted.

Table 104: Characters of hybrids selected for clonal garden

Hybrid	No. of pods/ year	Total wet bean weight/pod (g)	No. of beans/pod	Single dry bean weight (g)	Fat (%)	Phenol (%)
VSD 11.11	101.20	109.69	50.00	0.78	55.26	1.197 (6.273)
VSD I. 29.9	96.00	160.34	49.80	1.00	56.53	0.657 (4.646)
VSD I 33.4	102.40	129.96	52.00	1.07	54.73	1.563 (7.182)
PIV 59.8	135.80	176.62	45.10	1.19	53.00	1.259 (6.442)
P II 12.11	95.80	152.98	51.30	1.30	51.63	0.427 (3.748)
P IV 19.9	118.20	161.27	47.50	1.06	56.80	0.697 (4.778)

Table 105: Disease Reactions of selected hybrids

Selected hybrids	*Phytophthora*	Tea mosquito bug on shoot	Tea mosquito bug on pod
PII 12.11	Resistant	Highly resistant	Highly resistant
PIV 19.9	Slightly resistant	Susceptible	Highly susceptible
VSDI 33.4	Slightly resistant	Highly resistant	Highly resistant
VSDI 11.11	Highly resistant	Resistant	Susceptible
VSDI 29.9	Resistant	Resistant	Resistant
PIV 59.8	Highly resistant	Highly resistant	Resistant

Newly planted polyclonal garden

Vegetative multiplication of genotypes for establishing polyclonal garden

Varieties were budded and kept in nursery to establish a new polyclonal garden and distribution to other institute for establishing polyclonal gardens. Out of 2128 plants budded, 1465 were successful.

Budding details of varieties

Sl. No.	Variety	No. of plants budded	Bud take
	CCRP 2	100	72
	CCRP 3	200	143
	CCRP 4	100	59
	CCRP 5	100	76
	CCRP 6	200	122
	CCRP 7	100	31
	CCRP 11	300	234
	CCRP 12	180	149

	CCRP 13	400	240
	CCRP 14	120	109
	CCRP 15	328	230
Total		**2128**	**1465**

Maintenance of existing clonal gardens

Clonal gardens are maintained by regular irrigation (Once in 5-7 days during dry period), fertilizer application (Irrigated: 4 times (April- May, Sept- Oct, Dec & Feb). Maintenance of garden from pest and diseases on need basis. Weed management at required intervals. Harvesting at pod maturity. Management of pests and diseases for budded plants in nursery is by regular spraying with insecticides and fungicides.

These clonal gardens have a capacity to produce on an average of one lakh seed pods. Supplied to different states through Mondelez International. An average of 38 lakh seedlings was produced in each year. Hence statistics shows that 90 percent of Indian cocoa farms are established with KAU seedlings.

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

Vijayarai

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

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IX. MONITORING REVIEWS AND MEETINGS

Monitoring Reviews

Due to rampant COVID-19 pandemic situation in all around the country, the project coordinator has made review meetings to monitor the technical programmes, budget utilization and progress of the projects of all the centres as per the need through virtual mode. Time to time advice and direction was given for proper implementation of the technical programmes through emails, personal contact and over direct contact via phone as and when required. Monthly progress report and budget utilization information were obtained from centres regularly and the same were reviewed critically. During the review meetings, discussions were held with concerned the scientists of ICAR-AICRP on Palms for the smooth functioning of the research programmes. During review meeting, PC has given guidelines to proper utilization of budget, publications and improving the technical programmes.

Meetings

29th Annual Group meeting of AICRP on Palms

The ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala organized the *"Virtual 29th Annual Group Meeting of All India Coordinated Research Project on Palms"* from 10th to 11th August, 2020. Dr. A. K. Singh, Deputy Director General (Hort. Sci.) was the chief guest of the function and Dr. B. K. Pandey, Assistant Director General (Hort. Sci-II), ICAR; New Delhi was the guest of honour of the event.

Dr. Anitha Karun, Director, CPCRI, Kasaragod welcomed the dignitaries and delegates in which she applauded the positive concern of the Deputy Director General over the health of the palm scientists across the nation. She also overwhelmed on the long standing relation of the Assistant Director General with CPCRI. The Director painted a caution note that coconut is undergoing acid test due to debilitating pests and diseases and that palm scientists should join hands to restore the glory of the palm.

Dr. H. P. Maheswarappa, Project Co-ordinator, AICRP (Palms), briefed about activities of project dealing with the mandate crops such as coconut, oil palm, palmyrah, arecanut and cocoa distributed across 28 AICRP centres of 14 states and one Union Territory with collaboration of 13 SAUs, four ICAR institutes and one CAU. He added that total budget outflow during last year was 543.60 lakhs. Twenty three research papers, 62 popular articles, 6 extension folders and 2 technical bulletins were published during 2019 -20. He enlisted that Impact assessment of cyclone hit areas in the Western Ghats of the country, Management of the debilitating pests of coconut - Rugose Spiraling Whitefly employing the parasitoid *Encarsia guadeloupe* and Development of Multi-tier and Integrated Farming System models are the noteworthy contributions of AICRP (Palms). Effective Transfer of Technology from lab to land through diverse tools and modes remain the major strength of this AICRP programme. He also highlighted that AICRP (Palms) has contributed for release of three technologies which are recommended to the farming community. The Assistant Director General highlighted that all the research a programme of AICRP (Palms) needs to be tailored to go in tandem with the present extra–ordinary situation.

In his inaugural address, the honorable Deputy Director General gave a bird's eye view of the overall growth of horticultural sector and its significant contribution to GDP and nutritional security of the nation with special emphasis on oil palm. He hinted that carbon sequestration potential of palms may be explored, to take over research forward in the era of climatic vagaries. He underlined the need for developing high yielding varieties, user friendly technologies for the betterment of the farm front and to connect ourselves with the farmers with benefitting technological outputs. He portrayed that adoption of remunerative location specific intercrops and integration of animal enterprises in coconut ecosystem through IFS approaches can help farmers to realize better income than sole cropping. He noted the fluent financial grants of Government of India for Agricultural sector, with gratitude. In the backdrop of COVID pandemic, he inspired the palm scientists and invited them to explore every possibility to reach the pinnacle of success in Palm research by advocating the farmers on diverse avenues for revenue generation with technological platform. Dr. R. K. Mathur, Director, IIOPR, Pedavegi suggested that high yielding traditional varieties of oil palm be conserved for scaling up its production. Dr. Maheswarappa, H. P., The Project Co-ordinator proposed the vote of thanks.

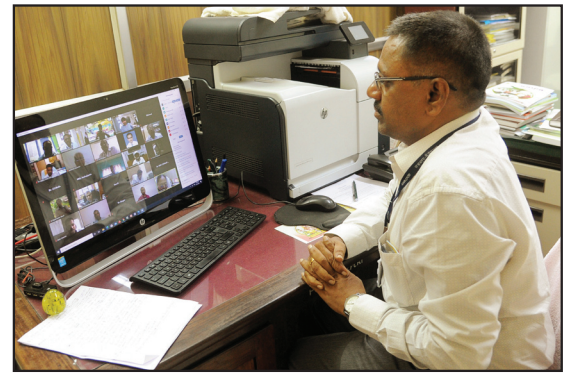
The crops experts also provided their valuable suggestions / recommendations for further improving the efficacy of the AICRP on Palms. The detailed progress made during 2019-20 was presented and the technical programmes for ensuing *next year* were finalized during the Webinar. A total of 70 participants from various parts of the country participated in the Virtual Meeting including scientists

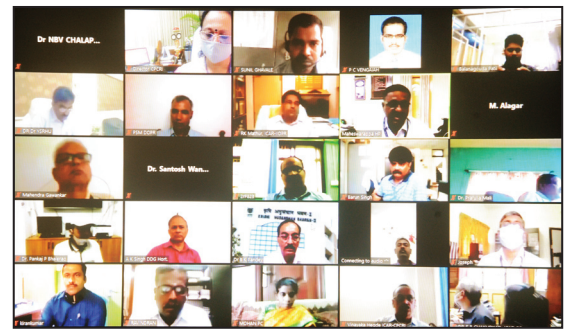
from AICRP centres and ICAR institutes. The inaugural session was followed by technical sessions on genetic resources and crop improvement, crop production, crop protection and post harvest technology.

Following technologies have been recommended to farming community

- **Intercropping of black pepper in coconut garden:** Based on evaluation, black pepper variety Panniyur - 1 recorded significantly higher number of spikes, spike length, number of berries per spike and dry yield compared to other varieties/ hybrid. Hence, Panniyur -1 is recommended as suitable intercrop under coconut gardens in the Assam and West Bengal region.
- **Integrated management of Eriophyid mite**: Integrated Nutrient management as well as Integrated Pest management packages involving application of recommended dose of fertilizers with 20 kg vermicompost and 5 kg neem cake, growing of green manuring with Cowpea / sunnhemp in the inter rows, application of Keraprobio (100 g/palm) and root feeding with fenpyroximate 5%EC @ 10 ml (March) and spraying of palm oil-sulphur emulsion (December) is recommended as it was found effective in reducing infestation of Eriophyid mite in coconut.
- **Integrated management of slug caterpillar**: The IPM packages comprising mechanical removal and destruction of larval and pupal stages, installation of light traps @ 5/ha, application of recommended dose of fertilizers, spraying of insecticide chlorantraniliprole 18.5 % SC @ 0.3 ml/litre and release of potential parasitoid Pediobius *imbreus* @ 60/palm is recommended in order effectively manage the incidence of slug caterpillar in coconut.
- **Management of rugose spiralling whitefly**: Installation of yellow sticky traps in coconut garden is recommended for effective attraction of RSW in coconut in order to mitigate their incidence.

Inaugural address by Hon'ble DDG (Hort. Sci.)





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X. EXTENSION, POPULARIZATION OF TECHNOLOGIES

Coconut

Aliyarnagar

Training programme for farmers

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

Farmer's training on RSW in coconut

Training programme organized for extension personnel

Date	Topic of training	Number of extension personnel trained
31.01.2020	Identification of predators and parasites for Rugose Spiralling whitefly	20
20.2.2020	State level training programme on identification of parasitoids and predators for the management of rugose spiraling whitefly	60

Distribution of Inputs under SCSP

Research - Extension - Farmer interface programme

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

Training programme organized for SCSP farmers

S.No,	Date	Place	Name of the training programme	Beneficiary
1.	09.01.2020 13.01.2020 27.2.2020 16.3.2020 17.3.2020 18.3.2020	Nagaruthu I Angalakuruchi Thampampathy Saralapathy Gopalpathy	Coconut cultivation and production	150 Nos

Diagnostic field visit and farmers queries

Date	Location of field	Problem noticed in coconut palms
06.02.2020	Tiruppur	Rugose spiralling whitefly
8.02.2020	Anaimalai	Rugose spiralling whitefly
11.02.2020	Odaiyakulam and Ramapattinam	Rugose spiraling whitefly and basal stem rot
15.02.2020	Pongalur, Tiruppur district	Rugose spiralling whitefly
19.03.2020	Ramapattinam	Rugose spiralling whitefly

23. 9. 2020	Udumalpettai	Rugose spiralling whitefly and basal stem rot
20.10.2020	TK Pudur	Root(wilt), Rugose spiralling whitefly
10.12.2020	Aliyar	Rugose spiralling whitefly, Stem bleeding and basal stem rot
06.02.2020	Tiruppur	Rugose spiralling whitefly

Radio / TV programme/ press media

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

Publication of extension literature

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

Field problems solved / Farmers queries answered

Field problems and farmers queries pertinent to crop improvement, crop production and crop protection of coconut and groundnut were solved in the regions of Coimbatore, Tirupur, Thanjavur, Erode, Salem, Dindigul and Theni districts of Tamil Nadu.

Sl.No	Field problems solved/ farmers queries answered	Beneficiaries
Crop Improvement		
1.	Varietal selection of coconut and groundnut varied resource conditions	250
2.	Varietal selection in cocoa	7
Crop Production		
1.	Pencil Point disorder in coconut	50
2.	Nutrient management in coconut	100
3.	Button shedding in coconut	40
4.	Vermicompost technology	50
Crop Protection		
1.	Pests of coconut (Black headed caterpillar, Rhinoceros beetle, Red palm weevil, coconut scales, spiraling white flies in coconut)	1500
2.	Diseases of coconut (Thanjavur wilt, Kerala wilt, Bud rot, Stem bleeding, Leaf blight and Root wilt)	450

Ambajipeta

Training programmes

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

Technology Demonstration

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

Publication of extension literature

Technology highlighted and title of publication	Type of extension publication
Coconut based cropping systems in Godavari Districts of Andhra Pradesh	Technical Bulletin

Radio / TV programme/ press coverage

Four radio talks and 5 television programmes were broadcasted on *Eriyophid* mite damage to coconut and its management practices in coconut, present scenario of coconut Rugose spiralling whitefly and remedies to improve nut size and yield in All India radio station, Visakhapatnam and TV9, 10TV, Doordarshan, Vijayawada respectively. A total of 10 press coverages were made on RSW and root (wilt).

Arsikere

Training programmes

Sl. No	Training topic	Date	Number of participants
1	FoCT Palms Climbing Training Programme for unemployed youth	03.02.2020 to 08.02.2020	20
2	Nutrient, Pest and disease management in Coconut cultivation	24.02.2020	53
3	World coconut day	4-9-2020	82
4	Intercropping and Moisture conservation in coconut	20-10-2020	20
5	Bee keeping and its management	29-10-2020	69
6	FoCT Palms Climbing Training Programme for unemployed youth	03.02.2020 to 08.02.2020	20
7	Nutrient, Pest and disease management in Coconut cultivation	24.02.2020	53

A scientist from centre has participated in five training programmes organized by various bodies like KVK, NABARD, and NIPHM as resource person. The interaction was made with farmers or participants on various aspects of recent advances in coconut, IPM on coconut, integrated crop management in coconut, pest and disease management in coconut, Coconut diseases and their management and future live in research for coconut.

Diagnostic field visits/ consultancy

Field visit/ consultancy	Problems identified and solution given on
Field visits: 150 Through Phone: 300 Farmers visit to HRES: 1000	• Moisture conservation in coconut • Intercropping in coconut • Drip irrigation in coconut • Nutrient management in coconut • Pest management in coconut • Disease management in coconut • Varieties of coconut • Planting method in coconut

Demonstration of technologies

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

Krishi Mela/ Horticulture Mela/ Exhibition

Participated in five exhibitions conducted by Krishi mela, UAS, Bangalore and Field day at UHS Bagalkot, Flower show at Hassan National Horticulture Fair-2020 IIHR and approximately about 20225 farmers were attended the programmes.

Radio/ TV programme

One television programmes were broadcasted on intercrops in coconut cultivation and recent advances in coconut cultivation in Doordarshan respectively.

Bhubaneswar

Training programmes

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

Training progarmme organized at Bhubaneshwar

Demonstration of technologies

Sl. No.	Name of the training programme	Date and place	No. of farmers attended
1	FOCT Training Programme	**15.01.2020** KVK,CIFFA , Bhubaneswar	40
2	FPO Training programme on "Coconut Farming "	**12.02.2020** Satyabadi block, Puri	60
3	Field Day Farmer's Training Programme	**26.02.2020** Nischintakoeli, Cuttack	60
4	FPO Training programme on " Coconut Farming "	**13.3.2020 Balikuda, Jagatsinghpur**	60
5	Regional level webinar on Coconut Farming	07-10-2020 Pitapalli, Khurdha	**50**
6	Regional level webinar on Coconut Farming	11-11-2020 Pitapalli, Khurdha	**50**
			320

Women empowerment activity

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

Distribution of sprayer to farmers under SCSP

Linkage with the District KVK and ATMA

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

Goa

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

Kahikuchi

Training programmes

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

Women empowerment programme at Kahikuchi

Training programme organized for extension personnel

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

Women empowerment activities

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

Research-Extension-Farmers interface programme

Date	Theme of interface programme	Agencies involved	No. of participants
24.09.2019	Zonal Research and Extension Advisory Committee Meeting	HRS, Kahikuchi, KVKs of LBVZ of Assam, RARS, Gossaigoan, State Dept. of Agriculture	150

Linkage with District KVK and ATMA

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

Mulde

Sr. No	Particulars	Numbers	Number of Participants
1	Farmers Visits		76
2	Students visit	3	150
3	Visit to framers plots	1	3
4	Participated in Exhibition	1	9000
5	Marathi Doordarshan Programme on Oil Palm Cultivation		

Navasari

Training programmes

Training programme on 'Production technology of coconut', 'Value addition of coconut' and Identification and integrated management practices of Rugose Spiralling Whitefly (RSW) in coconutwere conducted benefitting 215 farmers.

Training programme at Navasari

Linkage with the district KVK and ATMA

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

Online Webinar on Coconut RSW

The online webinar on "Identification and integrated management practices of Rugose Spiralling Whitefly (RSW) in coconut" was organized by All India Coordinated Research Project (Palms), ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari through Google meet platform (https://meet.google.com/rri-ztgv-xjn) on 19-09-2020. Dr. S. R. Chaudhary (Hon'ble VC), in his presidential address briefed on the importance and functions of biocontrol and pesticide laboratories of university. He also focused on the use of bio-control agents (predators and parasites) for the control of insect-pest and diseases whiteout any harmful effects of nature.a technical session which was conducted by the guest speaker Dr. N. B. V. Chalapathi Rao, Senior Scientist (Entomology), Dr. Y. S. R. Horticultural University, H.R.S., Ambajipeta, Andhra Pradesh on the topic entitled "Identification and Integrated management practices of RSW in coconut".

More than 130 coconut growers and officials (online/ offline) participated in this online webinar.

Pandirimamidi

- Dr. K.Rajendra Prasad, Scientist (Horti.) Delivered lecture on "Palmyrah Importance and its utility in tribal areas" and "Fibers from Palmyrah and its uses in tribal areas" in the adopted village Tamarapalli, Rampachodavaram East Godavari dt, Andhra Pradesh on 21.10.2020 and 27.11.2020.
- Er.P. C Vengaiah, Scientist(Food Sci.& Tech.) delivered lecture on "Utilisation of palms in rural areas for sustainable development" through online webinar conducted by Dr BR Ambetkar university, Srikakulam on 12.08.2020.
- Participated SCSP plan distribution programmes for distribution of coconut seedlings and climbers on 09.12.2020.

Pasighat

The scientist in charge of the center has under taken the following extension activities for popularizing the oil palm crop in North Easter Region of the country during the year 2020.

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

Pattukkottai

Training programmes/field days

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

Radio/Television Programme:

Sl. No.	Date	Department/ Centre	Topic
1.	10.02.2020	ARS, Pattukkottai	Radio talk in the topic on "Oil Palm Cultivation in Tamil Nadu" at All India Radio-Trichy

Ratnagiri

Training programmes

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

Demonstration of technology

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

Radio/TV programme/ press coverage

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

Diagnostic field consultancy

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

Field visit/ consultancy	Problems identified and solution given on
	• Pest management in coconut • Disease management in coconut • Varieties of coconut

Veppankulam

Training programmes

Title of the training	Date	Place	Source of fund
Training on Coconut cultivation technology for the development of Scheduled Caste coconut farmers	13.03.2020	CRS, Veppankulam	ICAR-AICRP on Palms
Hands on training to extension functionaries of Pattukottai block on in situ identification of Encarsia parasitoids	19.03.2020	CPCRI, Kasaragod	ICAR-AICRP on Palms
Webinar on E-conference on Enhancing the economic viability of coconut production and processing technologies related to World Coconut Day 2020	02.09.2020	Nambivayal and Kasangadu	ICAR-AICRP on Palms

Under the SC –SP component, 50 farmers *viz*., 36 men and 14 women farmers were selected under this programme. The villages along with beneficiaries *viz*., Alathur (2), Nambivayal (10), Naduvikottai (9), Thuvarankuruchi (3), Kasangadu (6), Mannankadu (3), Mahilankottai (2), Veppankulam (5), Nattuchalai (1), Thokkalikadu (1), Vattagudi (2), Anaikkadu (1), Kilamangalam (1), Periyakottai (1), Keelakuruchi (2) and Sokkanavur (1) were selected and a training was given on 23.03.2020. Various inputs *viz*., Fertilizers and tools were distributed for the farmers.

Vijayarai

Training programme- 4

26.06.2020	Cocoa fruit nipping for quality bean production
30.07.2020	Fertilizer management in cocoa
30.07.2020	Use of organic manures and biofertilizers in cocoa production
10.08.2020	Training and pruning in young cocoa plantations

Wakawali

Trainings organized to the farmers on Arecanut and spices:- 01

Date	Name of training	Place	No. of Participant	Organising Institute
25.02.2020	Production technology and Inter cropping of Spices in Arecanut garden	Central Experiment Station, Wakawali	350	Principal Investigator, AICRP on Palms, Arecanut Centre, Asond Farm

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XI. PUBLICATIONS

Reports

1. AICRP on Palms, 2020. Proceedings of the XXIX Annual Group Meeting and Technical Programme for 2020-21 of ICAR- All India Co-ordinated Research Project on Palms. (Eds. Maheswarappa, H.P., Balanagouda Patil and Sumitha, S.). ICAR-CPCRI, Kasaragod). AICRP on Palms, ICAR-CPCRI, Kasaragod. 87p.

2. AICRP on Palms, 2020. Technical Report for 2019-20. XXIX Annual Group Meeting of AICRP on Palms. (Eds, Maheswarappa, H. P., Jilu V. Sajan and Balanagouda Patil) ICAR-CPCRI, Kasaragod. 234 p.

3. AICRP on Palms, 2020. Annual Report for 2019 of ICAR- All India Co-ordinated Research Project on Palms. (Eds. Maheswarappa, H.P., Jilu V. Sajan and Balanagouda Patil). ICAR-CPCRI, Kasaragod. 140p.

Research articles in journals

1. Alagar, M., Rajamanikam, K., Chinnadurai, S., Yasmin, A. and Maheswarappa, H. P., 2020. Surveillance, assessment of infestation, biology, host range of an invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin and status of its natural enemies in Tamil Nadu. *Journal of Entomology and Zoology Studies*. 8(3):2041-2047.

2. Apurba Bandyopadhyay, Dipak Kumar Ghosh(LKN) , Benukar Biswas , Maheswarappa H.P. and Jagadish Timsina. 2020. Fertigation Effects on Nutrient Use Efficiency, Energy Productivity, and Economics of Coconut (*Cocos nucifera* L.) Cultivation in the Eastern Indo-Gangetic Plains of South Asia. *International Journal of Fruit Science*. https://doi.org/10.1080/15538362.2020.1812016.

3. Ghavale, S. L., Shinde, V. V., Wankhede, S. M., Maheswarappa, H. P. and Haldankar, P. M. 2020 Carbon sequestration and productivity potential of coconut (*Cocos nucifera* L.) hybrids and varieties under coastal eco-system of Maharashtra. *Cur. J. Appl. Sci. Technol.,* **39**(22): 30-37.

4. Merin Babu, Thangeswari, S., Josephrajkumar, A., Krishnakumar, V., Karthikeyan, A., Selvamani, V., Mol Daliya, Vinayaka Hegde, Maheswarappa, H.P. and Anitha Karun. 2020. First report on the association of 'Candidatus Phytoplasma asteris' with lethal wilt disease of coconut (*Cocos nucifera* L.) in India. *Journal of General Plant Pathology.* https://doi.org/10.1007/s10327-020-00970-y.

5. Paul, S. C., Acharya, G. C., Chakraborty, R., Maheswarappa, H. P., Hussain, M. and Ray, A. K. 2020. Sustainability of soil health and system productivity through arecanut based cropping system in the NE region of India. *Journal of Plantation Crops*, 48(2): 111-119.

6. Rajeswari, E, Ramjegathesh, R., Sivakumar, V., Praneetha, S., Pugalendhi, L. and. Maheswarappa, H.P. 2020. Occurrence and distribution of Coconut diseases in Tamil Nadu, India. *Int.J.Curr.Microbiol. App.Sci., 9*(10): 3859-3869.

7. Shinde, V. V., Maheswarappa, H. P., Ghavale, S. L., Sumitha, S., Wankhede, S. M. and Haldankar, P. M. 2020. Productivity and carbon sequestration potential of coconut-based cropping system as influenced by integrated nutrient management practices. *Journal of Plantation Crops*, 48(2): 103-110.

8. Sivakumar, V., Subramanian, A., Geethanjali, S., Praneetha S. and Maheswarappa, H. P. 2020. Assessment of genetic variability for growth, floral, yield and its component traits in coconut (*Cocos nucifera* L.). *Electronic Journal of Plant Breeding*, 11(3):809-813.

9. Srinivasan ,T., Chalapathi Rao, N. B. V., Gurav,S.S., Chandrika Mohan and Maheswarappa, H. P. 2018. Effect of integrated nutrient management in coconut on eriophyid mite, *Aceria guerreronis* in different agroclimatic regions. *Indian Journal of Plant Protection,* 46 (2-4):121-125.

10. Sudhalakshmi, C. and R. Kumaraperumal. 2020. Potential of soil resources of Coconut Research Station, Aliyarnagar for Agrotechnology Generation. Journal of Plantation Crops. 48 (3): 171- 183.

11. Sumitha, S., Maheswarappa, H.P., Basavaraju,T.B., Prashanth, M. and Swetha. 2020. Potential coconut (*Cocos nucifera*) hybrids developed using Gangabondam (GBGD) as maternal parent for yield and quality for southern dry tract of Karnataka (India). *Indian Journal of Agricultural Sciences,* 90 (8): 1467–73.

12. Wankhede, S. M., Shinde, V. V., Ghavale, S. L., Joseph Rajkumar, A. and Maheswarappa, H. P. 2020.

Efficacy of biorationals and Chlorantraniliprole against coconut rhinoceros beetle (*Oryctes rhinoceros* Linn.). *Journal of Entomology and Zoology Studies,* 8(6): 483-486.

13. Wankhede, S.M., Shinde, V.V., Maheswarappa, H.P. and Ghavale, S.L. 2020. Impact of integrated management package on eriophyid mite, *Aceria guerreronis* (Keifer) and yield of Coconut. *Journal of Entomology and Zoology Studies,* 8(5): 1967-1971.

Papers presented in conferences/ seminars

1. Bhalerao P. P. and H. P. Maheswarappa (2020). Impact of integrated nutrient management in coconut based cropping systems under South Gujarat condition. Abstract presented in Indian Horticulture Summit-2020 (Mitigating climate changes and doubling farmer's income through diversification) on 14-16th February, 2020 at MGCGV, Chitrakoot (M. P.).

2. Chandrashekar, G.S., Swetha, Prasad P. S., Vishnuvardhana.,. Maheshwarappa, H.P and R. Siddappa, 2020. Screening of coconut genotypes against coconut eriophyid mite (*Aceria guerreronis* Keifer.) in Arsikere region of karnataka state, 'International E-conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity. 24-27th November 2020.

3. Chandrashekar, G.S., Swetha, Siddappa R., Maheshwarappa H.P., Vishnuvardhana. and Prasad P. S. Screening of coconut genotypes against rhinoceros beetle, *Oryctes rhinoceros* (Coleoptera: Dynastidae) in Arsikere region of Karnataka state, 'International E-conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable. 24-27th November 2020.

4. Rani, S., H.P.Maheswarappa and C.Sudhalakshmi. 2020. Profitability of coconut based cropping system. In: Proceedings of the 2nd International Conference on Emerging Innovation and Advancement in Biological Science, Human Welfare and Agricultural Research in current era. July 25 – 27, 2020. Pp. 49

5. Rajeswari,E R. Ramjagathesh, C. Sudhalakshmi and V. Sivakumar.2020. Coconut Root wilt intensity and its management. Proceedings of the Fifth National Tamil Conference – 'Tamil Can Do' jointly organized by Tamil Nadu Agricultural University, Coimbatore and Tamil Society, New Delhi, 10.10.2020 and 11.10.2020

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8. Sudhalakshmi, C., S. Rani, K. Venkatesan and H. P. Maheswarappa. 2020. Integrated Nutrient Management in Dwarf Coconut Gardens. Proceedings of the Sixth National Tamil Conference – 'Tamil Can Do' jointly organized by Tamil Nadu Agricultural University, Coimbatore and Tamil Society, 22.10.2020

9. Sudhalakshmi, C., M .R.Latha and K.Venkatesan. 2020. Is cocoa a remunerative intercrop under coconut intercropping system in calcareous soils. Proceedings of the Fifth National Tamil Conference – 'Tamil Can Do' jointly organized by Tamil Nadu Agricultural University, Coimbatore and Tamil Society, New Delhi, 10.10.2020 and 11.10.2020

10. Sudhalakshmi, C., T.Sindu, Rahamath Nisha, M.Elayaraja and K.Arulmozhiselvan. 2020. Pencil Point Disorder in Coconut – A Field Survey. Proceedings of the Fifth National Tamil Conference – 'Tamil Can Do' jointly organized by Tamil Nadu Agricultural University, Coimbatore and Tamil Society, 10.10.2020 and 11.10.2020.

11. Siva Kumar.V.A.Subramanian, N.Shoba, Sudhalakshmi, C, E.Rajeswari and M.Alagar. Selection of the best variety of ginger for intercropping in coconut. Proceedings of the Fifth National Tamil Conference – 'Tamil Can Do' jointly organized by Tamil Nadu Agricultural University, Coimbatore and Tamil Society, New Delhi, 10.10.2020 and 11.10.2020.

12. Sumitha. S, H. P Maheswarappa and P.C. Vengaiah. 2020. Collection and conservation of palmyrah germplasm under AICRP on Palms. In International

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13. Tamil Selvan. M., A. Karthikeyan, L.Pugalendhi and H.P. Maheswarappa. (2020). Evaluation of hybrids in Oil Palm (Ennaippanaiyil Athiga magasool tharum Eragangalaik kandarithal – Tamil Article) in Souvenir of the Fifth National Conference on Agricultural scientific in Tamil held at TNAU, coimbatore during 09-10, October, 2020 (ISBN No: 978-81-946828-0-6), P. No: 227-229.

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Books

1. Alagar,M, E. Rajeswari, V. Sivakumar, C. Sudalakhsmi, S. Praneetha, C. Ushamalini, S. Rani, L Pugalendhi and H. P. Maheshwarappa. 2020. Advances in coconut cultivation Technology, p150.

2. Vanaja, T., Jayaprakash Naik, B., Balakrishnan, P.C. and Nikhil, P. G. 2020. Compendium of Coconut Germplasm collected and conserved at RARS, Pilicode. Published by Kerala Agricultural University

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1. Vaibhav V. Shinde, Sunil S. Ghawale, Santosh, M. Wankhede, Khandekar, R.G. Salavi, B.R. Maheswarappa, H.P. and Haldankar, P.M. 2020. Integrated Nutrient Management in Coconut Based Cropping System under Konkan Region of Maharashtra. Technical Bulletin No. 5/2020.ICAR-AICRP on Palms, RCRS, Bhatye, Maharashtra. 24p.

2. Sudhalakshmi, C, S. Rani, E. Rajeswari, V. Sivakumar, M. Alagar, B. Meena , L Pugalendhi and H. P. Maheshwarappa. 2020. Technical Bulletin on Coconut based farming/ cropping system in Tamil Nadu p54.

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1. Alka Gupta, Murali Gopal, Krishna Prakash and H.P. Maheswarappa. 2020. *Nariyal baag ki antarfasal makke ke bhuse se banayen kenchua khaad* (Produce vermicompost from stovers of baby corn grown in coconut garden). *Bharatiya Nariyal Patrika*. **31(2)**: 6-10 (Hindi).

2. Alagar, M. V. Sivakumar, S. Chinnaduari, P. A. Saravanan, T. Srinivasan and S. Praneetha. 2020. Bio Intensive Management of Invasive Rugose Spiralling Whitefly in Coconut. Biotica Research Today 2(8): 768-771.

3. Alagar, M. C. Chinnadurai, S. Praneetha, B. Meena, C. Sudhalakshmi, V. Sivakumar and E. Rajeswari. 2020. Management of new invasive pest rugose spiralling white fly in coconut. *Tamil Nadu Journal of Cooperation.* 93(6): 45-50.

4. Bhalerao, P. P. and Maheswarappa, H. P. 2020. Organic farming in coconut - a success story from Gujarat. *Indian Coconut J*., 13(2): 18-19.

5. Bhalerao, P. P. and Maheswarappa, H. P. 2020. Doubling the farmers income through coconut farming by intercropping of turmeric: a profitable spice crop under coconut garden. *Bharatiya Nariyal patrika*, **30** (4):12 -15 **(In Hindi).**

6. Bhalerao P. P. 2020. *Naliyarima nikasni tako. Bagayati pedash: aayat-nikas halni paristhiti ane bhavi,* Vol. 81: 43-54

7. Chalapathi Rao, N. B. V., Chakkani Priya, K., Ramanandam, G., Bhagavan, B. V. K. and Maheswarappa, H. P. 2020. Successful management of slug caterpillar outbreak in Andhra Pradesh through IPM. *Indian Coconut J*., 13(2): 24-26.

8. Chandrashekar, G.S., Maheswarappa, H.P., Jilu V. Sajan and Siddappa, R. 2020. Biological control of Coconut Black Headed caterpillar. *Indian Coconut Journal,* **13**(4): 14-16.

9. Maheswarappa, H. P., Sumitha, S., Rani, S., Nath, J. C., Basavaraju, T. B., & Shinde, V. V. (2020). Commercial flower crops in coconut garden under different agro-climatic conditions.

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11. Rajeswari, E. Sudhalakshmi, C. Sivakumar, V. Rani, S. Alagar, M and Ushamalini, C. About Aliyar Coconut Research Station. Pachai Bhoomi 7 : 26- 29

12. Rani, S., C.Sudhalakshmi and H.P.Maheswarappa. 2020. Coconut nursery establishment techniques. Indian Coconut Journal. Mar – May 2020. Pp. 1214.

13. Rajeswari E., Sivakumar,V . H.K .Maheshwrappa., 2020. Integrated Disease Management Strategy for Basal Stem Rot in Coconut. Biotica Research. Today 2(8): 805-807

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15. Ramjegathesh, R. Rajeswari, E.and Rajamanickam K. 2020. Management of leaf blight in coconut. Uzhlavarin Valarum Velanmai 12(6): 43-44

16. Sahoo, S. C. and Maheswarappa, H. P. 2020. Plant Health Management in Coconut grown in littoral sandy soil of Odisha. *Indian Coconut J.*,Vol. LXII:pp23-2

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19. Shinde, V. V., Maheswarappa, H. P., Ghavale, S. L., Khandekar, R. G. and Mahaldar, S. R., 2020. Nisarga : The strongest tropical cyclone striked the coconut ecosystem of Maharashtra state. *Indian Coconut Journal,* **13**(3): 23-26.

20. Sudhalakshmi. 2020. Perspectives of coconut cultivation in India. Agrobios Newsletter. 19 (02): 47.

21. Sudhalakshmi,C., S.Rani and K.Venkatesan. 2020. Irrigation and Drought Management. Pachai Bhoomi. June 2020. Pp. 28 – 29.

22. Sudhalakshmi, C., S.Rani and H.P.Maheswarappa. 2020. Goat Farming in Coconut Gardens - A Pivot of Confidence for Rural Unemployed during COVID era. Indian Coconut Journal. LXIII (05): 13-18

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24. Sudhalakshmi, C., V.Sivakumar and E.Rajeswari. 2020. Prevention is better than cure in coconut. Uzhavarin Valarum Velanmai.8: 45-48

25. Sudhalakshmi, C., B.Meena, S.Praneetha and H.P.Maheswarappa. 2020. Scorching of cocoa leaves in coconut gardens. Indian Coconut Journal. Vol. LXIII. No.7. November 2020. Pp. 26 -28.

26. Sudhalakshmi, C., Rani, S. and Maheswarappa H. P. 2020. Goat farming in Coconut gardens : A pivot of confidences for rural un employed during COVID era. *Indian Coconut Journal*, **13**(5):13-17.

27. Sudhalakshmi C, Meena. B, Praneetha S, and Maheswarappa. H.P. 2020. Scorching of cocoa leaves in coconut gardens. *Indian Coconut Journal*, 63(7):26 -29.

28. Sudhalakshmi ,C. E. Rajeswari and K. Venkatasan. 2020. Preaparation of vermicompost. Patchai Boomi.11: 16 – 17

29. Sumitha, S. and Maheswarappa, H.P. 2020. Coconut based cropping systems developed for different agro-climatic regions. *Indian Coconut Journal, 63* (6): 25-27.

30. Tamil Selvan,M A.Karthikeyan, A.Bharathi and S.Vivekananthan. Oil Palm – A Potential Oil Producing Palms in Tropics. *Tamil Nadu Co-operative Union*. July – 2020. Vol. 20 (9): 23-32.

Awards/Fellowships

1. Dr. C. Sudhalakshmi Bagged the Best Oral Presentation Award in the Fifth National Conference on Agricultural Scientific Tamil in Soil Science Section for the paper ". Is cocoa a remunerative intercrop under coconut intercropping system in calcareous soils" on 11.10.2020.

2. Dr. P. C Vengaiah, Scientist (Food Sci. & Tech.) awarded "Excellence in Research Award" by 'Samagra Vikas Welfare Society (SVWS)' during the "World Environment Day-2020 Celebration" held at, online on 5th June, 2020.

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XII. WEATHER DATA OF COORDINATING CENTRES

Coconut centres

Aliyarnagar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	32.6	17.6	95.5	89.2	0
February	33.2	17.5	90.8	87.9	0
March	34.9	21.4	83.1	79.3	7.2
April	35.2	22.0	84.8	82.9	70.1
May	35.2	22.0	86.8	82.3	70.1
June	33.9	23.3	82.4	76.2	93.8
July	32.8	25.5	85.3	80.3	117.8
August	33.2	24.4	85.0	77.7	22.9
September	32.1	24.8	86.0	80.7	38.6
October	32.3	23.2	90.6	84.2	96.0
November	32.4	21.1	91.1	88.2	32.7
December	32.5	18.5	90.3	88.5	60.0

Ambajipeta

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	34.2	21.6	95.2	78.4	21.4
February	36.8	20.0	96.0	59.7	0.0
March	40.1	20.6	94.4	70.7	0.0
April	41.1	23.3	89.0	69.8	0.0
May	43.0	26.1	88.4	75.2	96.2
June	39.1	25.9	84.8	62.0	29.0
July	35.2	25.2	83.8	68.0	86.8
August	34.8	25.5	82.6	70.0	50.0
September	33.8	24.8	86.4	75.1	96.6
October	35.1	24.4	88.0	67.8	36.2
November	32.2	23.4	92.9	79.7	185.4
December	28.0	21.0	94.1	83.2	348.4

Arsikere

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	27.5	18.9	71.9	61.2	0
February	31.0	14.6	55.7	37.9	0
March	36.1	18.5	51.7	31.9	0
April	37.1	19.0	44.8	33.9	20.4
May	36.5	22.2	30.7	30.7	95.2
June	32.7	20.8	57.7	34.9	80.0
July	32.0	21.3	67.1	56.4	197.4
August	29.4	22.1	66.0	52.9	74.4
September	28.7	21.3	68.1	52.3	118.0
October	27.3	21.0	69.3	54.4	193.0
November	28.6	18.9	81.9	56.7	32.0
December	24.2	20.4	76.6	55.0	37.2

Bhubaneswar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	27.1	16.1	94.0	52.0	12.7
February	28.5	16.1	93.0	46.0	94.2
March	34.2	22.4	95.0	49.0	56.5
April	36.9	24.7	93.0	50.0	107.9
May	35.5	25.9	92.0	58.0	157.1
June	34.9	25.7	93.0	68.0	95.3
July	34.4	26.5	93.0	67.0	158.9
August	33.0	26.2	94.0	75.0	591.5
September	34.2	26.5	93.0	69.0	129.7
October	31.9	24.3	95.0	75.0	247.6
November	31.4	19.6	90.0	53.0	5.6
December	29.7	14.3	94.0	41.0	0.0

Jagdalpur

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	28.5	12.4	97.0	42.0	14.1
February	29.2	12.9	94.0	41.0	32.4
March	33.6	17.3	88.0	39.0	26.0
April	36.1	21.0	76.0	34.0	147.4
May	36.8	22.3	74.5	39.5	35.8
June	32.3	23.2	87.8	66.5	250.4
July	30.6	22.9	92.0	72.9	261.3
August	28.3	22.6	94.0	79.4	437.4
September	30.9	22.4	93.3	70.6	277.1
October	30.3	20.2	93.9	59.7	150.3
November	29.4	14.9	93.9	43.7	33.2
December	28.6	8.6	94.6	33.8	0.0

Kahikuchi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	23.6	10.5	81.0	72.0	8.0
February	26.0	11.9	74.0	68.0	2.8
March	29.9	13.7	71.5	65.0	5.2
April	30.2	19.1	77.0	69.6	170.
May	31.5	22.8	79.5	74.4	204
June	31.9	25.0	86.0	80.5	298
July	31.7	25.6	88.6	82.0	351
August	32.8	25.9	88.8	83.5	215
September	31.1	24.2	84.5	81.0	154
October	30.7	22.0	82.2	80.8	75
November	28.1	16.9	80.7	78.0	15
December	23.8	11.1	78.5	73.6	trace

Mondouri

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	21.7	11.2	94.8	70.2	1.3
February	27.0	13.3	88.7	49.5	0.0
March	30.5	18.4	89.3	54.6	1.1
April	33.2	22.4	89.0	59.4	2.6
May	32.4	24.5	90.5	70.8	12.0
June	33.6	26.1	93.2	73.7	5.7
July	33.2	26.7	93.4	76.1	12.1
August	32.4	26.5	94.9	80.1	12.1
September	33.1	26.2	94.0	77.6	5.5
October	32.4	24.8	92.9	71.6	7.9
November	30.0	17.5	89.0	50.1	0.0
December	28.4	12.8	87.5	39.0	0.0

Navsari

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	29.0	11.6	87.00	55.00	0
February	32.5	15.4	83.00	40.00	0
March	33.4	18.2	89.00	49.00	0
April	37.1	23.2	90.00	54.00	0
May	36.2	26.8	84.00	61.00	0
June	33.2	25.6	95.00	77.00	117
July	31.8	25.2	95.00	86.00	674
August	29.5	24.5	98.00	92.00	1265
September	32.4	24.7	94.00	78.00	210
October	34.9	22.5	91.00	63.00	5
November	33.6	16.7	80.00	49.00	0
December	30.7	14.8	86.00	59.00	39

Pilicode

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	29.3	24	87.5	60.0	0
February	28.7	23.9	88.8	68.5	0
March	29.5	24	85.6	51.1	0
April	33.9	26.1	90.0	54.0	3.4
May	33.7	25.9	84.0	61.0	122.1
June	29.4	23.9	95.0	77.0	973.7
July	28.5	23.9	95.0	86.0	959.1
August	28.8	23.6	98.0	92.0	1024.5
September	29.7	23.9	94.0	78.0	804.5
October	30.2	23.9	91.0	63.0	278.1
November	33.1	22.4	80.0	49.0	34.2
December	33.9	26.1	86.0	59.0	3.4

Ratnagiri

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	32.3	18.6	91.7	54.6	0.7
February	33.1	18.1	93.5	57.9	0.0
March	32.3	19.9	90.8	63.8	0.0
April	33.7	24.3	89.8	60.8	0.0
May	34.5	25.8	84.1	67.2	9.0
June	31.5	24.0	91.6	76.3	793.7
July	29.7	24.2	94.6	86.8	1253.7
August	30.1	24.3	91.6	83.3	1174.0
September	30.2	23.8	58.4	83.0	574.6
October	31.0	24.1	54.5	79.2	239.8
November	34.6	26.2	50.6	65.5	0.0
December	33.3	24.1	45.2	62.0	0.0

Sabour

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	21.8	8.7	93.0	70.9	6.0
February	24.0	9.6	88.3	66.6	38.4
March	30.5	16.7	86.6	59.1	48.0
April	33.0	20.1	88.7	65.0	71.4
May	33.9	23.6	86.3	69.5	137.8
June	33.7	26.1	86.1	69.5	155.8
July	33.1	25.8	83.7	65.9	353.5
August	34.0	26.3	82.4	68.7	112.8
September	33.8	22.6	85.4	74.3	20.8
October	33.8	22.6	85.4	74.3	20.8
November	30.4	15.3	85.5	75.1	0.0
December	23.6	10.7	89.2	76.3	0.0

Veppankulam

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	34.2	21.6	95.2	78.4	21.4
February	36.8	20.0	96.0	59.7	0.0
March	40.1	20.6	94.4	70.7	0.0
April	40.0	20.0	90.0	70.0	0.0
May	43.0	26.1	88.4	75.2	96.2
June	39.1	25.9	84.8	62.0	29.0
July	35.2	25.2	83.8	68.0	86.8
August	34.8	25.5	82.6	70.0	50.0
September	33.8	24.8	86.4	75.1	96.6
October	35.1	24.4	88.0	67.8	36.2
November	32.2	23.4	92.9	79.7	185.4
December	28.0	21.0	94.1	83.2	348.4

Oil palm centres

Mulde

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	33.7	17.3	90.1	42.8	0.0
February	35.6	17.5	90.9	40.5	0.0
March	35.3	18.3	83.5	38.6	0.0
April	37.2	24.2	86.7	45.3	0.0
May	36.2	24.9	79.4	47.2	3.2
June	31.6	23.9	91.2	78.0	1026.3
July	29.3	23.6	95.6	85.7	1509.3
August	29.4	23.7	95.6	86.2	1259.7
September	30.6	23.7	95.7	79.4	704.9
October	32.2	23.0	95.7	71.8	337.0
November	34.5	19.4	86.7	43.8	0.0
December	35.02	17.9	90.6	46.1	19.6

Pasighat

Month	Temperature (°C)	Relative Humidity (%)		Rainfall (mm)
	Max.	Morning	Evening	
January	15.7	90.9	86.1	97.2
February	18.3		95.0	48.8
March	21.8	91.6	90.5	377.0
April	25.6	89.0	95.6	172.0
May	25.1	92.3	90.6	439.0
June	26.7	93.5	92.8	1469.0
July	27.3	94.5	93.0	1414.7
August	27.3	92.7	91.3	581.0
September	27.9	86.1	85.5	991.3
October	29.9	77.8	76.7	183.4
November	22.9	78.3	69.0	48.0
December	18.8	83.6	66.5	15.3

Note: Data for Minimum Temperature is not available at meteorological observatory of College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh.

Pattukkottai

Month	Temperature (°C)		Rainfall (mm)
	Max.	Min.	
January	34.3	21.7	21.4
February	36.9	20.1	0.00
March	40.1	20.6	0.00
April	39.5	23.3	0.00
May	43.0	26.1	96.2
June	39.2	25.9	29.0
July	35.3	25.2	86.8
August	34.8	25.5	50.0
September	33.8	24.9	96.6
October	35.1	24.4	36.2
November	32.2	23.4	185.4
December	28.0	21.0	348.4

Note: Data not recorded for Relative Humidity (%) at centre observatory

Pedavegi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.2	20.2	99.0	56.3	87.0
February	31.2	20.3	98.7	54.5	57.0
March	34.5	22.5	97.7	48.5	182.0
April	36.2	24.2	96.7	50.1	48.0
May	38.6	27.0	92.8	45.2	0.3
June	35.5	26.4	95.5	58.1	167.9
July	31.9	24.9	99.4	75.0	493.6
August	31.7	25.1	97.6	74.2	228.9
September	33.1	25.3	98.4	70.4	206.2
October	30.4	24.7	97.3	78.2	201.0
November	25.2	21.7	95.9	82.3	3.4
December	29.3	18.9	95.6	58.7	0.0

Vijayarai

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.2	19.2	90.5	64.1	0.2
February	30.9	19.3	92.0	61.4	0.0
March	31.2	20.5	85.2	49.5	0.0
April	36.2	24.2	96.7	50.1	48.0
May	38.6	27.0	92.8	45.2	0.3
June	35.5	26.4	95.5	58.1	**167.9**
July	31.9	24.9	99.4	75.0	**493.6**
August	31.7	25.1	97.6	74.2	**228.9**
September	33.1	25.3	98.4	70.4	**206.2**
October	30.4	24.7	97.3	78.2	**201.0**
November	25.5	21.7	95.9	82.3	**3.4**
December	29.3	18.9	95.6	58.7	0.0

Arecanut centres

Goa

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	33.4	18.0	87.3	40.7	0.0
February	35.1	20.1	88.6	38.2	0.0
March	34.4	22.5	88.1	46.9	0.0
April	35.5	25.2	83.8	54.2	6.0
May	36.3	26.6	78.7	55.2	0.4
June	31.0	24.0	92.6	80.1	1215.2
July	29.3	24.0	94.2	85.6	1347.7
August	29.4	24.1	93.0	82.6	1060.0
September	30.3	23.9	94.7	80.9	729.0
October	31.6	24.0	93.3	70.7	215.0
November	34.3	22.4	78.6	45.0	0.0
December	33.8	21.6	75.6	39.9	54.0

Port Blair

Month	Rainfall (mm)	Temperature (°C)		Humidity (%)
		Maximum	Minimum	
January	2.6	30.2	24.2	66
February	0	30.7	23.6	70
March	0	31.5	24.1	66
April	4.5	32.9	26.4	68
May	25.0	32.3	25.9	76
June	657.1	30.3	25.1	84
July	382.5	30.2	24.8	83
August	351.7	30.5	25.3	84
September	403.9	30.1	24.7	85
October	461.8	29.8	24.3	88
November	192.9	33.4	30.8	74
December	163.3	32.5	29.8	77

Shivamogga

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	31.8	16.3	84.3	53.7	50.4
February	32.7	16.6	76.5	48.2	41.7
March	35.0	19.4	74.6	56.0	38.4
April	35.7	21.1	78.1	64.2	38.3
May	34.7	21.9	78.1	55.3	49.61
June	29.8	20.9	86.0	82.8	116.6
July	28.5	20.5	89.2	80.1	154.4
August	27.4	20.1	89.5	78.8	265.8
September	29.1	20.2	93.0	82.2	191.6
October	29.8	19.3	91.9	76.5	148.0
November	30.7	17.4	87.1	48.0	68.2
December	29.7	16.5	92.6	40.2	72.7

Wakawali

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	33.9	21.2	88.8	57.3	0
February	33.5	22.2	82.2	56.6	0
March	32.0	24.8	90.7	76.8	0
April	34.5	24.0	96.1	91.1	0
May	34.8	23.4	95.9	87.7	0
June	28.7	23.6	96.2	89.6	1204.8
July	28.4	21.9	91.8	72.9	736.1
August	28.3	24.4	91.9	60.5	1711.2
September	30.9	19.5	85.3	39.2	1312.8
October	28.7	13.2	87.5	28.1	154.4
November	30.9	14.5	82.3	25.8	45.2
December	31.5	15.7	76.7	52.5	12.2

Palmyrah centres

Killikulam

Month	Temperature (°C)		Avr. Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	20.9	31.4	74.0	3.0
February	21.6	33.3	72.0	3.0
March	23.5	35.1	72.0	0.0
April	24.8	36.3	72.0	64.4
May	25.4	36.9	69.0	20.2
June	26.2	37.5	70.0	0.0
July	25.2	36.5	72.0	13.8
August	25.0	36.5	71.0	14.6
September	24.1	35.5	71.0	13.8
October	23.9	36.5	68.0	1.4
November	21.9	32.0	70.0	218.0
December	21.0	29.1	72.0	139.4

Pandirimamidi

Month	Temperature (°C)		Avr. Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	16.9	30	77.77	9
February	13.27	35.98	78.2	0
March	16.68	38.05	75.95	56.2
April	18.15	39.3	73.56	68.2
May	20.51	42.35	70.18	38.4
June	23.52	39.27	83.76	144.4
July	23.16	35.08	93.11	250
August	26.47	35.27	87.31	0
September	22.96	35.52	75.82	375.2
October	18.1	35.62	91.89	301.8
November	14.66	34.62	85.91	101.4
December	10.97	31.23	85.24	3.8

Cocoa centres

Thrissur

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	34.1	22.4	78.0	43.0	0.0
February	35.5	23.2	71.0	37.0	0.0
March	36.4	24.4	85.0	46.0	33.4
April	36.4	24.7	86.0	55.0	44.7
May	35.0	25.2	90.0	63.0	59.6
June	31.1	23.7	94.0	75.0	427.2
July	30.5	23.2	96.0	78.0	563.0
August	30.2	23.1	96.0	77.0	607.7
September	30.0	22.4	96.0	80.0	587.6
October	31.0	21.5	95.0	69.0	310.3
November	33.0	22.0	84.0	57.0	56.1
December	32.0	21.9	75.0	55.0	7.7

Sirsi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morning	Evening	
January	30.9	15.1	87.0	62.0	0.0
February	32.3	14.5	85.3	56.8	0.0
March	34.0	17.0	85.2	50.1	0.0
April	35.0	20.7	87.4	43.0	28.6
May	33.5	21.4	89.6	55.0	77.8
June	28.5	21.1	89.9	76.1	456.6
July	27.2	21.2	90.9	78.4	503.4
August	26.5	21.0	92.2	83.0	971.4
September	28.0	21.0	90.3	76.1	282.6
October	29.1	20.3	89.5	72.5	225.4
November	30.1	17.4	84.6	66.0	0.0
December	30.2	15.4	85.0	64.9	0.0

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भाकृअनुप
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