भाकृअनुप
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वार्षिक प्रतिवेदन
ANNUAL REPORT
2004-05

राष्ट्रीय तेल ताड़ अनुसंधान केन्द्र
(भारतीय कृषि अनुसंधान परिषद)
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(Indian Council of Agricultural Research)
Pedavegi-534 450, West Godavari Dt., A.P.

NATIONAL RESEARCH CENTRE FOR OIL PALM

वार्षिक प्रतिवेदन

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1 Oil Palm Bunch
2 Release of publication during National Seminar
3 View of participants

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Preface

I have the immense pleasure to present the 10th Annual Report of National Research Centre for Oil Palm. A decade of significant achievements of the Centre were well appreciated in the National Seminar on Research and Development of Oil Palm in India held during 19th and 20th of February, 2005 to commemorate the successful completion of 10 years of activities. The recommendations emanated in the Seminar have helped to re-orient and prioritize the research and development programmes on Oil Palm in the wider interest of the nation.

Importance of Oil Palm towards attaining self-sufficiency in edible oil production and economic growth of the country is well realized now. This crop is getting more and more acceptable to the farmers mainly due to the reason that the income accrued has helped in improving their economic status. It is the need of the hour to totally utilize the palm oil produced in the country for edible purposes by curtailing other industrial uses being practised by some agencies now. It is heartening to note that requests are reaching us in identifying new potential areas for oil palm cultivation in the already identified states and also additional states like Mizoram and Chattisgarh etc. This Centre continues its task of co-ordinating oil palm farmers, entrepreneurs and both the Central and State Government agencies concerned. A detailed report of the progress achieved in the ongoing research projects on all aspects of oil palm both at the Head Quarter and its regional Station at Palode, Kerala and other collaborating agencies are presented in this document.

India is still in its infancy in oil palm research when we compare Malaysia and other countries in the fray. It needs concerted and faster action to cope up with these countries for which strategies need to be outlined. Adoption of proven technologies by these countries through mutual agreement and understanding can be the shortest way of achieving the goal rather than trying to re-invent the available technologies elsewhere. Adoption of Tissue Culture techniques for regeneration of elite palms, production of superior *tenera* hybrids, development of high water use efficient cultivars, self sufficiency in supply of oil palm sprouts indigenously, water and fertilizer management including organic farming, integrated pest management, value addition, product diversification etc. are the thrust areas for the future.

I am thankful to all the Scientists and staff members of this Centre for successfully accomplishing the envisaged progress for the current year and I look forward for the sustenance of the same spirit of hard work for the coming years also.

Date : 31-12-2005
Station : Pedavegi

M . Kochu Babu
Director

कार्यकारी सारांश

जननिक सुधार

- पौधशाला में छः बौना पौधों का चयन किया गया है। बौनापन के चयन के लिए पत्रकों के बीच की दूरी को चयन-सूचिका के रूप में काम लिया जा सकता है।
- दस ओलिफ़रा ताड़ों में असंतृप्त वसीय अम्ल की कुल मात्रा ज्यादा दर्ज की गयी, इन्हें तेल की श्रेष्ठता पर किये जा रहे प्रजनन कार्यक्रमों में उपयोग किया जा सकता है।
- पालोड़ केन्द्र में पालोड़ संकर 75डी x 32डी में कोस्टारिका संकरों की अपेक्षा अधिक उत्पादन दर्ज किया गया।
- ड्यूरा मूल्यांकन अध्ययन के अंतर्गत प्रयोग-1 में 271 डी (सेल्फ़), प्रयोग-2 मे 65डी x 266डी और प्रयोग-3 मे 12डी सेल्फ़ में अधिकतम ताजा फ़ल गुच्छों का उत्पादन दर्ज किया गया।
- राजमन्द्री बीज उत्पादन केन्द्र के डी x पी सन्ततियों में ऊँचाई और घेरे में सार्थक अंतर दर्ज किया गया।
- लक्ष्मीपुरम बीज उत्पादन केन्द्र में, 46पी पिसिफ़ेरा ताड़ ने पराग परिपक्वता के लिए ज्यादा समय लिया जवकि 409पी में परिपक्वता त्वरित गति से हुई। 633डी और 703डी ड्यूरा ताड़ों में अंकुरण जल्दी प्रारम्भ हुआ और अंकुरण पूरा होने के लिए बहुत कम समय दर्ज किया गया।
- पेदवेगी बागान में टी x टी आबादी में ड्यूरा(22): पिसिफ़ेरा (13): टेनेरा (83) का अनुपात दर्ज किया गया है।
- तारका बीज केन्द्र के ड्यूरा ताड़ों में ताजा फ़ल गुच्छों का वजन 344 किग्रा / ताड़ तक दर्ज किया गया। इस केन्द्र के द्वारा व्यवसायिक स्तर पर बीज उत्पादन चालू किया गया है।
- दो डी x पी संकरों में अकालपक्व पुष्पण देखा गया।
- जी x ई जाँच में सी11086 (पेदवेगी) और सी11189 (पालोड) में सव से अधिक उत्पादन दर्ज किया गया। पेदवेगी में कोस्टारिका के 18 ड्यूरा ताड़ों का चयन किया गया। भीमनकोल्लि के संकरों में कुल उत्पादन की दृष्टि से काफ़ी भिन्नताएँ देखी गयी। यहाँ सी11097 संकर में अत्यधिक उत्पादन और सी11214 में अत्यधिक लिंग-अनुपात दर्ज किये गये।
- अधिक उपज वाले जिनोटाइपों के चयन में मादा - पुष्पक्रमों की संख्या की अपेक्षा जल्दी-उत्पादन देने वाली चयन सूचिका को उपयुक्त पाया गया।
- पेदवेगी में अंतर्जातीय संकरों में तीन अधिक-उपज वाले ताडों का चयन किया गया है।
- पालोड केन्द्र में 16ईओ x 81ईजी में गुच्छों की संख्या और ताज़ा फ़ल गुच्छों का उत्पादन अत्यधिक दर्ज किया गया।
- विभिन्न देशों के संकरों में गरदनी घेरा और ताजा फ़ल गुच्छों के वजन में भी सार्थक विभिन्नताएँ देखी गयी। आइवरी कोस्ट संकरों में गुच्छा-सूचिका ज्यादा पायी गयी।
- फलभिक्ति में जल एवं तेल की मात्रा में नकारात्मक एवं सार्थक सह-संबन्ध पाया गया।
- फ़लों को सात दिन तक 50 डिग्री से. तापमान तक रखने के बावजूद लाइपेज एन्जाइम की क्रिया में स्थिरता पायी गयी, जिसके कारण एफ़. एफ़. ए. कम रहा।
- तेल ताड के पर्णों के ऊतकों से कोई डिटर्जेंट के बगैर उच्च गुणवत्ता के डी.एन.ए. पृथककीरण का नया तरीका विकसित किया गया।
- प्रकाश-संश्लेषण दर का पत्तियों में नत्रजन की मात्रा, शुष्क-पर्ण-भार , विशेष पर्ण भार, प्रस्वेदन दर और रन्ध्री-चालकता के साथ सकारात्मक सह-संबन्ध पाया गया।

- तेल ताड के बीजों को पहले पाँच दिन तक भिगोने के बाद सुखाकर 60–70 दिन थर्मल प्री–हीटिंग उपचार देने के बाद फ़िर पाँच दिन भिगोने से अंकुरण अच्छा होता है।
- सोडियम सायनामायिड के उपचार में बीजों के अंकुरण में वृद्धि दर्ज की गयी लेकिन उपचार में लगे लोगों को जलन महसूस हुई। एतेफ़ोन और सल्फ़ूरिक अम्ल से उपचारित बीजों में अंकुरण बहुत उत्तेजित हुआ लेकिन विकसित पौधों में असामानताएँ पायी गयी।
- फ़फ़ून्द से उपचारित बीजों को गिरी हुई पत्तियों में रखने से अंकुरण त्वरित गति से होना पाया गया और काफ़ी स्वस्थ्य अंकुर पैदा किया जा सके।
- अंकुरण के समय में घुलनशील प्रोटीनों की मात्रा भ्रूणपोष से भी भ्रूण में ज्यादा पाया गया।
- पेदवेगी में तनाव परिस्थितियों में जाँबियन प्रविष्टियों में गुच्छों की संख्या और गुच्छों का कुल वजन सर्वाधिक दर्ज किये गये।
- जेड.एस.–3, जेड.एस.–5 और टी.एस.11 प्रविष्ठियों में अधिक पर्ण तापमान और कम प्रकाश–संश्लेषण दर और रन्ध्री–चालकता दर्ज किये गये।
- जी.बी.–22 / 311 और जेड.एस–3 में रन्ध्री–आवृति अत्यधिक थी। जेड.एस–5 में एपिडेर्मल आवृति, जेड.एस–2 में रन्ध्री–सूचिका, टी.एस.–11 और टी.एस–9 में रन्ध्री–प्लास्टिड संख्या और टी.एस–9 में रन्ध्री–संरक्षण कोशिका की लंबाई सब से अधिक दर्ज की।
- रन्ध्री–आवृति और संरक्षण–कोशिका की लंबाई में नकारात्मक सह–संबन्ध देखा गया। रन्ध्री–आवृति के साथ प्रकाश–संश्लेषण दर और प्रस्वेदन में सार्थक सकारात्मक सह–संबन्ध पाया गया।
- जाँम्बिया की प्रविष्ठियों में औसत ताजा फ़ल गुच्छों का कुल भार अत्यधिक था, इन पविष्टियों में मानक विचलन अधिक था।
- भारतीय बौना तेल ताड–2 में सिर्फ़ स्त्री–पुष्पक्रम ही पाये गये और छोटे गुच्छों का उत्पादन हुआ।
- जाँम्बिया की प्रविष्ठियों के बीजों की लंबाई, चौडाई, छिलका भार और दाने का भार सब से अधिक पाये गये।
- नेल्लूर में लगे जाँम्बिया की प्रविष्ठियों में स्त्री–पुष्पण, पत्ती–क्षेत्रफ़ल और पत्ती का सूखा वजन अत्यधिक दर्ज किये गये। आदिलाबाद में टाँजानिया प्रविष्ठियों में अत्यधिक ऊँचाई, पत्तियों की संख्या, पत्तियों का क्षेत्रफ़ल और पत्तियों का क्षेत्रफल अत्यधिक दर्ज किये गये।
- पालोड में गुवाना बिस्सु प्रविष्ठियों में गुच्छों की संख्या अत्यधिक दर्ज की गयी, ताँजानिया प्रविष्ठियों में अत्यधिक ताजा फ़ल गुच्छों का भार और पी.सी.के.एल. में जाँम्बिया प्रविष्ठियों में कुल पुष्पण अत्यधिक दर्ज किये गये।

फ़सल उत्पादन

- तेल ताड में फल उत्पादन शुरू होने के समय में उर्वरक की आवश्यकता पर किये जा रहे उपचारों में घेरे और पत्तियों के क्षेत्रफ़ल में बहुत अंतर देखा गया।
- ड्रिप और जेट सिंचाई पद्वतियों में ताड़ की ऊँचाई, तने का घेरा, पर्ण शुष्क भार और उत्पादन सबसे अधिक थे। सिंचाई के स्तर में कमी के साथ घेरा, पर्ण शुष्क भार और क्षेत्रफ़ल में भी कमी दर्ज की गयी।
- विभिन्न सिंचाई स्तरों पर किये गये अध्ययन में आई–1 (आई.डब्लू / सीपीई–1) में सर्वाधिक उत्पादन दर्ज किया गया। तीन उर्वरक स्तरों का वृध्दि एवं उत्पादन पर कोई सार्थक प्रभाव नहीं देखा गया। सभी उपचारों में पोषक तत्वों का स्तर साधारण दर्ज किया गया एवं इन उपचारों में प्रकाश संश्लेषण दर और रंन्ध्री चालकता के लिए अन्तर दर्ज किया गया।

- तेल ताड़ की काँटी-छाँटी गयी पत्तियों और खाली फूल के गुच्छों का इस्तेमाल करके बडे पैमाने पर सेंद्रिय खाद की तकनीक का विकास और उसका प्रदर्शन किया गया।
- अध्ययनों से यह पता चलता है कि दो तिहाई अथवा पूर्ण रूप से अकार्बनिक खाद के उपयोग का गुच्छों की संख्या और भार में कोई सार्थक अन्तर नहीं पाया गया।
- मिश्र खेती पध्दति पर किये जा रहे प्रयोगों से पता चला के केला, शोभांजन, मकई बीज, हेलिकोनिया फ़ूल, लोकी आदि को तेल ताड में अन्तरा: सस्य के रूप में लिया जा सकता है। उपलब्ध जल को समुचित उपयोग करके तेल ताड़ फ़सल में अन्तरा: सस्य अथवा थले में फसलों को उगाया जा सकता है जिससे अच्छे उत्पादन के साथ-साथ सगर्भता-काल में अच्छी आमदनी ली जा सकती है।
- वीथिका फ़सल पध्दति में कोको, सिन्नेमान, ग्लिरीसिडिया पर ली गई काली एन्तूरियम (पुष्पीय पौधा), कचोलाम (औषधीय पौधा) और गिन्नि ग्रास (चारा) आदि को लेने के अच्छे परिणाम मिलें।
- जैव-अभियाँत्रकी उपचारों से यह पता चला कि बरसात में पानी के प्रवाह को रोककर मृदा एवं जल संरक्षण किया जा सकता है। तेल ताड़ में अन्तरा: सस्य के रूप में पुष्प (एन्थुरियम) और औषधीय (काचोलम) पौधों की खेती सफ़लतापूर्वक की जा सकती है और उत्पादन भी काफ़ी उत्साह-जनक दर्ज किया गया।
- इस वर्ष 1294 पत्तियों एवं 1103 मृदा नमूनों का पोषक तत्वों के लिए विश्लेषण किया गया।
- उर्वरकों द्वारा किये गये सभी पोषक तत्वों की पिछले वर्ष की उपज के साथ धनात्मक सह-सम्बन्ध पाया गया, यह सह-सम्बन्ध उसी वर्ष की उपज के साथ नहीं पाया गया।
- नत्रजन, फास्फोरस एवं पोटाश की मात्रा पत्तियों के टूटने की प्रचण्डता के साथ कम होते पाये गये जबकि केल्शियम की मात्रा बढती हुई पायी गयी।

फसल संरक्षण

- राइनोसिरस भृंग, साइकिड और घोंघा इल्ली तेल ताड़ पर लगने वाले मुख्य हानिकारक कीडें पाये गये। पर्ण-छेदक इल्ली जाडों के महीनों में आन्ध्र प्रदेश के पश्चिम गोदावरी और कृष्णा जिलों में देखा जाता है। साधारण स्तर से भारी हानि पहुँचाने वाले पक्षियों में कृष्णा जिले में कौआ और जंगली कौआ, पश्चिम गोदावरी जिले में पर्कीतें, विजयनगरम जिले में मैना शामिल हैं। पर्ण-छेदक इल्ली से भी छोटे स्तर पर सामान्य हानि होती है। स्तनधारियों में चूहों का प्रकोप बहुत पाया गया।
- दो ताड़ों के बीच जमीन से 3 फ़ीट ऊँचाई पर प्लास्टिक वायर की जाली लटकाकर पक्षियों के नुकसान पर काफ़ी प्रभावकारी नियंत्रण किया गया। पर्ण-छेदक इल्ली के नियंत्रण में *बीवेरिया बासियाना* काफ़ी उपयुक्त पाया गया।
- ताड़ो के शीर्षों पर *मेटाराईजियम एनिसोपिले* के स्प्रे करने से भृंग के नुकसान को छह महीनों तक रोका जा सकता है, इसे एफ़ वाई.एम. के गड्ढों में लगाने से कीडों को प्रजनन स्थल पर ही नियंत्रण कर सकते है।
- कृमि-खाद के साथ *मेटाराईजियम एनिसोपिले* और *टी. विरिडी* देने से कोई नकारात्मक प्रभाव नही पाया गया।
- तेल ताड़ में लगने वाली बीमारियों के लिए किए गये सर्वेक्षण में मोहितनगर (प.बंगाल) एवं राजमन्द्री (आं.प्र.) में बेसल तना सडन से संक्रमित ताड़ पाये गये।
- गानोडर्मा के वियुक्तों में किये गये आर.ए.पी.डी. विश्लेषण में इनमें काफ़ी बहुरूपता पायी गयी।

कटाई-उपरान्त प्रौद्योगिकी

- एक चल तेल ताड़ अपशिष्ट कटाई इकाई की संरचना की गयी है। 12 हेच.पी. पावर टिलर के साथ इस मशीन की कुल कीमत रु 1.50 लाख आँकी गई है।

- फार्म स्तर पर ताड़ तेल के निष्कर्षण हेतु एक छोटी स्क्रू प्रेस की संरचना एवं प्रारूप देयार किया गया और इसकी क्षमता का आकलन किया जा रहा है।
- तेल ताड़ के खाली फलों के गुच्छों ब्रिकेटिंग के द्वारा इन्धन बनाने की क्रिया के काफी उत्साहजनक परिणाम पाये गये।
- तेल ताड़ अपशिष्ट पदार्थों से पेपर बोर्ड बनाने की प्रक्रिया का मानकीकरण किया गया है।
- तेल ताड़ के खाली गुच्छों से निकले रेशों से गर्मियों में छत पर ठण्डा रखने वाली गददी बनायी गयी।
- केरोडिनाइड को शुद्ध पूप में गहन फ्रिज में रख सकते है जिससे उनके क्षय को कम किया जा सकता है और तरह इसका आसानी से भण्डारण किया जा सकता है।
- फुलर्स अर्थ को अपरिष्कृत ताड़ तेल से केरोटिनाइड के अधिशोषक के रूप में और उससे पुन: निष्कर्षण के रूप में काम में लिया जा सकता है।
- प्रयोगशाला स्तर पर पोम से बचा हुआ तेल निकालने के लिए और निथार एवं अवसादन टैंक का विकास किया गया।
- भेडों की वृध्दि एवं विकास पर पोम और ताड़-दाना केक को काम में लेते हुए एक जाँच शुरू की गयी है।

कंप्यूटर एप्लिकेशन्स एवं प्रौद्योगिकी प्रसार

- तेल ताड़ बागानों के लिए उपयुक्त सूचना तन्त्र की सी.डी. बनायी गयी और उसको सारे बीज उत्पादन केन्द्रों को दिया गया। इस अवसर पर एक विशेष प्रशिक्षण का भी आयोजन किया गया।
- केन्द्र की वेबसाईट का खाका पुन: तैयार किया गया एवं उसका अद्यतन किया गया।
- प्रौद्योगिकी का प्रसार व्यक्तिगत या सामूहिक संपर्कों से या दोनों के माध्यम से हो रहा है। प्रशिक्षित अधिकारियों ने सुझाव दिया गया कि तेल ताड़ खेती से संबन्धित उत्पादन प्रौद्योगिकी, सिंचाई एवं पोषण प्रबन्ध, अन्तरा: सस्य पध्दति, ताजा फ़ल गुच्छों की कटाई, पर्ण विश्लेषण, कीट एवं रोग प्रबन्ध आदि अंशों पर प्रशिक्षण की और गहन आवश्यकता है।
- प्रशिक्षित किसानों ने सुझाव दिया कि लम्बे ताड़ों से गुच्छों की कटाई, अन्तरा: सस्य, सिंचाई एवं पोषण प्रबन्ध, आदि पर लगातार रिफ्रेशर कार्यक्रमों का आयोजन करने की सख्त आवश्यकता है।
- आइ.वी.एल.पी. परियोजना के अन्तर्गत विभिन्न हस्तक्षेपों, जैसे धान की अधिक उपज वाली किस्मों का परीक्षण, धान में कीट-रोग नियंत्रण, धान से संघठित पोषक प्रबन्ध, तम्बाकु इल्ली के नियन्त्रण के लिए अनुशंसित कीटनाशों को अपनाना, तेल ताड़ की खेती में अनुपात में तालाबों में मछली-अंगुलिकों का उपयोग आदि आयोजित किये गये।
- आइ.वी.एल.पी. परियोजना के अन्तर्गत धान और तेल ताड़ की खेती पर प्रशिक्षण, पशु स्वास्थ्य का विशेष प्रचार कार्यक्रम, दत्तक गाँव में क्षेत्रीय दिवस आदि के आयोजन किये गये।
- तेल ताड़ उत्पादन तकनीक संकर बीजों का उत्पादन, फ़सल संरक्षण, पर्ण-पोषक विश्लेषण और खेती संबन्धित अंशों पर प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिनमें 88 अधिकारी प्रशिक्षित किये गये।
- तेल ताड़ की खेती, संघठित पोषण एवं जल प्रबन्ध, लम्बे ताड़ों से गुच्छों की कटाई आदि पर कई एक-दिनसीय प्रशिक्षण कार्यक्रमों के आयोजन किये गये जिन से कुल 2521 किसानों को फ़ायदा हुआ।
- बीज गाँव परिकल्पना के अन्तर्गत धान की अधिक उपज वाली किस्मों के बीजों के उत्पादन पर भी कार्य किया गया।

EXECUTIVE SUMMARY

GENETIC IMPROVEMENT

- Six dwarf seedlings have been identified in nursery for further investigation. The inter-leaflet distance could be used as selection index for dwarfness.
- High total unsaturated fatty acid content was recorded in 10 Eo palms, which could be utilized in breeding programme on superior oil quality.
- At Palode, Palode cross 75Dx32P recorded maximum yield when compared with Costa Rican hybrids.
- In Dura evaluation trials 271D-self in trial I; 65D x 266D in trial II; and 12D-self in trial III recorded the maximum FFB yield.
- Variation for height and girth was recorded significant in DxP Progenies of Rajahmundry Seed Garden.
- At Lakshmipuram, Pisifera palm 46P took more duration for pollen maturity, whereas 409P was early in maturity. In Rajahmundry seed garden dura palms, 633D and 703D, showed early initiation of germination and took less time to complete total germination.
- At NRCOP seed garden segregation ratio of Dura (22): Pisifera (13): Tenera (83) has till now been observed in T x T population.
- At Taraka Seed garden FFB weight in dura palms up to 344 Kg was recorded. Commercial seed production has been initiated.
- Occurrence of precocity for flowering was observed in two DxP crosses.
- In GxE trial, the highest FFB yield was recorded in C11086 at Pedavegi and in C11189 at Palode. At Pedavegi 18 Dura palms have been identified in Costa Rican hybrids. At Bheemanakoli, significant differences among hybrids were recorded for cumulative yield, the highest yield was recorded in C11097; the highest sex ratio was recorded by C11214.
- It was found that early yield could be used as the selection criterion for selecting high yielding genotypes. The selection for female inflorescences may not be effective.
- Three high yielding palms identified in inter-specific hybrids at Pedavegi, could be used in back crossing programme after ascertaining quality and other parameters.
- At Palode, maximum number of bunches and FFB yield was recorded in 16Eo x 81Eg. Variation in types of fruits for shape and seedlessness were noticed in single bunch.
- Significant variation in seed length, shell thickness, shell and kernel weights were recorded in teneras of different countries. Differences among hybrids from different countries were significant for stem girth and FFB weight. Among the four sources, ASD Costa Rica produced the maximum yield followed by Palode.
- There was a very strong negative correlation found between moisture content and oil content .
- The lipase activity was observed consistent and steady up to 50^{o}C temperature even after 7 days of incubation of the fruits resulting in low FFA.
- A novel method of DNA isolation from oil palm leaf tissue without using any detergent has been developed. By this method high quality DNA with sufficient quantity could be extracted from the oil palm leaf tissue.

- The photosynthetic transpiration rates and stomatal conductance were higher in young leaves and decreased with increase in age of leaf.
- Photosynthetic rate was positively correlated with leaf N content, leaf dry weight, Specific leaf weight, transpiration rate and stomatal conductance.
- Seed soaking for five days and thermal dry pre-heat treatment for 60-70 days followed by five days soaking of dura seeds was found to be optimum to get maximum germination.
- Sodium Cyanamid stimulated seed germination, but was found unsuitable as it caused irritation to workers. Treatment of seeds with Ethephon and Sulphuric acid though stimulated germination, resulted in abnormal seedling development.
- Fungal treated seeds along with shredded media initiated germination after 28 days of incubation much earlier than the control and also resulted in healthier sprouts.
- During germination soluble proteins in the embryo were more than that of endosperm.
- At Pedavegi under stress conditions number of bunches and total bunch weights were recorded highest in Zambian accessions followed by Tanzanian.
- Photosynthetic and transpiration rates were highest in GB 25 followed by GB 22/311 and ZS 2. Guinea Bissau accessions had high stomatal conductance, less leaf area and significantly lower leaf temperatures.
- Highest stomatal frequency was observed in GB 22/311 and ZS 3. High epidermal frequency was observed in ZS 5. Stomatal index was significantly high in ZS 2.
- The negative correlation between stomatal frequency and guard cell length was observed. Stomatal frequency had significant positive correlation with photosynthetic rate and transpiration.
- Mean height of Cameroon accessions was lowest while the Zambian accessions were moderate in height. The average FFB weight of Zambian accessions was the highest with high standard deviation.
- Indian Dwarf Oil Palm II was characterized; female inflorescence and small bunches were produced without male inflorescence.
- Seeds of Zambian accessions had maximum length, width, shell weight and kernel weight. Shell thickness was found maximum in Tanzanian accessions and minimum in Guinea Bissau.
- At Nellore maximum girth, number of female inflorescence, leaf area and leaf dry weight were recorded by Zambian accessions. At Adilabad Tanzanian accessions recorded maximum height number of leaves, leaf area and leaf dry weight
- At Palode Guinea Bissau accessions recorded highest number of bunches. Highest FFB weight was recorded in Tanzanian accessions. At PCKL maximum number of inflorescences were recorded in Zambian accessions.

CROP PRODUCTION

- In an experiment on fertilizer requirement of oil palm during early stages of bearing treatments differed for girth and leaf area.
- Palm height, stem girth, leaf dry weight and leaf area were recorded maximum in drip irrigation that was on par with jet irrigation. Girth, leaf dry weight and leaf area decreased with decreasing levels of irrigation. Maximum yield was recorded in Drip irrigation method followed by jet.

- Among irrigation levels maximum yield was recorded in I-1 (IW/CPE=1) followed by I-2 (IW/CPE=0.8) & I-3 (IW/CPE=0.6). Maximum number of bunches were recorded in Drip irrigation. There was no significant difference due to three fertilizer levels on growth or yield parameters studied. There was no significant difference in leaf nutrient levels among the various treatments.
- Organic composting of oil palm wastes in large scale using pruned leaves and empty fruit bunches have been perfected and large scale production of organic compost both by aerobic method and vermi-composting were carried out and demonstrated during the year.
- The production of bunches and FFB yield showed that 2/3rd organic source or even full as organic source were on par indicating the possibility to substitute 2/3rd of the inorganic fertilizer need of oil palm with organic compost.
- In experiment on mixed farming, banana, drumstick, seed maize, Heliconia flowers, bottle gourd etc were found promising intercrops. Rhinoceros beetle infestation was observed higher in Malaysian cross-compared to other crosses. Various intercrops grown as tertiary ones in the interspaces and the basins using the available water yielded well and increased the sustenance of oil palm farming by providing income during gestation period. Biogas extraction from oil palm sludge was demonstrated, application of compost wash through drip system, preparation of vermi-compost, effect of microorganisms on earthworm population, production of Oyster mushroom on oil palm mesocarp waste, sheep rearing etc were the components of mixed farming systems.
- Alley cropping system with Cocoa, Cinnamon, black pepper trailed on glyricidia and intercropping of anthurium (flowering plant), Kacholam (medicinal plant) and guinea grass (fodder) were well established under humid tropical conditions.
- The bio-engineering treatments were found to conserve soil and water by reducing the run off during the rainy season in high rainfall tracts. The newly tested system of raising floriculture (growing Anthurium) and medicinal plants (Kacholam) has been found successful and given promising yields.
- The newly tested practice of growing black pepper trailed on Glyricidia planted as alley crop in between palm rows has given multipurpose benefits as a fertilizer crop, green manure crop and also as standard for trailing black pepper in Oil Palm plantations.
- Agro forestry by raising multiple species of crops in combination with oil palm in a multi-tier system of canopies viz: Oil palm + Cocoa or Cinnamon or glycidia with black pepper + pepper trailed on oil palm + Anthurium (flower plant) or Kacholam (medicinal plant) were found promising.
- Analysis of 1294 leaf and 1103 soil samples was carried out for different nutrients.
- Soil Mg was negatively correlated with yield of just concluded year. All the major nutrients applied in the form of commercial fertilizers were positively correlated with current year yields.
- In studies on Leaf breaking in Oil Palm leaf nutrient analysis revealed that the concentrations of N, P and K were higher in the healthy leaves and decreased with the severity of the leaf break incidence whereas Ca content followed reverse trend. Potassium was the only nutrient, which was deficient in all the leaves. Secondary nutrients (Ca and Mg) and micronutrients (Cu, Zn, Mn and Fe) were found to be in the optimum range in all the three categories of leaves.
- In survey on light infiltration through oil palm canopy, the amount of light that penetrated through oil palm canopy varied between 3-15%.

CROP PROTECTION

- Rhinoceros beetle, psychid and slug caterpillar were observed major pests. Incidence of leaf eating caterpillar was observed in West Godavari and Krishna districts during the winter months. House crow, Jungle crow among birds in Krishna district, parakeets in West Godavari district, mynah in Vizianagaram district were found predominant avian pests causing moderate to heavy damage. Incidence of leaf eating caterpillars of Oil palm was observed at low to moderate level. Among mammalian pests, rodents were observed as the major pest.
- Hanging of fishnets in between two palms at 3ft above ground at random places was found effective in controlling the bird menace.
- Incidence of leaf eating caterpillars was observed at low to moderate level, in its control *Beauveria bassiana* (causing white muscardine disease) was found effective.
- Application of commercial formulation of *Metarhizium anisopliae* on crown region of Oil palms proved effective in arresting the beetle incidence for six months. Application in FYM pits and coconut logs proved effective in reducing the pest population in the breeding sites.
- Commercial formulation of the product was supplied to different Oil palm growers for further multiplication and spread into the plantations.
- No antagonism was found between *Metarhizium anisopliae* and *Trichoderma viride* when applied to PDA media indicating the compatibility between fungi.
- Fungal growth of *Metarhizium anisopliae* and *T. viride* were found affected by use of copper oxy chloride like, cypermethrin and fenvalerate were relatively safe.
- Significant observations were recorded on Basal Stem Rot (BSR) at Mohitnagar and Rajahmundry.
- RAPD analysis revealed that Ganoderma isolates were highly polymorphic and all the primers produced polymorphic bands.

POST- HARVEST TECHNOLOGY

- A mobile oil palm waste shredding unit was designed and developed. The total cost of machine along with a 12HP power tiller was estimated at Rs.1.5 Lakhs.
- Preliminary study has been conducted on Gasification of oil palm wastes
- Preparation of Cooling pad from oil palm EFB fibre has been found promising.
- The loss of carotenoids was minimum when it is stored in 'pure form' in Deep fridge storage. The Fuller's Earth could successfully be reused for extraction of carotenoids from Crude Palm Oil. Among the synthetic adsorbents, Diaion HP 20 showed maximum net recovery followed by Diaion HP2MG and they were on par.
- An anaerobic digestion system for POME was designed and installed. It is envisaged to utilize the biogas from POME during anaerobic digestion for supplementary boiler fuel in palm oil mills.
- A lab scale settling and sedimentation tank was fabricated for conducting settling studies and residual oil removal from POME.
- Animal growth trials and fish culture on POME and Palm Kernel Cake based feeds have been initiated.

COMPUTER APPLICATIONS & TRANSFER OF TECHNOLOGY

- Data on area of oil palm and production of FFB from the oil palm growing states were collected and analysed.
- The CD on Oil Palm Seed Garden Information System was given to all seed gardens and specialized training for 3 days was imparted.
- The institute website was re-designed and updated.
- It was observed that technology diffusion was being done either through individual or group contacts or using both. The officers suggested in depth need for training on oil palm production technology, irrigation & nutrient management, intercropping, harvesting of oil palm FFB, leaf analysis, and pest and disease management.
- The trained farmers suggested to have refresher courses on harvesting of oil palm FFB in tall plantations, intercropping, irrigation and nutrient management *etc*. Overall, farmers were satisfied with present set up of extension system.
- Under IVLP programme, various interventions like testing High Yielding Varieties of paddy, control of pest & disease incidence in paddy, integrated nutrient management in paddy, adoption of recommended pesticides against tobacco caterpillar and use of NPV reduced the pest incidence, Application of recommended dose of fertilizers in oil palm, improvement of health of buffaloes through vaccination, and use of fish fingerlings in community pond in recommended ratio were taken up.
- The seed village concept was promulgated through multiplication of high yielding paddy varieties for their future.
- The institute took active part in events like kisan mela and exhibitions. Participating in *All India Radio and Television network programmes;* Organisation of video film shooting; replies to Queries on oil palm through postal services and in field visits.
- Under TAR-IVLP programme the institute was involved in organizing Trainings on Paddy cultivation and oil palm cultivation; Animal Health campaigning; a field day programme etc in adopted Pedakadimi village
- Training programmes on Oil Palm Production Technology, Oil Palm Hybrid Seed Production, Plant Protection in Oil Palm, Leaf Nutrient Analysis in Oil Palm and Oil Palm Cultivation were organised to 88 officers.
- Sixteen one day training programmes on Oil Palm Cultivation, 11 one day training programmes on Integrated nutrient and water management in oil palm; and 10 one day training programme on harvesting of Fresh Fruit Bunches from tall palms were organised for 1529 farmers.

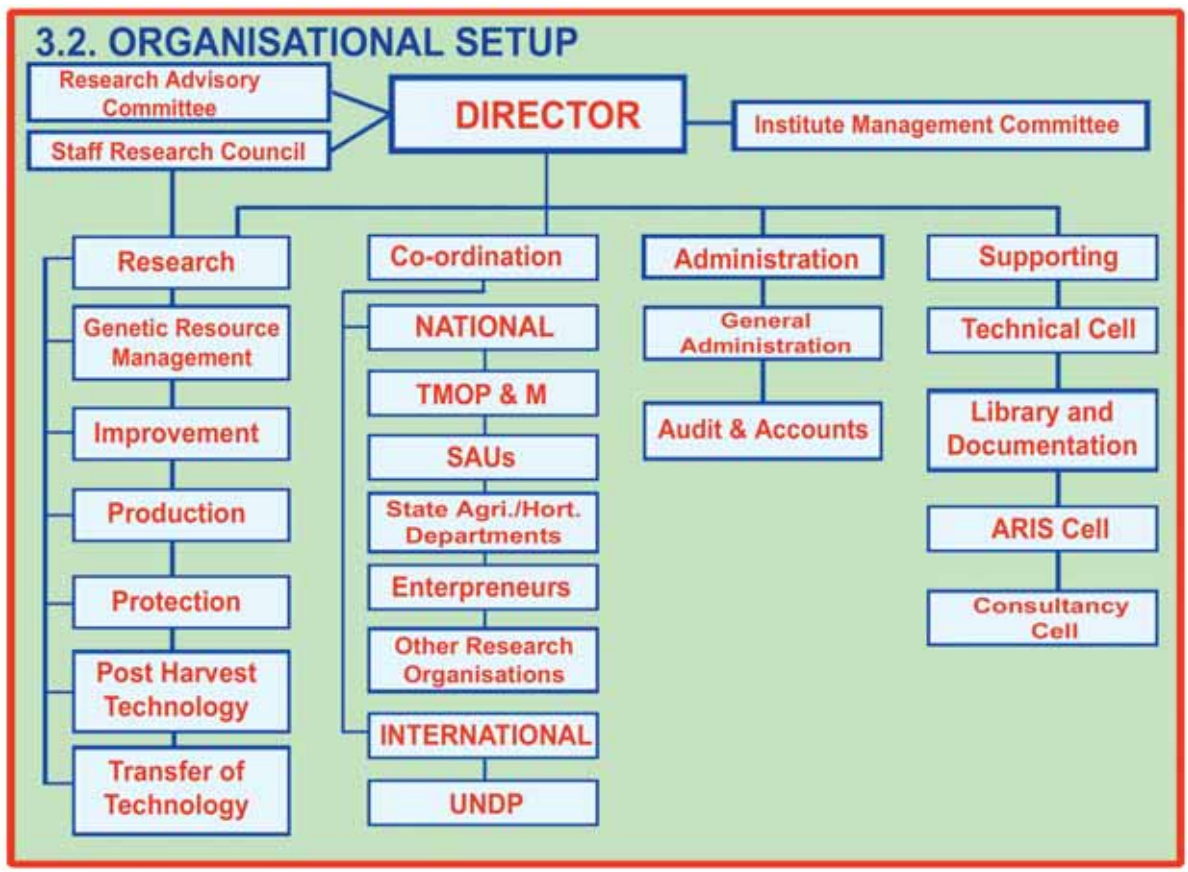
3. INTRODUCTION

The National Research Centre for Oil Palm is a pioneer institute established under the aegis of Indian Council of Agricultural Research (ICAR) at Pedavegi, West Godavari District of Andhra Pradesh on 19th February' 1995. The Centre is 13 Km away from Eluru, which is the district headquarter of West Godavari. The then CPCRI (Regional Centre), Palode was merged with NRCOP in April'1999 with a view to unifying oil palm research under one management. The Regional Station Palode is 35 Km away from Thiruvananthapuram, Kerala on Thiruvananthapuram-SenKottah route. NRCOP serves as a Centre of Excellence for conducting and coordinating research on Oil Palm in the fields of germplasm collection and conservation; genetic improvement, production, protection, post-harvest aspects and dissemination of knowledge through transfer of technology.

3.1. MANDATE

- To conduct mission oriented research on all aspects of Oil Palm with an objective to improve the productivity and quality
- To serve as national repository for Oil Palm germplasm and clearing house for all research information on Oil Palm and coordinate national research projects
- To generate nucleus planting material
- To collaborate with national and international agencies in achieving the above
- To act as center for training in research methodology and technology of Oil Palm

3.2. ORGANISATIONAL SETUP



3.3. Financial Outlay (during 2004-05)

HEAD	PLAN			NON-PLAN	
	BE 2004-05	RE 2004-05	Expenditure	RE 2004-05	Expenditure
Establishment	5,15,000	(OTA) 15,000	15,000	1,25,55,000	96,40,277
TA	5,00,000	5,00,000	4,99,999	2,95,000	2,94,910
Equipment	99,77,000	1,35,00,000	1,85,79,154	38,50,000	93,50,740
Works	82,08,000	81,85,000	33,40,553	5,50,000	38,65,574
Others	8,00,000	3,00,000	65,156	50,000	3,33,326
Total	2,00,00,000	2,25,00,000	2,24,99,862	1,73,00,000	2,34,84,827

3.4. Externally Funded Schemes (for 2004-05)

S.No.	Name of the Scheme	Opening Balance	Funds Received	Expenditure Incurred	Balance
1.	G x E	(-)33,365	10,00,000	9,01,406	65,229
2.	STOP	98784	6,00,000	2,76,313	4,22,471
3.	LAL	(-)39354	4,00,000	1,51,499	2,09,147
4.	NATP-INWM	9,372	-	9,372	-
5.	NATP-IPM(M)	12,958	-	12,833	125
6.	NATP-IPM (R)	63	-	63	-
7.	NATP-BSR	15,775	-	15,775	-
8.	NATP-PSR	22,765	1,24,235	1,47,000	-
9.	NATP-SWC (Western Ghats Project)	76,332	-	71,195	5,137
10.	NATP-IVLP	4,85,739	1,11,194	5,12,294	84,639
11.	NATP-O&M	9,540	1,50,000	1,50,000	9,540
12.	NATP-CGP	49,776	31,987	31,985	-49,773
	AP Cess fund Schemes				
13.	POME	-	8,11,760	1,85,196	6,26,564
14.	Acceleration of Germination in Oil Palm Hybrid seeds	-	5,42,880	34,945	5,07,935
15.	Network Projects	-	2,06,000	28,946	1,77,054
	State Govt. Funded Schemes				
16.	Seed Garden, Rajahmundry	38,790	3,51,800	1,73,857	2,16,733
17.	Seed Garden, Taraka	87,114	2,11,800	1,86,433	1,12,481
18.	OPDP , Karnataka	0	7,05,000	2,59,973	4,45,027

3.5. STAFF POSITION (as on 31-03-2005) :

The Centre is having the highest vacancies in the scientific cadre. The filling up of the scientific positions is essential to tackle the research priorities of oil palm, which is a newly introduced crop.

Grade	Sanctioned	Filled	Vacant
RMP	1	1	Nil
Scientific	22	12	10
Technical	18	18	Nil
Administration	13	13	Nil
Supporting	30	29	1
Total	84	73	11

4. Research Achievements

Genetic Resources

जननिक संसाधन

CHARACTERISATION & EVALUATION OF GERMPLASM

Characterization: The germplasm from African countries are being characterized for morphological, yield, bunch quality, physiological and biochemical characteristics. The variations for mesocarp content, fruit size, fruit testa colour, size of bunch and other characters have been recorded.

Characterization of Indian Dwarf Oil Palm II: The bunch component results obtained from the dwarf *dura* palm are furnished in table 1. Unlike other normal genotypes the dwarf genotype from Guinea Bissau was found to produce continuous female inflorescence and small bunches in all the cycles without male inflorescence with 60.8 fruit/bunch, 36.1 kernel/bunch and 6.1 oil/bunch percentages.

Evaluation of germplasm: In Andaman germplasm, average rate of leaf production in nursery plants before planting in field was 0.9 per month (SD±0.4). The height increment ranged from 2.8-11.0cm (average= 6.0cm; SD±1.6cm). The mean height of two Pune accessions were statistically similar with similar variation, also the rates of leaf production were at par.

Table 1. Bunch Components of Indian Dwarf oil palm II

Bunch Components (%)	
Fruit/bunch	60.8
Spike/ Bunch	9.8
Empty spikelets/bunch	27.2
Mesocarp/bunch	17.4
Nuts/bunch	36.1
Dry mesocarp/bunch	15.4
Shell/bunch	22.5
Kernel/bunch	9.1
Mesocarp/fruit	28.8
Oil/Wet mesocarp	7.5
Oil/Dry mesocarp	6.5
Fruit set	38.8
Oil/Fruit	10.0
Oil/ Bunch	6.1

Evaluation of *Elaeis oleifera*: The average number and weight of FFB produced by Malaysian *E. oleifera* (21) palms was 7.33 and 133.4 kg respectively, whereas Costa Rican palms recorded 4.0 number of FFB and 60.5 kg weight of FFB. In biochemical analysis *Eo-0*3 showed higher total unsaturated fatty acids (TUFA) (59.71%) Higher unsaturated fatty acids value of Palm No. 22 and 23 were established. These results confirmed the selection of ten superior *oleifera* palms No., *Eo*–23 (66.76), *Eo*–22 (66.53), *Eo*-05 (66.44%), *Eo*-11 (65.28%), *Eo*-02 (63.84%), *Eo*-04 (63.68%), *Eo*-19 (63.54%), *Eo*-20 (63.54%), *Eo*-18 (63.13%) and *Eo*-17 (62.17%), which can be immediately taken up for interspecific hybridization.

Performance of tenera introductions at Palode: The Germplasm assemblage at Palode were evaluated for their yield performance during the current year (Table 2). Of the two accessions planted in 1986, Dumpy dura x Pisifera recorded the maximum yield (83.2 kg with 6.3 number of FFB). Cameroon recorded the maximum number (7.5/ palm) and yield of FFB (98.4 kg) among the three accessions planted in 1988. Among the Costa Rica and Palode accessions, the cross 75Dx32P of Palode recorded maximum FFB yield (89.8 kg). Out of three accessions planted in 1991, inter-specific hybrid *EoxEg* recorded maximum yield of FFB (100.3 kg).

UTILISATION OF GERMPLASM

Evaluation of inter-specific hybrids: With a view to develop dwarf, compact and high yield oil palm, inter-specific hybrids between *Elaeis oleifera* and *Elaeis guineensis* were developed and are being evaluated at Pedavegi and Palode.

At Pedavegi: Stem girth and palm height were more in both inter-specific hybrids when compared to

Table 2. Performance of tenera introductions at Palode

S.No.	Accession	Year of Planting	FFB	
			No.	Wt. (kg)
1	Deli Dura x Pisifera (Indonesia)	1986	5.6	80.1
2	Dumpy Dura x Pisifera (Indonesia)		6.3	83.2
		Mean	6.0	81.6
3	Cameroon	1998	7.5	98.4
4	D x P (Palode)		4.9	70.0
5	Sampage		4.3	50.0
		Mean	5.6	72.8
6	45272-Costa Rica	1990	6.6	77.8
7	46264-Costa Rica		5.9	75.4
8	46695- Costa Rica		5.4	71.9
9	46787- Costa Rica		5.2	76.4
		Mean	5.8	75.4
10	120 x 102 (D x P (Palode)	1990	5.8	83.3
11	115 x266 (D x P (Palode)		6.5	73.8
12	75 x 32 (D x P (Palode)		6.6	89.8
13	65 x 266 (D x P (Palode)		8.5	112.3
		Mean	6.8	89.81
14	Kodungallore Dura	1991	7.2	77.4
15	Eo x Eg		10.3	100.3
16	Clone		6.0	71.3
		Mean	7.8	83.0

Total Palms: 275 Year of planting: 1986-91

tenera. Average yield of palms of I_2 was more than I_1. Frequency of production of hermaphrodite inflorescences is more in inter specific hybrids. Three high yielding palms have been identified which could be used in future back crossing programme.

At Palode: 361 *Eg* x11 *Eo* recorded maximum number of leaves (Table 3). Minimum number of male inflorescence was produced by DxP (Palode) and maximum number of female inflorescence was recorded by 12Eo x 82Eg. Maximum number of FFB (3.80) and yield (19.30 kg) was recorded in 16Eo x 81Eg. Two types of fruits were observed in single bunch of *EgxEo*. One type was round in shape and *dura* type and other was longer and seedless. Round and seedless fruits were noticed in some other crosses also (Fig 1&2).

Analysis of Fatty acids composition of the oils from selected progeny palms: Eleven interspecific hybrid progenies were analyzed for fatty acids composition. Average oleic acid content (resulting in average of TUFA content) was higher in the progenies of 261DX 11P crosses than that of 260 D X 13P which might be due to higher oleic acid and TUFA content of the parent (male) *oleifera* palm No. Eo-11 (Table 4).

SCREENING AFRICAN GERMPLASM FOR STRESS TOLERANCE

At Pedavegi: The African germplasm accessions of are being screened for high water use efficiency.

Replicated trial: Screening is being done under irrigated (IW/CPE=1.0) and stress (IW/CPE=0.5) environments.

Morphological parameters: Under stress conditions Guinea Bissau germplasm recorded maximum growth with a height of 133.5cm and girth 288.1cm (Table 5). Maximum number of

Fig. 1. Fruit types in a single bunch of an inter-specific hybrid

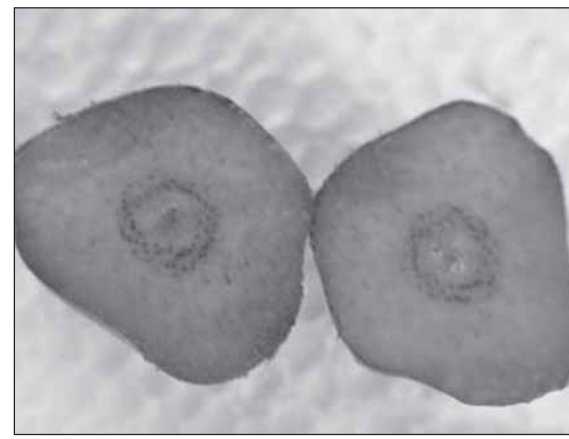


Fig. 2. Seedless fruit in an inter-specific hybrid

Table 3. Evaluation of inter-specific hybrids at Palode

S. No.	Accessions	No. of Leaves	No. of Inflorescence		FFB No.	Wt. (kg)
			Male	Female		
1.	360Eg x 13 Eo	24.0	8.1	1.2	1.8	13.3
2.	12 Eo x 82 Eg	24.0	9.3	3.0	2.3	13.8
3.	19 Eo x 81 Eg	24.0	11.0	1.2	1.0	3.7
4.	16 Eo x 18 Eg	26.6	7.2	0.6	1.7	6.7
5.	361 Eg x 11 Eo	27.7	8.5	2.7	3.8	16.8
6.	D x P Palode	21.7	7.0	1.5	2.1	7.1
7.	15 Eo x 18 Eg	23.8	11.2	1.8	2.2	11.3
8.	16 Eo x 81 Eg	24.7	11.3	0.5	3.8	19.3
9.	10 Eo Open	24.3	7.8	1.8	3.0	16.6

Table 4. Fatty acids composition of some interspecific hybrid palms (*E.g.* x *E. o*)

P. No	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	TSFA	TUFA
	Cross360D x 13P									
IS-12	0.98	39.9	0.14	3.98	44.8	9.3	0.66	0.25	45.1	54.9
IS-16	0.53	43.4	0.04	2.62	41.0	11.6	0.83	0.01	46.6	53.4
IS-19	1.74	44.9	0.06	3.25	36.9	12.7	0.32	0.15	50.0	50.0
IS-22	0.67	52.5	0.00	1.66	38.9	6.0	0.30	0.00	54.8	45.2
IS-25	0.61	42.3	0.00	2.94	44.6	9.0	0.57	0.00	45.8	54.2
IS-27	1.32	52.4	0.00	2.44	34.2	9.3	0.40	0.00	56.1	43.9
Mean	0.98	45.9	0.04	2.81	40.1	9.6	0.51	0.07	49.8	50.3
	Cross 361D x 11P									
IS-33	0.79	43.2	0.05	2.90	43.3	9.4	0.40	0.04	46.9	53.1
IS-37	1.23	44.2	0.01	2.21	41.8	10.3	0.31	0.00	47.6	52.4
IS-40	1.51	45.2	0.00	2.83	40.5	9.5	0.44	0.00	49.6	50.4
IS-42	1.30	40.2	0.03	1.98	44.9	110.0	0.61	0.00	43.5	56.5
IS-45	0.91	41.9	0.12	3.04	43.6	9.5	0.39	0.29	46.2	53.6
Mean	1.15	43.0	0.04	2.59	42.8	9.9	0.43	0.06	46.8	53.2

Table 5. Screening germplasm accessions for high water use efficiency at Pedavegi, A.P. (Replicated trial)

Germplasm Accessions	Height (cm)	Girth (cm)	Inflorescence		Rachis length (cm)	Leaf		Trunk DW (Kg)	Bunch	
			Male	Female		Area Sq m	DW (Kg)		No.	Wt. (Kg)
IRRIGATED ENVIRONMENT										
GB 22/311	111.4	282.0	3.6	2.7	315.8	2.8	1.7	110.9	11.6	38.4
GB 25/314	140.9	274.2	1.6	4.4	287.2	3.0	1.7	130.9	17.5	47.9
GB 21/310	116.4	275.5	3.6	2.8	303.1	3.3	1.5	110.0	14.5	51.4
ZS -1	82.3	280.3	2.9	2.0	361.4	4.0	2.2	86.5	13.6	98.7
ZS -2	80.3	248.9	4.9	0.6	397.2	4.3	2.5	66.8	15.5	132.0
ZS -3	82.5	276.3	5.0	0.5	367.9	4.7	2.8	83.9	11.2	89.7
ZS -5	86.5	281.7	3.7	2.7	342.9	4.7	2.6	90.7	13.8	105.9
ZS -8	82.3	263.8	3.4	1.2	369.6	4.4	2.9	76.5	11.9	99.3
TS -9	110.0	285.8	2.9	4.1	362.5	4.2	2.1	113.0	11.6	87.5
TS -11	94.9	279.6	2.3	2.8	383.0	4.7	2.6	96.2	7.7	72.4
SD (±)	20.2	10.9	1.1	1.3	36.0	0.7	0.5	19.5	2.7	29.5
STRESS ENVIRONMENT										
GB 22/ 311	105.4	288.1	4.4	0.6	325.2	3.1	1.5	112.4	10.1	29.7
GB25/314	133.5	268.3	1.2	3.2	317.0	3.3	1.8	112.3	11.4	24.8
GB21/310	87.7	252.9	2.8	1.9	259.3	2.5	1.5	83.6	7.3	22.0
ZS-1	76.5	254.2	4.4	1.3	336.7	3.5	2.2	65.8	10.3	73.4
ZS-2	77.4	247.9	4.1	2.4	372.0	3.9	2.5	63.3	11.5	90.6
ZS-3	84.7	267.4	3.4	1.3	362.7	3.9	2.6	77.1	7.5	51.3
ZS-5	76.0	265.8	3.0	1.7	358.3	3.9	2.9	74.3	10.9	80.4
ZS-8	76.3	255.4	4.1	2.1	365.3	5.4	3.1	72.5	11.5	92.8
TS -9	92.7	271.1	5.0	0.7	351.4	4.3	2.4	80.2	9.8	77.5
TS-11	85.1	266.9	2.4	2.7	349.3	3.8	2.6	83.5	8.3	56.5
SD (±)	18.2	8.4	1.2	0.8	34.9	0.8	0.5	14.3	1.7	26.4

female inflorescence (5.0) were recorded by Tanzanian collection TS–11. Highest trunk dry weight (112.4kg), the highest number of FFB (11.4) and TDW (trunk dry weight) were recorded in Guinea Bissau. More number of FFB (14.8) and total bunch weight were recorded in Zambian collection followed by Tanzanian with (112.5kg). Maximum leaf area (5.4 sq m) and leaf dry weight (3.1kg) were recorded by Zambian genotypes. Under irrigated conditions palm height was, in general, more (140.9cm) in Guinea Bissau accessions and least (80.3cm) in Zambian material. Maximum female inflorescence (4.4) was recorded by Guinea Bissau.

These accessions had a lot of variations for characters like long stalked male inflorescence, dwarfness, position of leaf lets, narrow petiole, having short rachis length, and virescence fruit forms etc.

Biochemical parameters: No significant difference observed in total as well as soluble sugar between the stressed and irrigated palms in any genotypes during the year 2004.

Physiological parameters: Guinea Bissau had lesser leaf area compared to that of Zambia and Tanzania germplasm (Table 6). Highest leaf area was observed in ZS 3 followed by ZS 8 and ZS 1, which did not differ significantly with each other. The lowest leaf area was recorded in GB-22/311 followed by GB 25/314, which did not differ significantly with each other, but differed significantly with rest of the germplasm. Total leaf dry weight varied from 65.58 to 156.60 Kgs. Lowest leaf dry weight was recorded in GB-25/314 followed by GB-22/311 and GB-21/310 but did not differ significantly among them. ZS-5 recorded highest leaf dry weight, which did not differ significantly with that of ZS-3 and ZS-1. Maximum leaf area (4.7 sq m) and leaf dry matter (2.90kg) was recorded in Zambian cross. The highest total bunch weight (132kg) was recorded in Zambian material.

The photosynthetic rate in the different germplasm varied from 4.90 to 8.74 $\mu mol.m^{-2}.s^{-1}$. Highest photosynthetic rate was observed in GB-25/314 followed by GB-22/310 and ZS-2, which did not differ significantly among them. Lowest photosynthetic rate was recorded in ZS-5. The photosynthetic rate of Guinea Bissau germplasm varied from 4.63 in GB-21/310 to 8.74 in GB-25/314. The Zambia accessions recorded rates between 4.90 in ZS-5 to 7.68 in ZS-2. Tanzanian germplasm recorded a photosynthetic rate of 4.94 $\mu mol.m^{-2}.s^{-1}$. The transpiration rate also followed the same trend as that of photosynthetic rate with high transpiration rate recorded in GB-22/311 followed by GB-25/314 and ZS-2. The lowest transpiration rate was observed in ZS-8, which did not differ significantly with that of other Zambia and Tanzanian germplasm. The stomatal conductance to the diffusion of CO_2 varied from 0.03 to 0.17 $mol.m^{-2}.s^{-1}$ in different germplasm. Guinea Bissau germplasm recorded higher conductance compared to that of Zambia and Tanzanian germplasm. GB-25/314 and ZS-2 recorded intermediate conductance. Lowest conductance was recorded in ZS-5 and ZS-8, which did not differ significantly with that of ZS-1, ZS-3, ZS-9 and TS-11.

Table 6. Stomatal characteristics and gas exchange parameters in African duras

Germplasm	Stomatal mean/ sq mm	Epidermal cells Mean/ sqmm	Mean Stomatal Index	No. of Stomatal Chloro-plast	Length of Guard cell (µm)	Frond LA Sq.m	Cs mol/ sq m/s	A µmol/ sq m/s	E mmol/ sq m/s
GB-22/311	234.78 ^{a}	290.76 ^{b}	44.67 ^{bcd}	9.56 ^{b}	33.35 ^{e}	1.26 ^{b}	0.11 ^{b}	8.47 ^{ab}	3.75 ^{a}
GB-25/314	208.70 ^{abc}	255.98 ^{c}	44.91 ^{bcd}	9.69 ^{b}	36.04 ^{abcd}	1.40 ^{b}	0.09 ^{bc}	8.74 ^{a}	3.50 ^{ab}
GB-21/310	192.93 ^{c}	228.26 ^{d}	45.81 ^{bc}	9.75 ^{b}	33.78 ^{de}	1.79 ^{a}	0.17 ^{a}	4.63 ^{ab}	2.34 ^{a}
ZS-I	186.96 ^{c}	210.33 ^{d}	47.06 ^{abc}	8.28 ^{c}	35.48 ^{bcde}	2.22 ^{a}	0.03 ^{cd}	5.53 ^{bcd}	1.54 ^{bc}
ZS-2	233.70 ^{a}	220.65 ^{d}	51.44 ^{a}	9.34 ^{bc}	34.93 ^{cde}	2.22 ^{a}	0.09 ^{bc}	7.68 ^{ab}	3.50 ^{ab}
ZS-3	234.78 ^{a}	249.46 ^{c}	48.48 ^{ab}	9.23 ^{bc}	32.84 ^{e}	2.40 ^{a}	0.04 ^{d}	5.77 ^{bcd}	2.41 ^{c}
ZS-5	188.59 ^{c}	315.76 ^{a}	37.39 ^{e}	9.96 ^{b}	36.99 ^{abc}	2.10 ^{a}	0.03 ^{d}	4.90 ^{d}	1.61 ^{c}
ZS-8	228.26 ^{ab}	291.30 ^{b}	43.93 ^{cd}	10.04 ^{b}	37.05 ^{abc}	2.53 ^{a}	0.03 ^{d}	4.93 ^{cd}	1.58 ^{c}
TS-9	203.80 ^{abc}	253.26 ^{c}	44.59 ^{bcd}	11.65 ^{a}	38.24 ^{a}	2.24 ^{a}	0.04 ^{d}	5.56 ^{bcd}	2.30 ^{c}
TS-11	196.20 ^{bc}	286.41 ^{b}	40.65 ^{de}	12.28 ^{a}	37.65 ^{ab}	2.45 ^{a}	0.04 ^{d}	4.94 ^{abc}	2.13 ^{c}
CD at 5%	33.37	20.95	4.19	1.10	2.66	0.70	0.04	1.93	0.96
CV %	9.52	13.39	8.68	11.69	5.28	21.26	70.72	25.64	33.99

* Values with same alphabets don't differ significantly with each other

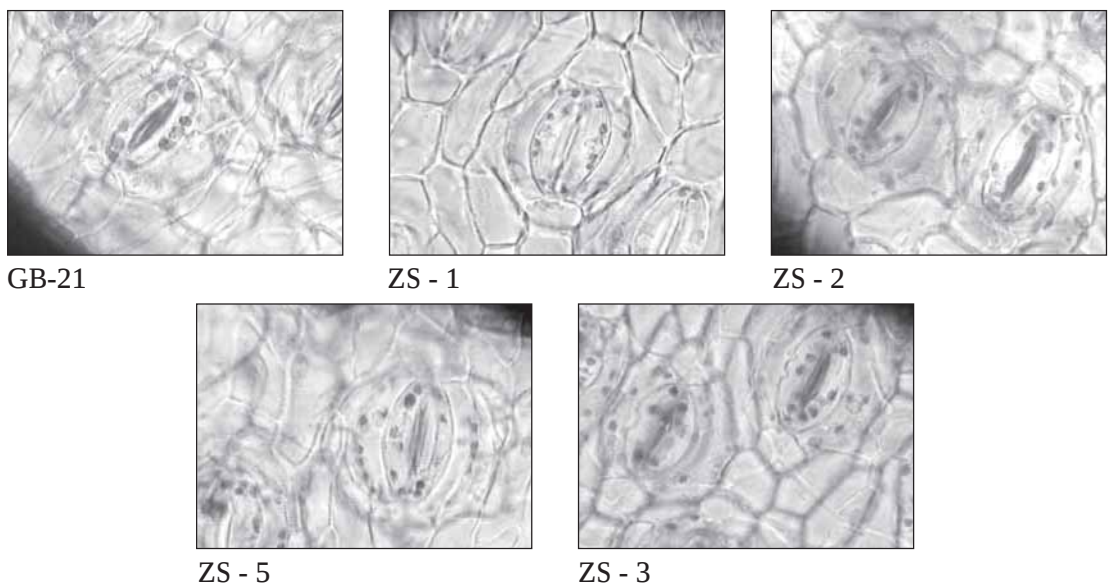
Leaf temperature ranged from 40.7 to 45.7°C in the different germplasm. The Guinea Bissau germplasm recorded significantly lower leaf temperatures compared to that of Zambian and Tanzanian germplasm. Higher leaf temperatures were recorded in ZS-3, ZS-5 and TS-11, which coincided with that of lower photosynthetic rates and lower stomatal conductances. The total chlorophyll contents in different germplasm ranged from 3.28 to 5.23 $mg.g^{-1}$fr.wt. Higher chlorophyll contents were recorded in ZS-1, which was not significant with that of ZS-2. The lowest chlorophyll content was recorded in ZS-8, which did not differ significantly with that of TS-11 and ZS-5. Carotenoids varied from 0.84 to 1.42 $mg.g^{-1}$fr.wt. in the different germplasm studied. Highest caroteniod content was recorded in ZS-1 followed by ZS-2 and GB-21/310, while the lowest content was in ZS-8. Germplasm, which recorded higher chlorophyll contents, also possessed high level of caroteniods and vice-versa.

B. Stomatal Characteristics: (Fig. 3) Significant differences in stomatal frequency were observed in different genotypes. Highest stomatal frequency was observed in GB –22/311 and ZS-3 followed by ZS-2, ZS-8, GB-25/314 and TS-9, which didn't significantly differ with each other but significantly differ from other genotypes. Lowest stomatal frequency was observed in ZS-1 followed by GB-21/310 and ZS-5, which did not significantly differ with each other. Stomatal frequency varied from 187.0 to 234.8 in all the germplasm.

Significant Variation in Epidermal cell frequency was also observed in different germplasm. High epidermal frequency was observed in ZS-5, which was significantly different from other genotypes. Lowest epidermal cell frequency was observed in ZS-1, followed by ZS-2, and GB-21/310, which did not significantly differ with each other. Epidermal cell frequency varied from 210.3 to 315.8 in all the germplasm. It showed high variability.

Significant difference of stomatal index is also noticed in different germplasm. Lower stomatal index was observed in ZS-5, it is significantly differ from other genotypes. Stomatal index is significantly high in ZS-2. Stomatal index shows high variability. Stomatal index varied from 37.35 to 51.12 in all germplasm. Like in many other stomatal characteristics, variations in stomatal plastid number were also observed. Stomatal plastid number shows less variability in different germplasm. Highest stomatal plastid number was observed in TS-11 (12.27) and TS-9 (11.65), which

Fig. 3. Microscopic view of the stomatal characteristics of different African dura germplasm



didn't significantly differ with each other but different significantly from others genotypes. Lowest stomatal Plastid number was observed in ZS-1 (8.275) and ZS-3 (9.225). These are significantly different from other genotypes. Plastid number varied from 12.27 to 8.28 in all germplasm.

Variations in guard cell length were also observed. The Largest stomatal guard cell length was observed in TS-9 ((38.24) which significantly differed from other genotypes. ZS-3 (32.84) and GB-22/311 (33.35) had lesser Stomatal guard cell length and are not significantly different with each other. Stomatal guard cell length showed high variability. Guard cell length varied from 32.8 to 38.24 in all germplasm.

There was no relationship between stomatal and epidermal cell frequency (Table 7), which was in contrast to that of earlier studies in many crops. In this study, there was a negative correlation between stomatal frequency and guard cell length. Stomatal frequency has a significant positive correlation with that of photosynthetic rate and transpiration. A highly significant correlation was observed between guard cell length and number of chloroplasts in the guard cells. As stomatal chloroplasts are associated with movement of guard cells, their number may be critical in performing the different physiological functions of stomata.

Observational Trial: Accessions (37) are being evaluated for water stress tolerance (IW/CPE=0.5). Mean height of Cameroon accessions was lowest while the Zambian accessions were moderate in height (Table 8). The average FFB weight of Zambian accessions was highest with high standard deviation suggesting variation in these accessions for this character. Similar trend was observed for number of female inflorescences and bunches.

Table 7. Relationship between stomatal characteristics and gas exchange parameters in African duras

	SC	EC	SI	SCN	GCL	LA	Cs	A	E
Stomatal mean (SC)	1.00	0.05	0.54	-0.20	-0.46	-0.06	0.08	0.52	0.56
Epidermal cells mean (EC)		1.00	-0.82	0.45	0.35	-0.04	-0.31	-0.11	-0.14
Mean Stomatal Index (SI)			1.00	-0.51	-0.56	0.01	0.30	0.39	0.44
Chloroplast number (SCN)				1.00	0.66	0.26	-0.18	-0.29	-0.11
Guard cell length GCL)					1.00	0.40	-0.56	-0.33	-0.44
Frond leaf area (LA)						1.00	-0.67	-0.70	-0.69
Stomatal conductance (Cs)							1.00	0.32	0.58
Photosynthetic rate (A)								1.00	0.90

Table 8. Evaluation of African accessions for water stress tolerance at Pedavegi (Observational)

Source	Para-meters	Height (cm)	Girth (cm)	Inflorescence		Leaf Area (Sqm)	Total bunch		
				Male	Female		DW (Kg)	No.	Weight (Kg)
Cameroon	M	101.2	243.3	6.2	10	3.1	3.0	4.1	9.07
(15)	SD (±)	11.53	121.2	1.2	2.3	0.4	1.1	1.0	3.2
G. Bissau	M	198	249	6.3	10	3.2	2.1	6.0	14.0
(12)	SD (±)	92.51	49	5.5	3.1	0.2	1.7	2.1	5.9
Inter-specific	M	295.1	133	19.2	9.3	5.7	3.9	3.9	26.7
Hybrids(2)	SD (±)	22.12	0.24	0.62	6.1	0.68	0.7	0.17	9.2
Tanzania	M	193.9	231	12.1	10	5.6	3.1	4.90	17.2
(5)	SD (±)	93.95	95	3.1	4.1	2.0	0.86	1.91	5.7
Zambia	M	160.2	201	10.	9.6	5.0	2.29	10.7	36.8
(5)	SD (±)	96.5	93	3.0	3.0	2.0	0.4	6.14	23.0

Bunch Analysis : Bunch analysis was done to study different components directly or indirectly related with oil yield per unit area and partitioning of dry matter of bunch into different fractions like fruit, spike, and further into fruit components like mesocarp, shell and kernel. In the present experiment, variation with regard to bunch size (bunch weight), number of fruits, fruit setting, proportion of mesocarp content, size of fruit and kernel, shell thickness characters etc were recorded. Variation for fruit testa colour like green (virescence)/ black or dark violet (nigrescence), very big/big/small sized fruits etc were also observed.

Seed descriptor analysis in African genotypes: In seed descriptor study (Table 9) it was found that among all genotypes, the seeds from Zambia had maximum seed length (3.3cm), width (5.57cm), shell weight(2.61g)and kernel weight(1.02g).The thickness of the shell was found maximum from Tanzania genotype. Minimum seed length (2.9cm), seed width (4.66cm) and kernel weight (0.77g) were recorded in Cameroon genotype. Minimum thickness of the shell (0.57cm) and shell weight (1.72g) were found with GB .

At Nellore (A.P.): The plantation is maintained under stress environment (IW/CPE= 0.5). Significant variation was observed among the genotypes for all the characters studied (Table 10). Maximum height (86cm) was recorded by Guinea Bissau collection. Maximum girth (238.3cm),

Table 9. Seed descriptor analysis for different African dura genotypes

Dura genotypes	Seed length (cm)	Seed width (cm)	Thickness of the shell (mm)	Shell weight per seed	Single Kernel weight (g)
Guinea Bissau	3.05	5.11	0.57	1.72	0.90
Zambia	3.31	5.57	0.61	2.61	1.02
Tanzania	3.19	5.39	1.26	2.15	0.97
Cameroon	2.91	4.66	0.65	1.76	0.77

Table 10. Evaluation of germplasm at Simhapuri Agro-products Pvt. Ltd., Nellore, A.P.

Germplasm Accession	Source	Palm height (cm)	Palm Girth (cm)	Inflorescence		Leaf			
				Male	Female	No.	Rachis length (cm)	Area (sqm)	Weight (Kg)
GB 27/316	Tanzania	84.8	217.4	10.5	2.9	18.0	248.8	1.87	0.98
GB 8/314	Zambia	81.3	180.3	10.4	1.4	18.6	263.8	1.85	1.17
GB 5/320	G. Bissau	72.9	167.6	11.8	2.6	19.5	275.4	2.15	1.13
GB 3/290	G. Bissau	77.9	224.0	13.4	1.3	20.6	293.7	2.42	1.27
GB 30/319	G. Bissau	86.0	224.4	10.5	4.4	19.1	306.8	2.04	1.15
GB 24/313	G. Bissau	59.9	189.7	9.5	0.6	18.6	280.1	1.81	1.13
ZS 2	G. Bissau	64.9	158.7	8.7	4.9	19.1	368.9	3.79	2.65
ZS 7	G. Bissau	76.6	211.5	10.8	6.1	21.0	360.1	3.90	2.46
ZS 3	Zambia	52.8	211.3	10.3	0.7	19.8	345.1	3.05	2.05
ZS 9	Zambia	75.7	238.3	9.3	5.1	20.7	318.8	3.06	2.02
TS 10	Tanzania	65.6	214.5	11.3	1.8	19.9	320.0	3.01	2.31
TS 7	Tanzania	79.2	182.6	9.4	4.8	20.5	346.3	3.63	2.29
TS 12	Zambia	64.6	208.7	10.7	0.6	20.4	314.7	2.91	1.85
TS 9	Tanzania	71.1	218.3	9.4	2.4	19.3	320.4	2.88	2.11
	SD (±)	9.7	23.6	1.2	1.9	0.9	36.2	0.7	0.6

number of female inflorescence (6.1), leaf area (3.9 sq m) and leaf dry weight were recorded by Zambian collection.

At Adilabad (A.P.): Tanzanian accession gained maximum height (61.6m) and also recorded maximum leaf production (25.0), maximum leaf area (1.9 sqm), leaf dry weight (1.5kg) when compared with other accessions (Table 11). Maximum inflorescence production was recorded by Guinea Bissau accessions.

At NRCOP-RS, Palode (Kerala): The palms are grown as rainfed. Guinea Bissau recorded highest number of FFB production (Table 12) when compared with other accessions. Tanzanian accessions had recorded highest FFB weight of 62 kg in whole year. Cameroon though recorded more number of FFB (11.2), the total bunch weight was very less (38.6kg).

At PCKL, Athirappaly (Kerala): The palms are grown as rain fed. No significant variation among the genotypes for leaf production was observed (Table 13). Maximum numbers of male and female inflorescences (15.0) were produced by Zambian accessions and minimum by Guinea Bissau, which also recorded the maximum sex ratio (1.0).

Table 12. Evaluation of stress tolerant Germplasm at Palode (Kerala)

S. No.	Source	FFB	
		No	Wt (kg)
1	Guinea Bissau	14.5	52.83
2	Cameroon	11.3	38.60
3	Tanzania	11.2	62.81
4	Zambia	10.2	45.20

Table 13. Evaluation of stress tolerant Germplasm at PCKL, Athirappaly (Kerala)

S. No	Source	No. of leaves	Number of Inflorescence	
			Male	Female
1	Guinea Bissau	26.70	6.67	6.79
2	Cameroon	24.61	9.99	5.82
3	Tanzania	23.56	8.79	5.60
4	Zambia	25.78	8.61	7.29

Table 11. Evaluation of germplasm at ITDA Farm, Jambuga, Adilabad, A.P.

Germplasm Accession	No. of leaves	Leaf area sqm	Leaf dry Weight (Kg)	Rachis length(cm)	Inflorescence	
					Male	Female
GB-2/298	31.2	1.2	0.6	184.4	6.12	1.9
GB-10/306	32.7	1.4	0.8	203.1	7.2	1.8
GB-21/310	30.8	1.1	0.7	186.6	8.0	1.4
GB-5/310	30.9	1.4	0.8	204.4	1.2	1.1
ZS-3	31.7	1.9	1.2	245.3	4.8	1.0
ZS-5	29.1	1.5	1.1	210.8	4.0	0.9
ZS-6	29.8	1.1	0.9	195.6	6.4	0.0
TS-5	30.5	1.9	1.5	253.0	4.8	0.0
TS-8	33.1	1.5	1.4	218.9	2.4	0.0
SD (±)	1.28	0.30	0.32	24.10	2.22	0.75

4. Research Achievements

Breeding and Seed Production

प्रजनन और बीज उत्पादन

EVALUATION OF DWARF TENERA PROGENY

The progeny of selfed tenera dwarf palm were evaluated in nursery for initial growth characters. Gibberellic acid sensitivity test was done to ensure the genetic nature of dwarfness. Height increment ranged from 15.2-70.2cm. Differential rates of height increment were recorded among the seedlings. Six seedlings having height increment <25cm/annum have been tagged for further investigation. The association between height increment and inter-leaflet distance (Fig. 4.1)was positive and significant. Similar trend was also found between inter leaflet distance and rachis length (Fig. 4.2). Thus, inter-leaflet distance, which can easily be recorded in seedlings, could be used as selection index for selecting slow growing and dwarf palms from a mixed population.

RESEARCH-CUM-DEMONSTRATION OF OIL PALM GENO-TYPES UNDER VARIED ENVIRONMENTS

At Pedavegi: The variation among hybrids were significant for palm height and number of leaves (Table 14). Palm height was maximum in C11022 (3.11m) and minimum in C11142 (1.92m) while maximum girth was recorded in C11166 (2.88m).The production of maximum number of leaves was recorded in cross number C11248 (27.36). The highest FFB yield was recorded in C11086 (132.6 kg/palm/year). Eighteen *Dura* palms (Fruit typed) in Costa Rican accession have been identified.

At NRCOP- RS, Palode (Kerala): No significant differences were observed among the crosses for trunk height, girth, number of leaves, inflorescence production and FFB yield (Table 15). Number of bunches varied between 5.1 (C11146) and 16.0 (C11225). The FFB yield varied between 41.5 kg/palm (C11075) and 100.34 kg/palm (C11189).

At Bheemanakoli, Karnataka (Final Report): The experiment consisted of 23 cross combinations of ASD Costa Rica origin and five indigenous Palode ones and was laid out in RCBD with four replications during 1995. The results of data pooled over four years (2000-01 to 2003-04) are presented in Table 16. Maximum height was recorded in cross C11023 (6.78m); it was least in 65D X 251P (3.23m). The highest stem girth was recorded by cross C11083 (2.49m), the lowest girth was recorded by Palode cross 65D x 251P (1.25m). Genetic differences were not significant for number of leaves.

Significant differences among the crosses were observed for number of male and female inflorescences produced in a year and also on

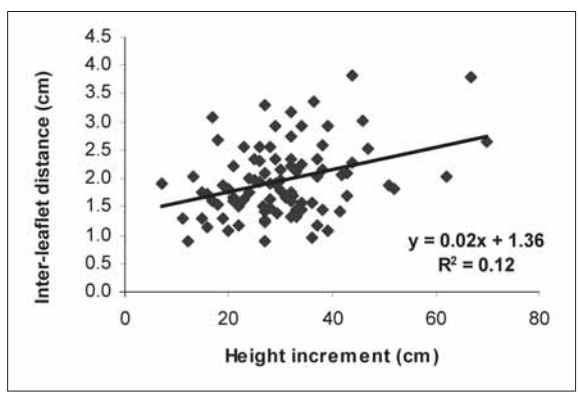


Fig. 4.1. Relationship between inter-leaflet distance and incremental height in dwarf tenera progeny

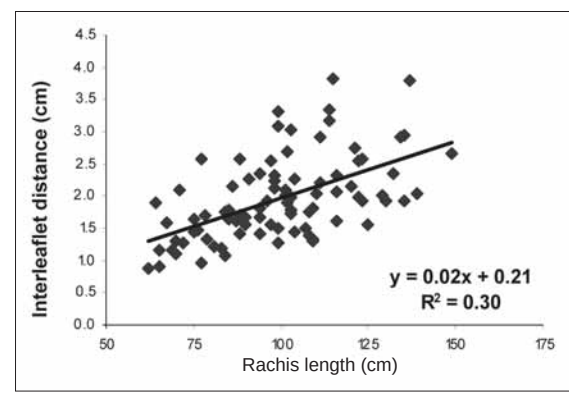


Fig. 4.2. Relationship between inter-leaflet distance and rachis length in dwarf tenera progeny

Table14. Performance in different oil palm hybrids from ASD Costa Rica at Pedavegi (A.P)

S. No.	Cross ID	Palm Height(m)	Stem Girth(m)	Number of				Bunch Weight (kg)
				Leaves	Male	Female	Bunches	
1	91C002	2.80	2.61	24.6	14.8	6.06	6.9	89.9
2	C11022	3.11	2.62	23.0	13.9	6.33	5.6	87.6
3	C11085	2.96	2.74	21.8	13.0	7.07	6.0	91.4
4	C11086	2.58	2.59	26.3	12.6	7.83	9.5	132.6
5	C11097	2.45	2.76	23.8	12.7	7.17	7.8	102.3
6	C11123	2.22	2.56	25.9	13.2	6.70	8.5	128.6
7	C11142	1.92	2.80	24.5	13.8	6.54	4.3	66.6
8	C11143	3.02	2.73	21.9	12.6	5.45	7.2	87.1
9	C11152	2.73	2.62	23.4	11.7	7.22	6.5	94.1
10	C11162	2.27	2.65	26.1	14.1	5.81	6.6	107.0
11	C11163	2.56	2.70	22.4	12.6	6.77	6.2	87.6
12	C11166	2.56	2.88	23.5	13.9	7.80	8.3	109.4
13	C11168	2.18	2.50	25.5	15.0	6.20	7.8	121.2
14	C11198	2.77	2.86	25.4	13.2	6.72	7.6	118.2
15	C11214	2.51	2.69	25.9	12.6	6.03	8.6	134.0
16	C11220	2.57	2.69	25.8	14.9	5.77	7.0	103.8
17	C11238	2.60	2.73	25.4	13.6	6.28	6.6	92.7
18	C11248	2.60	2.72	27.4	14.0	7.53	8.6	126.1
19	C11259	2.60	2.68	26.9	12.9	7.33	8.7	131.1
20	C65635	2.65	2.60	24.1	13.4	5.67	6.6	96.7
21	C65571	2.50	2.69	26.6	13.3	6.00	6.8	101.2
22	C66536	2.69	2.80	23.9	11.9	5.19	5.9	89.7
23	C11136	3.09	2.55	26.6	13.1	7.03	7.8	117.2
24	Palode	3.08	2.59	23.1	12.7	6.50	5.8	84.5
CD at 0.5 (±)		0.55	NS	3.47	NS	NS	NS	NS

cumulative basis. The highest number of female inflorescences were produced by the cross C11199 (25.1) followed by the cross C11214 (22.3) which had interestingly highest sex ratio too.

Significant differences were recorded for cumulative yield. The variation for cumulative FFB yield varied from 52.9-126.3 kg/palm. The highest cumulative FFB yield was recorded by the C11097 (126.3kg).

Association studies: It was interesting to note that the initial FFB yield though had significant correlation with cumulative yield; the magnitude of correlation coefficient was moderate which increased with the year, thus, indicating use of early yield as the selection criterion for selecting high yielding genotypes. Similar trend was also observed for number of bunch character. Very high significant and positive correlation was observed between cumulative number of bunches and total bunch weight. The intra class correlations for average bunch weight character among three years (from 2003-04 to 2001-02) were non significant.

The intra class correlations for number of male and female inflorescences for all the four years were non significant, thus, implying that early generation selection for female number of inflorescences will not be effective. There was significant positive association between number of female inflorescences and number of bunches on cumulative basis (r=0.58**).

Table 15. Performance in different oil palm hybrids from ASD Costa Rica at Palode (Kerala)

S. No.	Cross ID	Palm Height(m)	Stem Girth(m)	Number of				Bunch Weight (kg)
				Leaves	Male	Female	Bunches	
1	C65711	1.5	2.6	24.1	7.8	4.7	7.4	55.8
2	C11067	2.1	2.8	23.7	9.2	5.2	11.5	62.6
3	C11239	1.2	2.4	25.2	10.2	4.0	8.3	61.1
4	C11225	1.7	2.7	25.0	10.2	7.8	16.0	97.4
5	C11143	2.8	2.6	24.2	5.0	9.2	12.1	74.1
6	C11146	2.4	2.8	25.6	7.4	8.2	5.1	62.0
7	C65635	2.2	2.7	23.9	6.4	8.1	7.2	66.0
8	C11044	2.3	2.7	22.8	8.7	7.3	8.9	71.9
9	C11076	1.7	2.4	24.7	9.4	7.8	7.3	52.5
10	C11053	1.5	2.6	24.6	10.3	6.2	5.5	44.1
11	C65893	1.4	2.5	26.0	4.9	5.7	8.9	62.4
12	C11142	1.8	2.8	25.4	9.5	3.4	6.5	52.4
13	C65758	1.6	2.7	24.6	4.7	5.0	9.6	84.0
14	C11169	1.8	2.8	25.4	8.6	6.1	11.5	95.1
15	C11163	1.4	2.4	25.2	10.2	3.9	9.8	87.6
16	C11189	1.9	2.9	25.7	6.5	7.0	10.0	100.4
17	C11092	2.4	2.7	24.2	8.1	4.5	8.0	63.9
18	C11075	2.3	2.3	24.6	7.8	5.4	8.3	41.5
19	Palode	1.4	2.7	24.9	10.4	4.4	7.3	63.8
CD at 0.05 (±)		NS	NS	NS	NS	NS	NS	NS

PERFORMANCE OF SOURCES OF OIL PALM PLANTING MATERIALS

The experiment was planted during January 1996 with 11 hybrids from four different sources, namely ASD Costa Rica, Palode (India), Ivory Coast, and Papua New Guinea. Differences for palm height, number of male and female inflorescences, leaves and bunches were non-significant (Table 17). Maximum girth was recorded in Deli x AVROS (3.43m) and minimum was recorded in 9C x1001 from Papua New guinea (2.3m). The maximum FFB weight was recorded in DelixLame (123.4kg/palm/year) and minimum in 9Cx1001 (77.3) Among the four sources, ASD Costa Rica produced the maximum yield (100.5 kg/palm/annum) followed by Palode (93.1 kg); minimum yield was recorded in Ivory Coast (82.4kg) crosses.

Physiological Studies : The maximum leaf area was observed in ASD Deli Ekona and less in P128 X31323 (Table 18). P12 X 366 and ASD Deli X Lame recorded the maximum and minimum leaf dry weight. Palode hybrid12 X 266 hybrids recorded the highest vegetative dry matter followed by ASD Deli X Ghana. The lowest vegetative dry matter was observed in Ivory Coast hybrids. The bunch dry matter was more in Ivory Coast hybrids followed by P128 X 31323 hybrid. The bunch index was more in Ivory Coast hybrid followed by P128 X 31323. PNG and ASD hybrids recorded the lower bunch indices. Palode hybrid P12 x 313 and Ivory Coast hybrids recorded the maximum Photosynthetic rates, transpiration rates, and stomatal conductance followed by ASD Deli Avros and P65 D X 111. Minimum Photosynthetic rate was observed in ASD Deli X Ghana.

Seed descriptor : Seeds of tenera varieties namely Palode, ASD Costa Rica, Ivory coast and PNG were subjected to seed descriptor analysis. The tested varieties had significant variation in length of the seed, thickness of the shell, shell weight and kernel weight. The variety 18 C x 2501 from Ivory Coast had highest seed length (3.4cm) followed by PNG (1m-0069D x P) and lowest (2.36cm) seed length was also recorded in 9 c x 1001 from Ivory

Table 16. Morphological characters during 2003-04 and yield characters (During 2000-01 to 2003-04) recorded in Costarican hybrids at Bheemanakoli (Karnataka)

S. No.	Cross No.	No. of leaves	Palm height (m)	Stem girth (m)	Sex Ratio	Cumulative		ABW (Kg)
						BN	FFBW	
1	91C002	15.9	5.26	2.26	1.73	5.8	86.9	20.8
2	91C007	16.1	5.79	2.12	0.53	5.1	62.9	20.1
3	91C015	16.9	5.99	2.23	1.34	5.9	94.5	19.4
4	C11023	17.6	6.78	2.40	1.18	6.2	90.0	20.3
5	C11053	15.2	4.90	1.99	1.91	4.8	79.2	22.7
6	C11067	16.1	5.28	2.07	1.47	4.5	60.2	18.3
7	C11076	17.3	6.45	2.45	2.36	7.9	98.9	22.0
8	C11083	17.4	6.24	2.49	1.53	6.8	96.6	22.7
9	C11097	17.5	6.59	2.37	2.33	9.9	126.3	20.4
10	C11134	17.6	6.42	2.25	1.30	6.5	89.6	20.7
11	C11152	17.2	6.65	2.36	2.55	7.6	102.0	21.2
12	C11162	16.6	6.04	2.44	1.30	5.0	81.2	20.8
13	C11163	16.2	5.48	2.27	1.36	6.1	89.8	20.9
14	C11169	17.3	6.56	2.47	1.99	6.1	86.0	21.1
15	C11199	17.9	6.53	2.46	2.82	5.1	83.9	18.8
16	C11214	16.9	6.40	2.21	3.54	5.3	66.6	18.4
17	C11219	16.1	5.70	2.09	1.36	3.5	53.7	19.7
18	C11220	16.8	5.92	2.38	1.71	4.4	61.7	18.5
19	C11259	16.8	6.13	2.25	2.22	5.5	72.8	21.8
20	C65758	17.8	5.94	2.30	1.63	4.0	52.9	18.7
21	C66536	17.1	6.14	2.34	1.31	6.3	84.5	19.6
22	C11136	17.3	6.73	2.41	1.37	5.8	75.0	19.2
23	65D X 251P	12.9	3.23	1.25	2.31	2.5	26.0	12.0
24	35D X 111P	15.9	6.03	2.28	1.18	3.3	45.4	20.5
25	12D X 313P	14.3	5.67	2.20	0.80	3.7	60.4	22.0
26	120D X 283P	15.5	6.19	2.25	0.84	3.2	49.4	18.4
	CD at 0.05 (±)	1.10	0.28	0.24	0.68	0.62	8.28	0.80

Coast. Width of the seed and thickness of the shell was maximum in ASD varieties viz; Deli x Lame (5.14cm), Deli x AVROS (0.97cm) and minimum was found in PNG (1m-0069D x P).In case of shell weight and kernel weight, highly significant variation was found in different tenera combinations. Palode cross combination 12 X 266 had maximum shell weight (2.15g) and kernel weight (1.5g) followed by ASD variety Deli x Lame (1.77 g & 1.18g) . Minimum shell weight and kernel weight were recorded in ASD genotype Deli X EKONA (0.92 g & 0.73g). Non-significant results were obtained for width of the seed in all the tenera varieties.

EVALUATION OF DXP PROGENIES OF PALODE ORIGIN AT LAKSHMIPURAM

In trial I average bunch weight was found significant. In trial II, palm height and number of leaves were found significant. The cross 35D x 313P was found tallest while cross 128D x 32P was found comparatively dwarf in height. In trial III stem diameter was recorded significant.

Table 17. Performance of different sources of Oil Palm planting material at Pedavegi, A.P.

S. No.	Cross ID	Palm Height (m)	Stem Girth (m)	Number of				Bunch Weight (kg)
				Leaves	Male	Female	Bunches	
ASD COSTA RICA								
1	Deli x Avros	3.43	2.74	26.04	14.33	8.19	4.78	83.70
2	Deli x Ekona	3.35	2.80	25.30	13.63	8.52	5.96	89.59
3	Deli x Ghana	3.15	3.11	24.93	12.61	9.53	6.73	105.16
4	Deli x Lame	2.86	3.11	25.19	14.30	7.96	7.78	123.37
	Mean	3.20	2.94	25.36	13.72	8.55	6.31	100.46
PALODE								
5	65D x 111	2.98	2.79	25.26	13.44	8.78	6.93	97.32
6	12D x 313	2.96	2.62	25.93	13.85	7.37	5.00	78.63
7	12D x 266	3.18	2.77	25.19	11.52	9.74	6.70	101.07
8	128D x 31325	2.82	2.80	25.15	12.04	9.41	6.00	95.33
	Mean	2.99	2.75	25.38	12.71	8.82	6.16	93.09
IVORY COAST								
9	18C x 2501	2.37	3.35	25.44	12.41	8.26	5.41	87.41
10	9C x 1001	2.30	3.11	25.52	12.41	7.96	5.07	77.30
	Mean	2.34	3.23	25.48	12.41	8.11	5.24	82.35
PAPUA NEW GUINEA								
11	1M - 0069	3.41	2.64	26.19	12.89	8.56	7.41	99.39
	CD at 0.5 (±)	NS	0.30	NS	NS	NS	NS	25.60

Table 18. Dry matter production in the different sources of Oil Palm planting material

Source	Leaf area/ palm	Total leaf dry Sq m	Trunk dry wt. wt. kg	VDM kg	BDM kg/ Palm	TDM kg	Bunch Index	T mmol/ sqm/s	L T Temp ^{0}C	S C mol/ sqm/s	P R µmol/ sqm/s
P12x313	92.66	74.97	109.3	184.3	45.72	230.00	0.20	1.00	46.11	0.01	3.32
P12x266	96.23	109.26	112.0	221.3	35.87	257.13	0.14	0.77	46.40	0.01	1.81
P 128 x31323	76.78	62.35	101.6	164.0	68.71	232.69	0.29	1.05	49.78	0.01	1.63
P - 65 Dx111	85.25	68.42	92.00	160.4	31.39	191.81	0.15	1.68	48.92	0.02	2.18
ASD Deli x Lame	84.13	52.93	105.5	158.5	34.09	192.56	0.20	0.56	47.10	0.01	1.47
ASD Deli x EKONA	110.35	67.70	122.5	190.2	35.87	226.07	0.16	1.15	46.47	0.02	1.69
ASD - Deli x AVROS	92.94	66.13	132.1	198.2	37.10	235.30	0.16	2.41	49.91	0.03	2.43
ASD Deli x Ghana	96.52	68.03	139.4	207.5	32.44	239.89	0.13	0.61	45.39	0.01	1.25
I.C - 18 C x 2501	96.66	71.30	116.2	187.5	40.75	228.26	0.17	1.75	47.17	0.02	1.45
IC 9 C x 1001	90.93	64.97	91.80	156.8	70.42	227.19	0.31	2.12	47.92	0.03	3.07
PNG - 1 M-0069	93.03	66.79	102.3	169.1	26.20	195.28	0.13	0.84	49.73	0.01	1.47

OIL PALM HYBRID SEED PRODUCTION

Production, demand and supply of oil palm sprouts at national level: During 2004-05, about 10 lakh sprouts were supplied from different seed gardens to different indenting agencies.

NRCOP RS, PALODE (KERALA)

Hybrid seed production : During 2004 a total of 2,69,500 oil palm hybrid sprouts were supplied to various states in the country (Table 19).

Identification and evaluation of *Pisifera* at Palode: A total of seven *tenera x tenera* progenies were evaluated for yield performance and segregation pattern. The progeny 663T x 699T recorded maximum yield of 104.6 kg of FFB (Table 20).

Evaluation of Dura Progeny Trials I, II & III: Three sets of Dura self/ inter-crossed progenies are under evaluation at Palode since 1989.

The first batch of the seven *dura* self progenies (Table-21.1) was planted in 1989. Maximum yield was recorded by 271D self (101.4 kg) whereas maximum number of FFB was recorded by 266D self (11.6).

The second batch of 10 dura progenies was planted in 1993. The maximum bunch weight of 109.5 kg was recorded by 65D x 266D with maximum FFB number of 11.3 (Table 21.2).

The third set was planted in 1994 with 15 *Dura* progenies (Table 21.3). Maximum number of FFB (10.0) was recorded by 109D self and maximum yield of FFB was recorded by the 12D self (56.8 kg).

Table 19. Supply of Oil Palm sprouts

S. No.	States	No. of sprouts
1.	Andhra Pradesh	1,02,000
2.	Karnataka	30,000
3.	Tamil Nadu	64,500
4.	Gujarat	35,000
5.	Goa	20,000
	TOTAL	2,51,500

Table 20. Yield data of TxT/T self progenies

S. No.	Pedigree of progeny	FFB Yield	
		No.	Weight (Kg)
1	614T x 614 T	5.7	58.6
2	137T x 137T	6.5	52.4
3	323Tx 323T	5.5	54.8
4	648T x 65T	4.4	41.7
5	65T x 323T	4.9	52.7
6	763T x 323T	7.4	71.9
7	663T x 699T	7.5	104.6
	Mean	5.98	62.38

Table 21.1. Evaluation of *Dura* Progeny Trial–I

S. No.	Pedigree of progeny	FFB	
		No.	Weight (Kg)
1	156D self	8.13	81.07
2	65D self	8.85	85.17
3	120D self	8.79	77.61
4	139D self	6.88	70.55
5	125D self	9.21	82.83
6	271D self	11.53	101.42
7	266D self	11.61	98.31
	Mean	9.30	85.30

Total population: 252; Year of Planting: 1989

Table 21.2. Evaluation of *Dura* Progeny Trial–II

S. No.	Pedigree of progeny	FFB	
		No.	Weight (Kg)
1.	2D x 266D	6.8	66.9
2.	74D x 266D	5.9	41.7
3.	120D x 266D	10.9	93.1
4.	34D X 266D	8.1	66.5
5.	110D X 266D	7.7	82.3
6.	65D X 266D	11.3	109.5
7.	118D X 266D	9.1	79.7
8.	266D X 266D	9.2	75.4
9.	271D X 266D	9.3	100.3
10.	282 D X 266D	6.2	57.2
	Mean	8.5	77.3

Total population: 120; Year of Planting: 1993

Table 21.3. Evaluation of *Dura* Progeny Trial- III

S. No.	Pedigree of progeny	FFB	
		No.	Weight (Kg)
1	35D X7D	3.6	25.4
2	109DSelf	10.0	50.6
3	159DSelf	3.7	28.9
4	55DX110D	2.7	18.4
5	99D Self	4.5	25.9
6	115DX266D	3.4	18.8
7	12D Self	2.5	56.8
8	157D Self	6.0	33.4
9	11DX148D	8.2	51.2
10	7D Self	5.1	30.0
11	153D X99D	4.0	29.6
12	128D X99D	3.4	14.8
13	128D Self	6.6	44.4
14	2D X266D	3.6	21.2
15	148D Self	8.5	42.90
	Mean	5.1	32.8

Total Population: 180, Year of Planting: 1994

ICAR RF Scheme on Indigenous production of Oil Palm hybrid seeds: Oil palm hybrid seeds (*Tenera*) were produced commercially by crossing selected *dura* mother palm and 9 *pisifera* palms available at NRCOP, Regional Station, Palode. The details of the expenditure and income generated (01.01.2004 to 31.12.2004) are given as under

Expenditure Incurred	:	Rs. 2,30,222
Income generated	:	Rs.26, 95,000
Net Profit	:	Rs. 24,64,778

OIL PALM SEED GARDEN, RAJAHMUNDRY (A.P.)

Evaluation of Progeny Testing material received from Rajahmundry Seed Garden: Progenies of different tenera hybrids are being evaluated in nursery for leaf production, height and girth characteristics at regular intervals. Variation for height and girth was recorded significant. Effect of D/P on seedling growth shall be studied.

Pollen production and maturity: At OPSG, Rajahmundry *Pisifera* palm no. 2094 (107.5g) was found to produce more quantity of processed pollens followed by palm no. 2326(58g) and least (22g) production was recorded in *Pisifera* No 2277. With respect to pollen maturity, palm no 2094 took more (28 days) *dura*tion and 2299 showed early maturity. On average *pisifera* palms produced 48.5 g pollen and took 16 days for maturity from bagging to full maturity (Fig. 5).

Commercial Seed production: Hybrid seed production at present is mainly carried out using 153 *dura* palms. Against a target of 3.0 lakh sprouts, a total of 2.65 lakh sprouts were supplied during 2004-05.

Seasonal influence on duration of anthesis and bunch ripening in *Dura* palms: It was observed that duration of anthesis, bunch ripening, bunch weight and number of seeds/bunch varied with *dura* palms and season (Table 22). Inflorescence emergence during dry and wet season took 18.3 and 18.2 days for anthesis, 163 and 161 days for fruit maturity. Bunch weight and number of seeds per bunch were more during wet season than dry season.

NAVABHARAT SEED GARDEN, LAKSHMIPURAM (A.P)

Seasonal influence on duration of anthesis and bunch ripening in *Dura* palms: Mother palms in this seed garden exhibited significant differences for days to anthesis, fruit maturity and No. of seeds/ bunch during dry and wet seasons. Inflorescences took 18.6 and 12.7 days for anthesis, 164.6 and 172.5 days for fruit maturity, respectively during dry and wet seasons (Table 23).

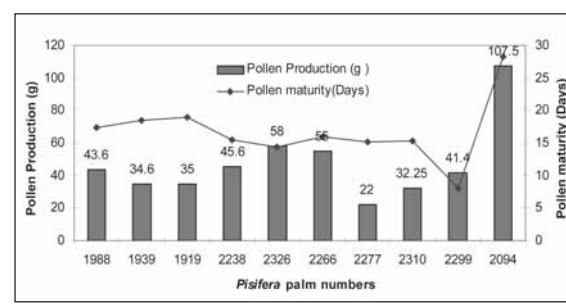


Fig. 5. Pollen production and maturity from selected pisifera palms utilised for hybrid seed production at Seed Garden, Rajahmundry

Table 22. Seasonal influence on days to anthesis, bunch ripening, bunch weight and number of seeds/ bunch in selected *dura* palms at OPSG Rajahmundry.

Palm	Days to Anthesis			Days to fruit maturity			Bunch weight (Kg)			No. of seeds/ Bunch		
No/ Season	Dry	Rainy	Mean	Dry	Rainy	Mean	Dry	Rainy	Mean	Dry	Rainy	Mean
32	23.3	34.0	28.7	167.3	182.0	20.7	19.7	21.7	20.7	921.7	1307.7	1114.7
92	14.3	15.7	15.0	189.0	173.7	21.5	19.3	23.7	21.5	698.0	1131.0	914.5
113	21.3	18.0	19.7	166.7	151.0	20.2	20.0	20.3	20.2	209.0	614.7	411.8
138	11.7	20.3	16.0	161.3	163.3	17.5	16.0	19.0	17.5	716.7	640.3	678.5
148	24.0	16.3	20.2	149.0	161.7	20.2	21.0	19.3	20.2	842.7	1081.7	862.2
478	14.7	16.0	15.3	167.3	161.7	24.2	20.7	27.7	24.2	814.3	1648.3	1231.3
521	11.0	16.0	13.5	167.0	165.7	12.5	10.0	15.0	12.5	175.7	649.7	412.7
546	16.7	10.7	13.7	146.7	159.7	22.7	21.0	24.3	22.7	525.7	935.7	730.7
682	18.3	22.0	20.2	163.3	149.7	25.3	20.0	30.7	25.3	456.3	1262.7	859.5
645	23.3	21.3	22.3	177.0	159.3	16.5	9.7	23.3	16.5	218.7	728.3	473.5
691	22.3	29.3	25.8	191.7	189.0	16.7	11.3	22.0	16.7	337.7	1026.0	681.8
739	13.3	15.7	14.5	164.0	157.7	20.3	21.3	19.3	20.3	1440.3	1075.0	1257.7
743	17.7	18.3	18.0	167.0	157.7	21.8	18.7	25.0	21.8	240.0	816.7	528.3
752	26.3	24.7	25.5	162.0	157.7	25.7	22.7	28.7	25.7	1240.0	1988.0	1614.0
812	22.3	18.0	20.2	146.3	155.0	150.7	20.0	25.7	22.8	505.7	1363.0	934.3
816	13.0	10.3	11.7	177.3	173.0	175.2	11.3	10.3	10.8	621.7	570.0	595.7
851	10.3	12.7	11.5	147.7	155.0	151.3	21.7	22.7	22.2	831.7	1290.0	1060.8
909	21.7	19.7	20.7	137.0	147.3	142.2	29.7	30.0	29.8	1612.3	1258.3	1435.3
1085	14.0	13.0	13.5	159.0	156.0	157.5	16.7	21.7	19.2	376.7	1100.0	738.3
1159	22.7	14.3	18.5	174.7	165.0	169.8	24.0	24.0	24.0	871.0	792.3	831.7
1571	22.0	21.7	21.8	145.3	155.0	150.2	28.3	30.7	29.5	1532.7	1921.0	701.4
1599	18.3	13.3	15.8	151.0	149.3	150.2	18.0	24.7	21.3	444.0	1360.7	902.3
Mean	18.3	18.2	18.3	62.7	160.6	161.7	19.1	23.2	21.2	701.4	1116.4	908.9

Dry season: Jan- April & Nov-Dec; Rainy season: May- Oct

Evaluation of Dura and TxT progeny: The commercial seed production of hybrid oil palm involved 100 *dura* and 10 pisifera palms. A target of supply of four lakh sprouts was allocated during 2004-05. Fruit typing in TxT block at this seed garden has been initiated for identifying Dura, pisifera and tenera palms for future use.

Pollen production and maturity: Palm no. 484 (250 g) produced more quantity of processed pollens followed by palm no. 409 (105g) and least 27g production was recorded in *Pisifera* No 379. With respect to pollen maturity palm no.46 took more (16 days) *dura*tion and 409 found to show early maturity. Over all average revealed that *pisifera* palms produced about 65 g pollen and it took 9 days for maturity from bagging to full maturity.

Precocity in DXP Progeny seedlings: In oil palm, transition from immature to fruiting stage takes place at about two and half years after field planting. Contrary to this occurrence of precocity for flowering was observed in two *Dura X Pisifera* combinations. In one seedling each from the two combinations *viz*., 92D x 379P and 113D x 379P, female inflorescence was noticed after 16-18 month period, the source of pisifera was palm number 379 of Oil Palm Seed Garden, Lakshmipuram (Fig. 6).

NRCOP, PEDAVEGI (A.P.)

Evaluation of Costa Rica Dura seedlings: Palms have started FFB production observations on morphological and phenological characters are being recorded. Some palms with high initial FFB weight have been identified.

Table 23. Seasonal influence on days to anthesis, bunch ripening, bunch weight and number of seeds/ bunch in selected *dura* palms at Lakshmipuram seed garden

Palm No/ Season	Days to Anthesis			Days to fruit maturity			Bunch weight (Kg)			No. of seeds/ Bunch		
	Dry	Rainy	Mean	Dry	Rainy	Mean	Dry	Rainy	Mean	Dry	Rainy	Mean
28	12.0	17.3	14.7	170	181.7	175.8	22.3	22.0	22.2	600.3	1100.0	850.2
40	24.0	16.7	20.3	148	161.3	154.7	16.7	18.3	22.5	1400.0	793.3	1096.2
44	22.0	6.7	14.3	179	186.3	182.7	23.7	19.0	21.3	533.3	876.7	705.0
43	21.0	8.0	14.5	199	185.7	192.3	21.3	14.3	17.8	816.7	500.0	658.3
57	21.7	5.0	13.3	171	189.0	180.0	25.0	19.3	22.2	966.7	582.7	774.7
58	22.3	14.7	18.5	150	175.3	162.7	13.3	22.3	17.8	611.7	879.0	745.3
61	18.0	18.0	18.0	167	167.0	167.0	16.7	16.7	16.7	580.0	580.3	580.2
75	33.0	14.0	23.5	171	175.3	173.2	11.3	14.3	12.8	169.7	770.0	519.8
97	13.7	13.7	13.7	169	167.3	168.0	15.0	16.7	15.8	127.0	408.3	267.7
112	14.0	15.3	14.7	162	160.0	161.0	20.0	23.7	21.8	466.7	1030.3	748.5
113	21.0	15.3	18.2	139	160.7	149.8	14.3	16.3	15.3	256.7	701.3	479.0
114	21.0	6.3	13.7	181	206.0	193.5	22.3	20.3	21.2	1000.3	1533.3	1266.8
118	20.7	12.7	16.7	159	175.7	167.2	16.7	16.7	16.7	736.7	805.3	771.0
135	31.3	14.0	22.7	169	143.0	155.8	19.0	18.0	18.5	679.7	551.0	615.3
146	7.0	17.7	12.3	147	147.7	147.3	15.0	14.0	14.5	700.0	686.0	693.0
165	16.0	8.0	12.0	154	149.3	151.5	18.0	18.0	18.0	873.3	1296.7	1085.0
198	19.0	12.0	15.5	169	202.0	185.8	14.3	21.7	18.0	523.0	2079.0	1301.0
419	23.3	20.0	21.7	152	177.0	164.5	23.3	22.3	22.8	1150.0	1465.0	1307.5
420	8.3	7.0	7.7	169	169.0	169.0	20.0	20.3	20.2	820.0	823.3	821.7
473	7.3	10.3	8.8	169	169.7	169.3	22.0	22.0	22.0	3020.0	1573.3	2296.7
475	13.3	14.7	14.0	163	172.7	167.8	22.3	20.0	21.2	1202.3	1713.3	1457.8
Mean	18.6	12.7	15.7	164	172.5	168.5	19.2	18.9	19.0	825.4	988.0	906.7

Dry season: Jan- April & Nov-Dec; Rainy season: May- Oct

Evaluation of Dura seedlings of Palode origin: Palms of two Dura families have started yielding. High yielding dura palms have been identified. Fruit typing is being done to confirm *dura* shell character. Data on morphological, Phenological & yield related characters were recorded. The FFB weight per palm ranged between 3–115kg per annum (Table 24).

Fig. 6. Precocity in Female flower initation in 113D X 379P combination

Table 24. Evaluation of *dura* populations at Pedavegi, A.P.

S. No.	Parameters	FFB*		
		Weight (Kg)	No.	Average (Kg)
1.	General mean	38.0	6.94	6
2.	SE (±)	1.42	0.22	0.12
3.	Minimum	2.0	1.0	1.0
4.	Maximum	115.0	20.0	15.0
5.	No. of palms above mean		270	

Total Population: 271; Year of Planting: 2000

Evaluation of TxT population: Palms of TxT Population are being monitored regularly for pattern of inflorescence production. Data on morphological, Phenological & yield related characters were recorded (Table 25). *Dura* palms with high FFB production are being monitored. Fruit typing is being done for shell characters. Eighteen palms were identified which produced only male inflorescences while seven palms produced female inflorescences but no bunches have also been identified. Based on fruit typing & shell character, a segregation ratio of Dura =22: Pisifera =13: Tenera =83 has been observed till now.

OIL PALM SEED GARDEN, TARAKA (KARNATAKA)

Selection of dura palms: Variation was observed among the palms for FFB weight. During the current year FFB weight up to 344 Kg was recorded. Fifty eight *dura* palms and 8 *Pisifera* palms are being utilized in commercial seed promotion.

Table 25. Variation in TxT population for different characters at OPSG, Pedavegi, A.P.

S.No.	Character	Mean	SE (±)	Maximum	Minimum
1.	Stem girth (cm)	212	4.8	306	0.0
2.	Palm height (cm)	26.9	0.96	57	0.0
3.	No. of Leaves/ palm	32.8	0.33	43.0	21.0
4.	Petiole width (cm)*	4.5	0.06	6.5	2.7
5.	Petiole depth (cm)*	3.9	0.05	5.7	2.2
6.	No. of leaflets per leaf*	215.1	1.93	346	124
7.	Leaflet length (cm)*	75.4	0.84	101.8	46.0
8.	Leaflet width (cm)*	3.8	0.04	5.0	2.2
9.	Rachis length (cm)*	335.1	6.33	467	3.3
10.	Leaf area (sqcm)*	3.4	0.07	5.9	0.9
11.	Leaf dry weight (Kg)*	2.0	0.05	4.0	0.8
12.	No. of male inflorescence/ palm	9.0	0.28	16.0	0.0
13.	No. of female inflorescence/ palm	1.0	0.17	9.0	0.0
14.	No. of palms producing no female inflorescences				32

* on 17th leaf; Total Population: 136, Year of Planting: 1998

MOLECULAR BREEDING

RAPD analysis of Palode and Costarican accessions: More primers were used for studying the genetic diversity among five dura accessions. A total of 33 primers were used in this study, RAPD for this set of palms was completed. Data was analysed for genetic diversity and also for primer evaluation. Significant variation was observed between different accessions and also between the different palms within a particular accession. As observed earlier, no two palms within any of the accessions were found genetically same. Five major groups were formed by cluster analysis using UPGMA (Fig. 7). The primers were evaluated for

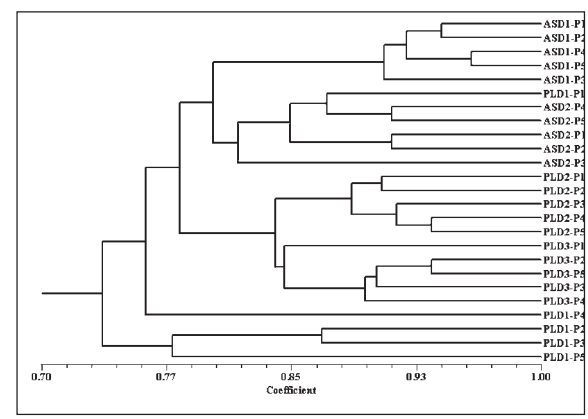


Fig. 7. Dendrogram showing relationship among 25 palms from five different oil palm germplasm accessions using RAPD markers

their utility, which could be used for individual palm identification. (Table 26).

RAPD analysis of African germplasm: A set of 24 palms from six accessions of Guinea Bissau, Zambia, Tanzania and Cameroon and one each from ASD Costa Rica and India were taken for genetic diversity study. Ten more random primers have been used during the reporting period for the study. This set of palms from exotic accession formed separate group with the palms in each accession.

DNA isolation from *dura* and *pisifera* palms: Research work on shell thickness marker was initiated and DNA from 20 *dura* and 20 *pisifera* palms from Palode (From a T X T garden) have been isolated using the newly developed method described below.

DNA isolation from oil palm leaf tissue without using any detergent: DNA was extracted from oil palm tender leaf tissue without use of any detergent. Quantity and quality (ratio of O.D. at 260nm/ 280nm) of crude DNA was found significantly higher in the new method than that of CTAB. This might be due to higher amount of RNA contamination in the crude DNA by new method, especially in case of *dura* samples.

Quality and quantity of purified DNA (after RNase treatment followed by purification Phenol-Chloroform) was higher in case of the new method, however no significant difference was observed between the two methods.

The DNA extracted without any detergent was of high molecular weight and without any degradation (Fig. 8.1 and 8.2). *Eco* RI restriction digestion showed complete digestion of the DNA by both the methods (Fig. 8.3). PCR amplification with a random primer also showed no difference in RAPD pattern between the two methods (Fig.8.4). Results of the present study suggested that high quality DNA with sufficient quantity (equal or more than the conventional method) could be extracted successfully from the oil palm leaf tissue without any detergent and the DNA could be used further for any other purpose.

Table 26. Grouping of 33 primers used for RAPD analysis of oil palm as per their usefulness for palm identification

	Most Useful →					Least Useful
	Group - I	Group - II	Group - III	Group - IV	Group - V	Group - VI
Primers	OPP-05 OPM-04 OPN-05	OPM-17 OPN-20 OPN-09	OPN-14 OPN-02 OPP-06 OPN-03 OPN-15 OPN-12 OPM-18 OPO-11	OPN-10 OPO-09 OPN-06 OPM-14 OPM-15	OPM-12 OPO-10 OPN-04 OPO-08 OPN-08 OPM-11	OPM-07 OPN-11 OPN-13 OPN-16 OPN-17 OPN-19 OPP-04
Total No. of Bands	24	28	51	25	22	17
Polymorphic band (%)	91.66	64.29	82.35	76.00	45.45	0.00
Mean EMR	7.33	6.00	5.25	3.8	1.67	0.00
Mean $H_{av(p)}$	0.69	0.79	0.62	0.58	0.30	0.00
MI	5.06	4.76	3.26	2.21	0.51	0.00
Mean R_p	3.73	2.59	2.39	1.34	0.45	0.00

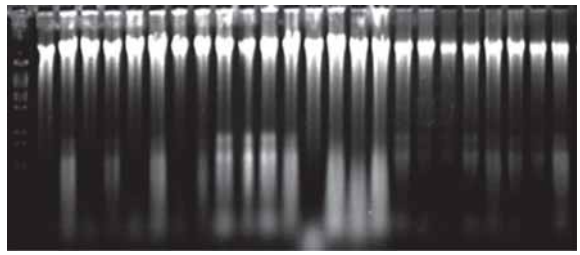


Fig. 8.1. Comparison of Crude DNA preparations by using CTAB buffer and without any detergents

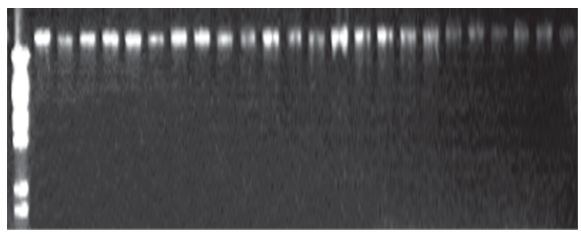


Fig. 8.2 Comparison of Purified DNA preparations by using CTAB buffer and without any detergents

Legends for Fig. 8.1&8.2 Lanes (From Left): 1: Marker (χ DNA digested by *Eco* RI + *Hind* III); Lanes 2-9: DNA isolated from *dura*(Lanes 2,4,6,8- DNA extracted with CTAB, Lanes 3,5,7,9- DNA extracted without CTAB); Lanes 10-17: DNA from *tenera*: (Lanes 10,12,14,16)- DNA extracted with CTAB, Lanes 11,13,15,17- DNA extracted without CTAB); Lanes 18-25: DNA from *pisifera*:(Lanes 18,20,22,24- DNA extracted with CTAB, Lanes 19,21,23,15- DNA extracted without CTAB)

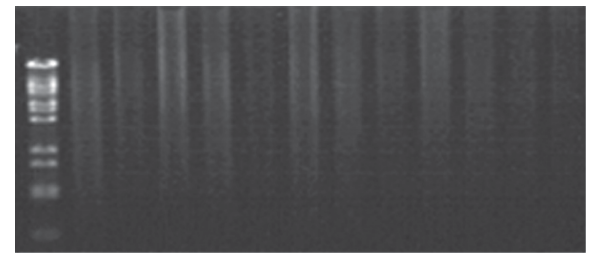


Fig. 8.3 Comparison of DNA preparations by using CTAB buffer and without any detergents after digestion with *Eco* RI restriction enzyme

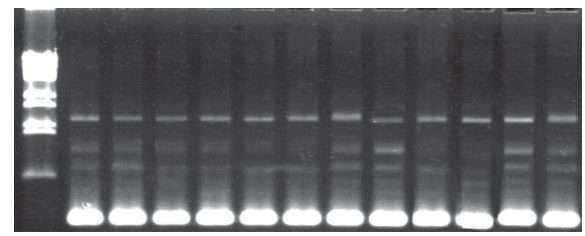


Fig. 8.4 Comparison of DNA preparations by using CTAB buffer and without any detergents after PCR amplification (RAPD) by using random primers

Legends for Fig. 8.3 & 8.4 Lanes (from left): 1: Marker (χ DNA digested by *Eco* RI + *Hind* III); Lanes 2-5: DNA from *dura*: (Lanes 2,4- DNA extracted with CTAB, Lanes 3,5- DNA extracted without CTAB); Lanes 6-9: DNA from *tenera*: (Lanes 6,8- DNA extracted with CTAB, Lanes 7,9- DNA extracted without CTAB); Lanes 10-13: DNA from *pisifera*:(Lanes 10,12- DNA extracted with CTAB, Lanes 11,13- DNA extracted without CTAB)

4. Research Achievements

Agronomy and Crop Management

शस्य विज्ञान और फसल प्रबन्धन

NUTRIENT & WATER MANAGEMENT

FERTILIZER REQUIREMENT OF OIL PALM DURING EARLY GROWING STAGE

The field experiment to standardize a suitable fertilizer dose during pre-bearing stage was continued at Palode, Kerala with the following sets of modified treatments from third year onwards to find out a suitable dose during early years of bearing. The treatments were, T_1: 0-0-0, T_2: 600-300-600, T_3: 900-450-900, T_4: 1200-600-1200, T_5: 1500-750-1500 and T_6: 1800-900-1800 (N, P_2O_5 and K_2O per palm per year). The treatments differed for girth and leaf area whereas, height and leaf number were similar for all the palms. For girth and leaf area, all the treatments except control were on par (Table 27). Maximum number of inflorescences was produced by T_4 and minimum by control. Early yield figures during the last six months indicated that T_4 has produced the highest number of bunches and bunch yield followed by T_5. All the nutrients were in the optimum range except for T_1 and T_2 wherein N and K values were slightly less.

NUTRIENT AND WATER MANAGEMENT DURING EARLY YIELDING STAGE

Studies conducted at Pedavegi, Andhra Pradesh revealed that drip irrigation has produced maximum height of 147.5 cm that was on par with jet irrigation (137.7 cm) (Table 28). Both these were significantly superior to basin irrigated palms (65.7 cm). Girth of oil palm was higher in drip and jet irrigated palms as compared to basin irrigated palms and in each of the methods, girth decreased with decreasing level of irrigation, however, the magnitude of decrease differed with each method. Jet irrigation produced maximum number of leaves/ year followed by drip and basin. Irrespective of irrigation method unopened spear leaves were more than one (2.7, 2.8 and 4.4 in drip, jet and basin irrigation respectively). Similarly leaf dry weight, area of 17th leaf and total leaf area were more in drip and jet irrigations as compared to basin irrigation treatment. Both these parameters showed a decreasing trend with decrease in the amount of water applied. Regarding yield parameters, Drip irrigation recorded maximum yield of 28.4 kg/palm followed by jet and basin (23.1 kg/palm & 4.9 kg/ palm). Among irrigation levels I-1 (IW/CPE=1) recorded maximum yield of 20.9 kg/palm followed by I-2 (IW/CPE=0.8) & I-3 (IW/CPE=0.6) 17.7 & 17.7 kg/palm respectively. Relating to bunch production Drip irrigation recorded maximum number of bunches (3.97) followed by jet and basin (3.34 & 1.01). In irrigation levels I-1 recorded maximum no of bunches (2.90) followed by I-2 and I-3 (2.70 and 2.80). There was no significant difference due to the three fertilizer levels on growth or yield parameters studied. There was no significant difference in the leaf nutrient levels among the various treatments (Table 29). All the treatments exhibited optimum levels of nutrients irrespective of different fertilizers.

Table 27. Growth parameters of young palms

Treatment	Palm Height (m)	Skm Girth (cm)	Leaf production No.of leaves	Leaf area (m^2)
T_1	3.75	1.13	20.18	1.556
T_2	4.08	1.31	19.50	1.846
T_3	4.08	1.40	19.87	1.856
T_4	4.23	1.42	20.77	1.996
T_5	4.21	1.26	18.69	1.833
T_6	4.13	1.29	20.56	1.801
CD (±)	0.495	0.265	2.147	0.357

The photosynthetic rate was maximum in Jet irrigation method at I1F3 level followed by drip (I1 F2) level and the lowest photosynthetic rate was observed in basin irrigation method. In the different irrigation methods, Jet irrigation recorded the maximum Photosynthetic rate. The maximum transpiration rate was observed in Basin irrigation at I2 F1 level followed by I3 F1 level and minimum rate was observed in jet irrigation at I1 F3 Level.

Table 28. Plant growth and yield of oil palm as affected by methods of irrigation, levels of irrigation and fertilizers at Pedavegi

Treatment	Pl. ht.(cm)	Stem girth (cm)	No. of leaves	No. of Un-opened leaves	No. of bunches	Bunch wt.(Kg/ palm)
Irrigation Methods						
Drip	147.5a	285.8a	21.6	2.7 a	3.97a	28.4a
Jet	137.7a	279.7a	21.7	2.8 a	3.34a	23.1a
Basin	65.7b	232.7b	19.8	4.4 b	1.01b	4.9b
S.Ed (±)	8.7	4.83	1.26	0.21	0.40	2.37
Irrigation levels						
100% Evapo.	123.9	227.4b	21.1	3.26	2.90	20.9
80% Evapo.	119.6	263.8a	21.0	3.27	2.70	17.7
60% Evapo.	107.4	256.9a	21.0	3.37	2.80	17.7
S.Ed (±)	8.7	4.83	0.42	0.21	0.38	2.34
Fertlizer Levels						
900: 450:900	119.5	263.1	21.1	3.09	2.8	18.9
1800:900:1800	117.4	267.7	20.8	3.50	2.9	19.7
3600:1800:3600	114.1	267.3	21.2	3.11	2.6	17.6
S.Ed (±)	4.0	3.82	0.30	0.25	0.26	1.94

The maximum stomatal conductance was observed in Basin irrigation at I2 F1 level and minimum was observed in Jet irrigation method at I1 F3 and I1 F1 levels.

Table 29. Leaf nutrient composition in various treatments

Treatment	P %	K %	Ca %	Mg %
Irrigation Methods				
Drip	0.13	0.69	0.67	0.42
Jet	0.14	0.75	0.80	0.49
Basin	0.14	0.84	0.64	0.43
S.Ed (±)	0.003	0.06	0.019	0.025
Irrigation levels				
100% Evapo.	0.14	0.71	0.71	0.48
80% Evapo.	0.14	0.80	0.68	0.44
60% Evapo.	0.14	0.77	0.72	0.42
S.Ed (±)	0.003	0.06	0.019	0.025
Fertlizer Levels				
900: 450:900	0.14	0.74	0.72	0.47
1800:900:1800	0.14	0.75	0.74	0.43
2700:1350:2700	0.14	0.79	0.65	0.44
S.Ed (±)	0.003	0.03	0.03	0.032

Maximum chlorophyll 'a' was observed at drip (I2F3) level followed by Basin (I3 F3) level and minimum chlorophyll 'a' was observed at Jet (I1 F1) level followed by jet I1 F2 level. In Jet irrigation, I1 F3 level recorded the maximum chlorophyll 'b' content and minimum was observed at Basin irrigation (I3 F2) level. Total chlorophyll was maximum in jet irrigation at I1 F3 level followed by drip I2 F1 level and minimum was observed in Basin irrigation method. Among three irrigation methods Jet irrigation method recorded the maximum chlorophyll content. Carotenoid content was more in drip (I3 F3) level and basin (I3 F3) level. Minimum was observed at Jet I2 F2 levels. Drip and Jet irrigation methods recorded the maximum carotenoid content.

NUTRIENT RECYCLING OF OIL PALM PLANTATION WASTES

Organic composting of oil palm wastes in large scale using pruned leaves and empty fruit bunches has been perfected and large scale production of organic compost by aerobic method and vermi-composting were carried out and demonstrated at Palode, Kerala during the year.

The nutrient value of oil palm waste compost thus evolved is on par with nutrient value of any good quality compost manure. Based on these nutrient values it was estimated that 65 to 70kg of such compost is required to meet full nutrient demand of inorganic fertilizers recommended. These composts were used in the field experiment on integrated nutrient management trial under the project and it was found that 2/3rd of the inorganic fertilizer needs can be substituted with the organic compost made out of oil palm wastes obtained from the plantation itself. Thus a self-recycling nutrient system of oil palm has been perfected. Various combinations of inorganic and organic nutrient supply were tested by imposing these treatments in the IPNM field experiment.

The soil sample analysis conducted for physical and chemical properties in various treatments during the year showed improvement in fertility parameters in those treatments, which received larger proportion from organic compost.

Foliar analysis carried out for N, P, K, Ca, & Mg in different treatments revealed optimum content with out variations due to different organic and inorganic combinations except in control plot that was significantly low. This again supports the addition of organic source of nutrition for oil palm with added advantages.

The production of bunches and FFB yield showed that 2/3rd dose as organic source and full dose as organic source were on par indicating the possibility to substitute 2/3rd of the inorganic fertilizer need of oil palm with organic compost. This practice reduced the input cost on inorganic fertilizers in addition to many more ecological advantages making it a sustainable nutrient management system.

N AND K MANAGEMENT IN ADULT OIL PALM (ON FARM TRIAL)

A field experiment was started at Pedavegi, A.P. during 2003-204 in a farmer's field with an objective to assess the nitrogen and potassium requirement of an adult oil palm. Number of bunches varied between 2.9 and 4.8 per palm per year among different treatments (Table 30). The bunch weight varied between 56.7 and 97.2 kg per palm per year. Both these parameters were not affected by the treatments. This could be due to the fact that this is the second year of treatment imposition and bunch initiation must started almost 3 years before. The leaf nutrient status before and after imposition of the treatments gave the information that all the nutrients were in optimum range. There was no significant difference in leaf nutrient status of different treatments. Soil physical analysis of the experimental plot was carried out (Table 31). The soil structure varied between sandy at the surface to sandy clay loam at 35-40 cm depth followed by sandy layer below this layer. Similarly the soil nutrient analysis after the imposition were also completed and provided in Table 32. The leaf nutrient deficiency symptoms observed in the experimental plot were recorded and presented in Table 33. There was no definite trend in appearance of deficiency symptoms in relation to levels of nutrients as affected by treatment imposition.

STUDY OF HIGH AND LOW YIELDING OIL PALM GARDENS OF M/S GODREJ AGROVET LIMITED:

Soils were acidic to neutral in reaction, EC was normal, Organic carbon was low in all gardens, Soil Phosphorus was medium to high, Soil Potassium was very high, Ca and Mg was less than adequate (Table 34 & 35). Leaf N was optimum

Table 30. Number of bunches and bunch weight in the different treatments

S. No.	Treatment	No. Of bunches	Total Bunch Wt.(Kgs)
1	N1K1	3.6	74
2	N1K2	3.6	80.53
3	N1K3	3.6	61.3
4	N2K1	4.8	87.53
5	N2K2	5	97.2
6	N2K3	3.53	75.6
7	N3K1	2.93	56.73
8	N3K2	3.7	59.93
9	N3K3	2.9	66

Table 31. Particle size analysis in the demonstration plot.

Soil depth cms	Course sand (%)	Fine sand (%)	Total sand (%)	Silt (%)	Clay (%)	Textural Class (%)
0-15	77.08	16.51	93.59	2.46	3.95	Sandy
15-30	64.7	18.17	82.87	3.91	13.22	Sandy Loam
30-45	63.07	12.6	75.67	3.47	20.85	Sandy Clay loam
45-60	48.66	14.93	63.59	4.99	31.42	Sandy

Table 32. Soil analysis in the Demonstration Plot after imposition of treatment

Treatment	Soil depth(cm)	Org.C %	P_2O_5 Kg/ha	$K_2 0$ Kg/ha	Ca meq/100g	Mg meq/100g
N1K1	15	0.32	0.58	400.36	0.68	0.24
	30	0.35	0.78	583.67	0.76	0.30
	45	0.24	0.70	748.57	0.90	0.37
N1K2	15	0.35	0.80	459.13	0.91	0.31
	30	0.25	0.94	710.53	1.06	0.39
	45	0.22	0.71	1024.54	2.07	0.47
N1K3	15	0.43	0.71	531.07	0.65	0.27
	30	0.42	0.96	830.03	0.82	0.36
	45	0.39	1.03	972.94	0.85	0.39
N2K1	15	0.31	0.87	518.00	0.68	0.28
	30	0.25	0.98	725.46	0.81	0.32
	45	0.19	0.96	906.38	1.01	0.35
N2K2	15	0.31	0.68	400.40	0.67	0.29
	30	0.27	0.84	521.81	0.90	0.38
	45	0.26	0.98	681.37	0.93	0.45
N2K3	15	0.22	0.65	365.87	0.82	0.34
	30	0.25	0.86	634.48	0.94	0.39
	45	0.23	0.75	738.38	1.00	0.41
N3K1	15	0.28	0.70	456.21	0.66	0.28
	30	0.23	0.84	629.93	0.73	0.32
	45	0.28	0.90	745.99	0.74	0.33
N3K2	15	0.30	0.81	784.78	0.77	0.30
	30	0.14	0.93	995.68	0.84	0.33
	45	0.25	0.91	1268.36	1.12	0.45
N3K3	15	0.41	1.20	455.13	0.88	0.37
	30	0.27	1.10	994.71	0.99	0.41
	45	0.29	1.19	1349.00	1.13	0.46

except in two gardens . Leaf P was less than optimum, Leaf K was optimum except in one case, both Ca and Mg were optimum.

In most of the gardens, N application was more than recommended. Applied P fertilizers were less than recommended. K fertilizers were applied in excess of recommended dose. Both Ca and Mg were applied much less than recommended dose.

Soil P was positively linked with yield of the just concluded year. Soil Mg was negatively correlated with yield of just concluded year. All the major nutrients applied in the form of commercial fertilizers were positively correlated with current year yields. None of the other nutrients in soil, leaf or fertilizers were significantly correlated with yield of just concluded year.

Table 33. Deficiency symptoms seen in the different treatments (average number of palms per plot of 5 palms)

Treatments	Deficiency		
	K	Mg	N/K
N1K1	0.67	1	0
N1K2	0.67	0.33	2.67
N1K3	0.67	0.67	1
N2K1	1.33	1	1.67
N2K2	0.67	0.67	1
N2K3	1.67	0	2.33
N3K1	1	0.33	1
N3K2	0.67	0.33	2
N3K3	1.33	0.67	1

LEAF BREAKING IN OIL PALM

In study on nutrient status of both broken and healthy leaves in a ten year old plantation with incidence of leaf breaking, three different categories of leaves were identified with incidence of leaf breaking as broken, about to break and healthy leaves.

The results indicated that soils were mild to moderately alkaline in reaction (pH=7.67 to 7.92) with low amounts of soluble salts (EC = 0.175 to 0.260 dS m^{-1}). Soils were low in organic carbon and very low available P status. Available K status was very high and exchangeable Ca and Mg contents were relatively low.

Table 34. Soil and leaf analysis of low yielding gardens of M/S Godrej Agrovet area, A.P.

Garden	Depth	pH	Soil nutrients						Leaf nutrients (%)				
			E.C	Org. C	P_2O_5	K_2O	Ca meq/ 100g	Mg meq/ 100g	N	P	K	Ca	Mg
No	cm		µ.S	%	Kg/ha	Kg/ha							
1	15	7.2	88.0	0.3	14.7	288.0	1.6	0.5	2.4	0.1	1.1	0.9	0.3
	30	7.3	184.4	0.2	30.8	209.4	1.2	0.7					
	45	7.9	113.7	0.4	43.1	470.2	0.8	0.8					
2	15	6.2	72.1	0.3	60.6	359.2	1.1	0.6	2.5	0.2	1.1	0.6	0.2
	30	6.0	88.9	0.3	14.6	114.0	0.8	0.4					
	45	5.7	104.3	0.4	23.8	232.5	1.6	0.5					
3	15	6.7	114.6	0.3	99.4	483.5	1.7	0.4	2.6	0.1	1.1	1.0	0.2
	30	6.5	139.2	0.3	14.9	713.0	1.1	0.4					
	45	6.8	93.2	0.3	27.0	317.8	2.0	0.3					
4	15	6.0	163.8	0.3	148.0	526.2	0.7	0.3	2.7	0.1	0.9	0.8	0.3
	30	6.7	149.8	0.4	120.3	611.1	1.5	0.3					
	45	5.6	255.4	0.3	35.2	625.1	1.3	0.4					
5	15	7.4	87.3	0.3	79.5	417.1	1.4	0.3	2.5	0.1	1.0	0.8	0.3
	30	7.3	105.5	0.2	32.7	249.0	1.2	0.4					
	45	7.1	148.3	0.2	50.0	505.8	1.0	0.6					
6	15	6.4	97.6	0.4	28.3	196.7	0.5	0.6	2.3	0.2	1.0	0.7	0.2
	30	6.2	107.3	0.3	29.0	58.8	1.1	0.2					
	45	6.3	152.7	0.3	42.3	499.6	0.9	0.4					
7	15	6.6	96.4	0.3	50.3	121.6	1.2	0.4	2.7	0.1	1.0	1.0	0.2
	30	6.5	118.1	0.3	45.4	324.4	1.0	0.7					
	45	6.5	183.1	0.2	25.5	495.5	1.3	0.9					
8	15	7.5	144.5	0.4	165.1	165.9	1.7	0.5	2.6	0.1	0.9	1.0	0.3
	30	7.6	144.9	0.4	74.9	648.8	1.2	0.8					

Table 35. Soil and Leaf analyses of High yielding gardens of M/S Godrej Agrovet area in A.P

Garden No	Soil								Leaf nutrients (%)				
	Depth cm	pH	E.C µS	Org. C %	P_2O_5 Kg/ha	K_2O Kg/ha	Ca Meq/ 100g	Mg meq/ 100g	N	P	K	Ca	Mg
1	15	6.7	120.1	0.2	68.8	620.5	0.9	0.6	2.5	0.1	0.9	1.0	0.2
	30	6.5	142.3	0.4	64.8	259.5	1.1	0.3					
	45	6.5	206.2	0.3	32.6	410.1	1.7	0.3					
2	15	7.0	103.2		171.2	196.4	1.6	0.3	2.7	0.1	0.9	0.7	0.3
	30	6.7	94.3	0.2	165.9	275.5	1.3	0.3					
	45	6.7	108.8	0.2	152.4	501.5	1.3	0.4					
3	15	6.1	75.3	0.3	76.7	423.2	1.0	0.2	2.5	0.1	0.9	0.7	0.2
	30	5.8	105.8	0.4	164.8	482.6	1.2	0.2					
	45	6.0	167.9	0.4	120.1	450.9	0.7	0.3					
4	15	7.4	83.5	0.2	176.9	379.5	1.6	0.4	2.7	0.1	0.7	1.0	0.3
	30	7.1	191.1	0.2	103.9	256.4	1.2	0.3					
	45	7.8	92.5	0.2	141.2	234.9	1.2	0.3					
5	15	6.3	84.0	0.3	113.5	410.3	1.3	0.5	2.7	0.1	0.9	0.9	0.3
	30	6.5	103.9	0.2	72.6	642.7	1.2	0.3					
	45	6.2	131.9	0.3	90.7	198.9	0.9	0.4					
6	15	7.3	80.6	0.3	49.5	68.5	1.0	0.2	2.4	0.1	0.7	0.9	0.2
	30	7.4	82.8	0.2	36.6	129.6	1.2	0.1					
	45	7.1	80.6	0.1	12.0	519.5	0.9	0.2					
7	15	8.1	153.8	0.3	77.1	272.9	0.9	0.5	2.8	0.2	0.9	0.8	0.4
	30	7.8	203.7	0.3	29.8	886.4	1.9	0.8					
	45	7.5	291.4	0.2	120.0	953.6	1.1	1.2					
8	15	6.6	133.0	0.2	147.3	756.9	1.4	0.4	2.5	0.1	1.0	0.9	0.3
	30	6.4	128.2	0.3	112.8	386.1	1.3	0.2					
	45	5.9	150.6	0.3	205.1	370.2	1.2	0.3					

Leaf nutrient analysis revealed that N and P concentration in lamina was optimum in both healthy and about to break leaves, while it was deficient in broken leaves. Potassium was the only nutrient, which was deficient in all the leaves (Table 36, Fig 9.1 & 9.2). Secondary nutrients (Ca and Mg) and micronutrients (Cu, Zn, Mn and Fe) were found to be in the optimum range in all the three categories of leaves.

The concentrations of N, P and K were higher in the healthy leaves and decreased with the severity of the leaf break incidence. There is a strong indication that N and K could have been translocated to the emerging leaves as the leaf broke, resulting in higher concentration in the healthy leaves. It was interesting to note that the K content in the leaf was in the deficient range even though available soil K status was very high. The concentration of Ca was significantly higher in broken leaf than that of about to break and healthy leaves. Ca and Mg were found to be optimum in leaves, even though they were relatively low in soil.

Copper concentration in lamina decreased with increase in severity of leaf break and rest of the micronutrients did not show any significant pattern with leaf break symptoms as per the data available in table 36.

During the subsequent year, leaf-breaking symptoms were not observed in the plantation and leaf nutrient analysis also revealed that all the nutrients were in the optimum range (Fig 9.3 & 9.4).

ANALYSIS OF LEAF AND SOIL SAMPLES

Analysis of 1294 leaf and 1103 soil samples was carried out for different nutrients. Samples from only one project i.e., drip irrigation project were received and analysed for P, K, Ca and Mg.

OIL PALM BASED CROPPING SYSTEMS

Survey on light infiltration through oil palm canopy was continued. Four gardens of different age were surveyed. Two of the gardens had Arecanut as inter crop while the other two had cocoa as inter crop. The amount of light that penetrated through the oil palm canopy varied between 3 and 15 per cent (Table 37). Light penetration through a coconut canopy of 20 year old garden allowed 40 per cent of the light to penetrate.

Fig. 9.1. Nutrient composition in the leaf breaking palms during 2003

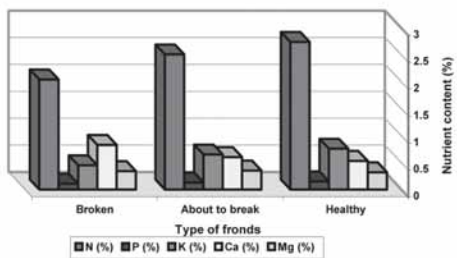


Fig. 9.2. Micronutrient composition in the leaf breaking palms during 2003

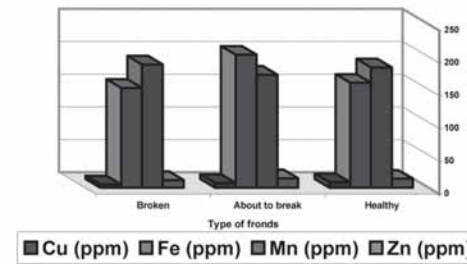


Fig. 9.3. Leaf nutrient composition in healthy leaves during 2004

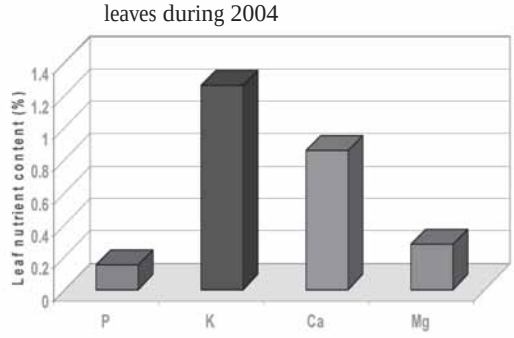


Fig. 9.4. Micronutrient composition in healthy leaves during 2004

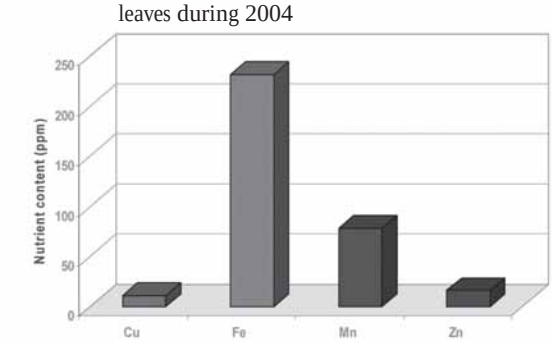


Table 36. Nutrient concentration in different categories of Oil Palm leaves

Category of leaf	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})
Broken	2.03	0.10	0.45	0.83	0.33	4.82	152.2	187.9	11.3
About to break	2.51	0.13	0.65	0.59	0.35	7.14	203.0	172.4	14.0
Frond no. 17 (Healthy)	2.73	0.15	0.76	0.53	0.32	8.17	160.1	183.7	13.5
LSD (p=0.05%)	0.30	NS	0.13	0.13	NS	1.00	32.4	49.9	3.2

Table 37. Radiation interception in oil palm gardens inter cropped with cocoa and other crops

Age Years	Intercrops grown	Radiation interception (Intercrops)		
		Open sky umol/sq.m/s	Above umol/sq.m/s	Below umol/sq.m/s
9	Oil Palm + Arecanut, Vanilla	1200	188.4	92.4
9	Oil Palm + Arecanut	1100	95.8	50.3
9	Oil Palm + Cocoa	1165	145.1	36.5
11	Oil Palm + Cocoa	1279	40	5.5
20	Coconut + Cocoa	1320	531	40

MIXED FARMING SYSTEM

Yield data of banana (with single row and paired row system) raised as intercrop was collected and found on par with solo crop. No pest problem was observed on banana though raised as intercrop. Custard apple that was raised as intercrop was found infected with psychids at low levels. Rhinoceros beetle infestation was observed higher in Malaysian cross compared to other crosses viz. Deli X Ghana, Deli X Nigeria and Palode. Drum stick (PKM 1) that was planted as intercrop recorded heavy yields of 250 fruits per plant on an average in a season. Various intercrops that were grown as tertiary ones in the interspaces and the basins using the available water yielded very well and increased the sustenance of oil palm farming by providing income during gestation period. Biogas was extracted from the oil palm sludge material replacing the cow dung, which is a new innovation having wide commercial application in palm oil factories. Compost wash was extracted from the structures constructed and applied directly through the drip system.

Seven tonnes of vermi-compost was prepared using the dung and leftover material of intercrops. Effect of microorganisms on the population of earthworms in the vermi-compost pits was studied using green muscardine fungus *Metarhizium anisopliae* and *Trichoderma viride*. Oyster mushroom (*Pleurotus sp.*) were raised on the oil palm mesocarp waste. Sheep were incorporated as one of the animal husbandry components of mixed farming systems. Heliconia flowers that were raised as intercrops fetched more market value compared to chrysanthemum and lilies. Maize was found to be the most suitable intercrop with more economic value to the farmer and best suited crop for vermi-composting as well as goat feed. Bottle gourd was found to be very remunerative crop when planted in the basins of oil palm.

NATURAL RESOURCE MANAGEMENT-SOIL WATER CONSERVATION TECHNIQUES AND LAND USE SYSTEMS

The purpose of this trial at Palode, Kerala was to increase the productivity of Oil Palm plantations by resorting to Agro forestry and multiple cropping systems. Systems of alley cropping with Cocoa, Cinnemon, black pepper trailed on glyricidia and intercropping of anthurium (flowering plant) Kacholam (medicinal plant) and guinea grass (fodder) were well established and yielded during the year.

The bio-engineering treatments were found to conserve soil and water by reducing the run off during the rainy season. All the subsidiary crops of the Agro forestry system have yielded during the year and yields recorded. Thus the productivity of the system has increased. The newly tested system of raising floriculture (growing Anthurium) and also medicinal plants (Kacholam) has been found successful and given promising yields.

The newly tested practice of growing black pepper trailed on Glyricidia planted as alley crop in between palm rows has given multipurpose benefits as a fertilizer crop, green manure and standard for trailing black pepper in Oil Palm plantations .The system was found successful and the black pepper have started giving yields which

were recorded. The pruning of glyricidia leaves was carried out 3 times a year and was used as green manure for nutrient enrichment in the system. This practice is found as a promising alley cropping system in oil palm plantation for recomme Alley cropping with Cocoa (oil palm+beverage system) in mature plantation has improved the soil fertility condition through addition of large quantity of shed leaves of cocoa in to the system. It has improved the soil moisture content, controlled the weed growth and also checked the soil and water run off during rainy season.

Agro forestry by raising multiple species of crops in combination with oil palm in a multi-tier system of canopies have also given very promising results. The crop combination in the multi-tier system *viz*: Oil palm + Cocoa or Cinnamon or glycidia with black pepper + pepper trailed on oil palm + Anthurium (flower plant) or Kacholam (medicinal plant) are found to grow and yield well when grown together thus increasing the out put of the system (Photographs given on coverpage of oil palm management).

Leaf nutrients values of N, P, K, Ca and Mg were all with in optimum range irrespective of the treatments. This showed that none of the agro forestry system has got adverse effect on the nutritional health and performance of the main crop of oil. Studies also revealed that agro forestry system has helped in reducing the run off of water and soil in these treatments. The water, soil and nutrient loss were determined for each treatment using multi slot devisors.

BIOCHEMICAL STUDIES

Studies on oil content and FAC of oil from different parts of bunch: To study the qualitative and quantitative differences of oil in different parts of FFB, samples were collected over a period of one year. Oil content and FAC in different portions of FFB and different part of individual fruits have been carried out.

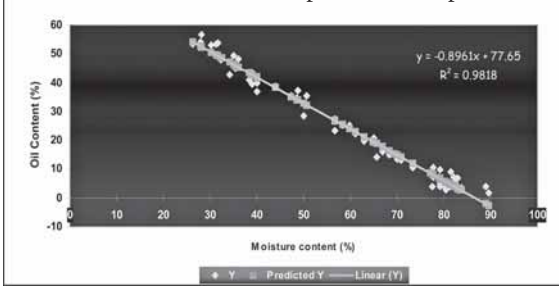
High oleic acid content in Part I; stearic acid, linoleic acid, linolenic acid and TUFA content were highest in Part II; Oil content, Palmitic acid, palmitoleic acid and TSFA content were highest in Part III, where as moisture content is highest in Part V.

Six months data of different portions of fruits were also averaged and it was found that Palmitic acid TSFA content were highest in Portion I; Mesocarp oil and linoleic acid content were highest in Portion II, where as moisture in the mesocarp, myristic acid, palmitoleic acid, stearic acid, oleic acid, linolenic acid, arachidonic acid and TUFA content were highest in the Portion III.

Estimation of oil and moisture of the mesocarp during maturation of oil palm Bunches: Ten pollinated bunches each from a separate *dura* palm from Rajahmundry (Andhra Pradesh) seed garden were tagged, and four fruits from the middle portion of each bunch were harvested from 16th week after pollination (WAP) onwards up to maturity (22 WAP). Objective of the study was to know the qualitative (in terms of fatty acids composition) and quantitative changes in palm oil during the fruit maturation under irrigated conditions. During 2004 this experiment was repeated.

Moisture content in the mesocarp gradually decreased from 16th weeks onwards to maturity. Moisture content as well as oil content during first two fortnights were significantly different. There after (last three weeks) both the parameter changed significantly every week. There was a very strong negative correlation between moisture content and oil content (r= -0.991) (Fig. 10). This would be useful in harvesting bunches by measuring the moisture content of the random fruit samples by an electronic moisture meter.

Fig. 10. Regression line between oil and moisture content in the oil palm mesocarp



Biochemical changes of oil for storing FFB at higher temperature for different time intervals after harvesting: To study the effect of higher temperature on FFA content in oil after harvesting the FFB, fully mature FFB (five bunches) were harvested and spikelets were separated. Spikelets from the middle of the bunches containing uniform sized fruits were incubated at 30, 40, 50 and 60°C temperature and in natural condition for a period up to seven days. Replicated samples (spikelets) were collected and sterilized for one hour and oil was extracted from each sample with the help of a mini hand press. Change in FFA content, Iodine value and Peroxide value were estimated from each sample. Results showed that i) the lipase activity was consistent and steady up to 50°C temperature even after 7 days of incubation of the fruits. FFA content increased in all the experimental temperature during storing but maximum was at 50 °C. ii) unsaturation of oil increased, when the harvested fruits were stored at higher temperature due to biochemical reaction; iii) there was no significant change and no trend was observed in Peroxide Value due to storage of FFB at higher temperature up to seven days; iv) there was no significant increase in FFA due to delay in processing FFBs upto the temperature around 40°C; and v) when properly mature bunches are harvested, storing at any temperature from 30-60°C up to 7 days before processing, amounted maximum accumulation of 3.5% FFA, which is below the permissible limit for edible oil. vi) Minimum increase in FFA was observed when the fruits were kept in open atmosphere (Natural temperature). The low FFA in the natural condition must be due to diurnal variation and fluctuation of weather, which was detrimental for lipase activity. FFA increase after seven days of incubation after 60 °C was close to natural condition but this must be due to heat inactivation of the enzyme. Analysis of data showed that shifing the FFB from lower to higher temperature increased the FFA except when shifting were to natural temperature or to 60 °C.

PHYSIOLOGICAL STUDIES

Diurnal variations in the photosynthetic rate and its associated parameters: Photosynthesis and related parameters were measured using portable photosynthesis system (Model LCA-4, ADC, U.K.). 9th leaf was used for the study. Observations were taken from 7.00 AM to 5.00 P.M. The photosynthetic rate ranged from 10.07 to 0.64 µmols/sq.m/s (Table 38). The highest photosynthetic rate was observed between 9:00 to 10:00 AM and decreased thereafter with increased leaf temperature. The lowest photosynthetic rate was observed at 5:00 PM. Maximum transpiration rate and stomatal conductance were observed at 7:00 A.M and it decreased with increase in leaf temperature. The photosynthetic rate, transpiration and PAR decreased from 3:00 to 5:00 P.M. (Fig 11.1, 11.2, & 11.3) Photosynthetic Water Use Efficiency was highest at 9:00 A.M and decreased as the day proceeded.

Fig. 11.1. Diurnal variations in photosynthetic rate in relation to PAR

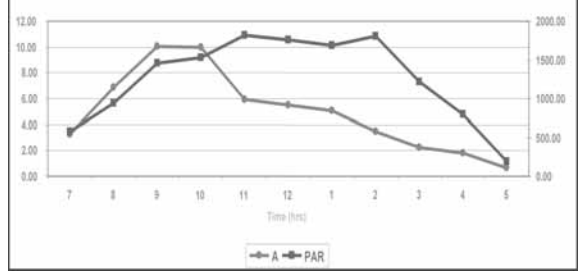


Fig. 11.2. Diurnal variations in photosynthetic rate in relation to leaf temperature

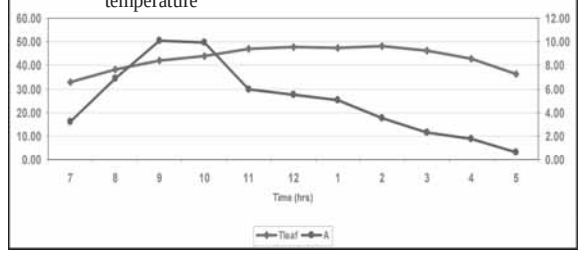


Fig. 11.3. Diurnal variations in photosynthetic rate in relation to stomatal conductance

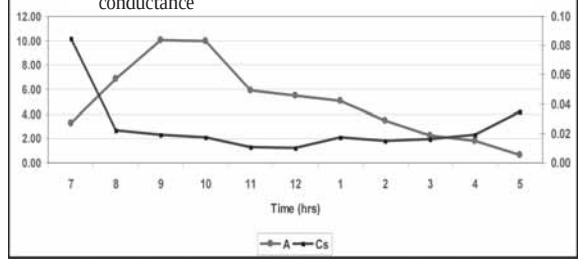


Table 38. Diurnal variations in the photosynthetic rate and its associated parameters

Time Hrs	PAR umol/sqm/s	T mmol/sqm/s	Tleaf oC	Cs mol/sqm/s	A umol/sqm/s	PWUE umol/mmol/sqm/s
7	584.33	1.87	32.96	0.09	3.25	1.74
8	943.06	0.82	38.25	0.02	6.86	8.41
9	1456.41	0.94	42.12	0.02	10.07	10.69
10	1527.34	1.05	43.95	0.02	9.94	9.46
11	1819.24	1.00	47.15	0.01	5.93	5.94
12	1758.27	1.01	47.95	0.01	5.51	5.47
13	1686.58	1.37	47.28	0.02	5.06	3.69
14	1809.71	1.30	48.29	0.02	3.51	2.70
15	1211.02	1.21	46.36	0.02	2.26	1.86
16	797.07	1.06	42.81	0.02	1.79	1.69
17	187.67	1.06	36.32	0.04	0.64	0.60

Photosynthesis and age of oil palm leaves: The photosynthetic rate was highest in the 5th leaf followed by 3rd leaf, but did not differ significantly among the different leaves. A comparison of the 9th, 17th and 25th leaf photosynthetic rates have indicated that there are not much variations amongst them (Table 39 and Fig. 11.4). Similarly the transpiration rates and stomatal conductance to the diffusion of CO2 were higher in the younger leaves and decreased with increase in the age of the leaf. The leaf area among the different leaves, which has not been given in the table ranged from 1.24 to 1.78 sq.m. The highest leaf dry weight was recorded in the 6th leaf and lowest in the 24th Leaf dry weight was more in the younger leaves and decreased with increase in leaf age. The rachis length ranged from 3.62 to 4.30 m. There was no consistent trend in the rachis length with age of the leaves. The specific leaf weight calculated from the leaf area and leaf dry weight, ranged from 1.02 to 1.74. Little variations were observed in the leaf Nitrogen contents with highest in the 8th leaf and lowest in the 23rd leaf. Higher leaf N contents were recorded in the younger leaves, while older leaves had lesser contents. A look at the relationship of the photosynthetic rate with that of other leaf characters indicated that photosynthetic rate is positively correlated with leaf N content, leaf dry weight and Specific leaf weight. I t was also positively associated with transpiration rate and stomatal conductance.

Fig 11.4. Photosynthesis and age of oil palm leaves under irrigated conditions

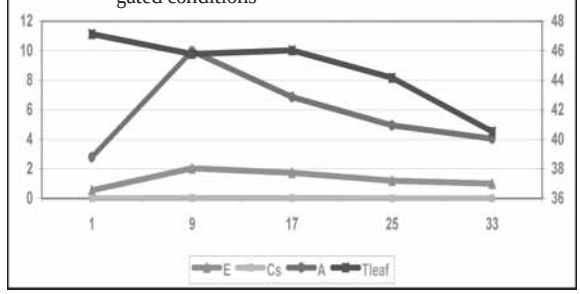


Table 39. Photosynthesis and age of oil palm leaves

Leaf No.	PAR umol/sq.m/s	E mmol/sq.m/s	Tleaf oC	Cs mol/sq.m/s	A umol/sq.m/s
1	1892.56	0.546	47.13	0.01	2.79
9	1827.71	2.04	45.77	0.03	9.98
17	1878.17	1.75	46.03	0.03	6.87
25	1646.09	1.21	44.17	0.02	4.95
33	1216.56	1.01	40.52	0.02	4.04

The leaf area and leaf N contents were also positively correlated. Finally the results indicated that the leaf of oil palm remain photosynthetically active through out their life and thus explains the high harvest index and yields obtained from oil palm under irrigated conditions. In another experiment, the photosynthetic rates of the 1st, 9th, 17th, 25th and 33rd leaf were recorded and it also followed similar trend. The photosynthetic rate was more in 9th leaf followed by 17th leaf and decreased with the age of the leaf. Transpiration rate and stomatal conductance also followed similar trend. Leaf temp decreased with increase in age of leaf.

SEED TECHNOLOGY RESEARCH

Effect of pre-heating and its intervals on germination: Freshly harvested Seeds were heat treated for different periods from 0 to 90 days at a temperature of 39-40^{0}C at 10 days intervals (Table 40). All the heat-treated seeds were subjected to dry heat dormancy breaking method and observed for initiation of germination, days to complete germination, and germination at four days interval and total germination. The duration of heat treatment in relation to germination was high at 60 and 70 days (93.0 & 94.8%). These periods have stimulated germination six days after incubation and reached 93 to 94 per cent within 18-22 days after incubation. Interestingly, the heat period of 50 d also resulted in satisfactory germination (90.4) than pre-heating periods of 40 d (64.4 %) and 30d (31.9%). In case of days to first germination, heating periods of 50, 60, 70 and 80 days took less time viz., 29, 22, 18 and 22 days after incubation, respectively than 30 (79d) and 40(60d). From this experiment, it was confirmed that seed soaking for five days and thermal dry pre-heat treatment for 60-70 days followed by five days soaking of *dura* seeds found to be optimum to get maximum germination of 94 per cent.

Effect of extended dry heat treatment on seed germination and seedling growth : The differences in germination capacity of different dura mother palms are evaluated in the laboratory and field nursery. Dura seeds were subjected to dry heat treatments at 40° C for 75, 85 and 95 days heating durations and days to initiation of germination, days to final germination and total germination were recorded. Field emergence and dry matter production were recorded under preliminary nursery condition. Seeds of mother palm numbers 633 and 703 found to initiate early germination and able to complete total germination also early. Due to extended dry heating duration reduction in germination, field emergence and dry matter of seedlings were noted in all the mother palms selected for present study. Palm numbers viz., 633,703,715 and 1488 were able to maintain satisfactory germination even after 95 days of heating duration. The palm number 1502 showed poor germination in all the heating durations. Repeatability for above observation will be continued.

Use of chemicals to accelerate germination: Though Sodium Cyanamid (2.5%) stimulated germination, it was found unsuitable as they caused irritation to workers. Soaking in Ethephon of 1.5 & 2.0% stimulated germination after 20 days of treatment and reached 80 per cent germination within 50 days. Soaking in Sulphuric acid 12 % for 20 min stimulated germination but resulted in abnormal seedling development.

Use of microbes: Oil palm fronds colonized by native fungi (Fig. 12) were brought from seed garden; Rajahmundry. This isolation was incorporated into finely shredded oil palm fronds

Fig. 12. View of growth of fungus on oil palm shredded fronds

Table 40. The capacity and rate of germination of *dura* seeds at different period of heat treatments under ambient temperature

Heating duration (days)	Days to initial germination	Days to maximum germination	Final germination	Flush germination (%)
0	-	-	-	-
10	-	-	-	-
20	-	-	-	-
30	7	79	7.5	32
40	4	76	32	64.4
50	9	29	88.3	90.4
60	6	22	93	93.6
70	6	18	94.8	94.8
80	6	22	53.7	53.7
90	8	32	61.7	62.8

and kept in buckets for incubation. The dura seeds were treated with these inoculums.

Initial observation indicated that treated seeds that received fungal treatment along with shredded media initiated germination after 28 days of incubation and the control seeds started germination after 60 days. The treated seeds produced sprouts, which were healthier than the untreated seeds sprouts.

Biochemical analysis of heat-treated seeds: Seed samples were treated at temperature of 40°c for 90 days and samples were collected at 10 days intervals (9 treatments and 1 control - '0'-day). Soluble proteins from each sample were estimated from both endosperm and embryos of the seeds to observe the change due to heat treatment. Endosperms were defatted and subsequently the soluble proteins were measured. SDS PAGE pattern for the soluble protein were also performed.

Results showed that soluble proteins in the embryo were more than that of endosperm (Fig. 13). In the endosperm, there was a gradual increase in soluble protein content and subsequently decreased during the different periods of heat treatment. Soluble protein in embryo did not show any trend. SDS PAGE pattern were not clear and no proper band was observed might be due to degradation of the protein.

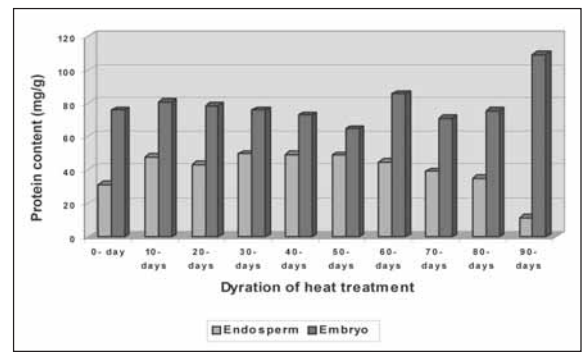


Fig. 13. Soluble protein content in endosperm and embryo of heat treated seeds

Fig. 1. Anthurium as an intercrop

Fig. 2. *In situ* vermicomposting of prunned leaves

Fig. 3. Multi species cropping system

Fig. 4. Pepper on glyricidia as mixed crop

Fig. 5. Cinnamon as mixed crop

Fig. 6. Black pepper trailed on oil palm

4. Research Achievements

Pest and Disease Management

नाशी – कीड़ा एवं बीमारी प्रबन्धन

PEST MANAGEMENT

Survey: Survey was carried out in the Oil palm gardens of Krishna, West Godavari, Visakhapatnam, Vizianagaram, East Godavari, Nellore districts of Andhra Pradesh and Rayagada district of Orissa. Rhinoceros beetle was observed as the predominant pest in all the gardens surveyed. Incidence of psychid and slug caterpillar was observed as alarming in the aged gardens. Incidence of leaf eating caterpillar was observed in West Godavari and Krishna districts during the winter months. House crow, Jungle crow among birds in Krishna district, parakeets in West Godavari district, mynah in Vizianagaram district were found predominant avian pests causing moderate to heavy damage. The incidence was observed moderate to heavy with 100% infestation in some gardens. Incidence of Rhinoceros beetle was observed highest in young palms during monsoon period and low to very low during summer months.

Incidence of avian pests was observed at moderate to heavy levels in Krishna, West Godavari and Nellore districts and low to moderate levels in the other districts of Andhra Pradesh. The per cent infestation was observed at 40-45% in the scattered gardens. Glue sticky traps were tested and found ineffective in controlling the avian pest damage. Application of sticky glue on the petiole region of FFB leaf was also not found effective. Hanging of fishnets in between two palms at 3ft above ground at random places was found effective in controlling the bird menace.

Incidence of leaf eating caterpillars on Oil palm was observed at low to moderate level. Incidence was also observed on cocoa, which is grown as intercrop in Oil palm. The cocoa leaves that were infested by the pest were dried and prematurely dropped. This indicates that the insect is releasing some toxins, which damage the entire leaves. No natural enemy was found causing mortality of the pest in any of the areas surveyed.

Investigations carried out on the slug caterpillar incidence on Oil palm as well as cocoa indicated that the pest which was migrated from coconut to Oil palm is now migrating to cocoa which is being grown as intercrop in both coconut and Oil palm. The symptoms observed on cocoa reveal that the leaves eaten by caterpillars are drying and dropping prematurely which is not seen in Oil palm.

Survey for leaf eating caterpillars and their natural enemies: Survey for leaf eating caterpillars of Oil palm was carried out in the Oil palm gardens of Krishna, West Godavari, Visakhapatnam, Vizianagaram, Srikakulam, East Godavari and Nellore districts of Andhra Pradesh.

Incidence was observed at low to moderate level. Incidence was also observed on cocoa, which is grown as intercrop in Oil palm. The cocoa leaves that were infested by the pest on have become dried and prematurely dropped. This indicates that the insect is releasing some toxins, which damages the entire leaves. No natural enemy was found causing mortality of the pest in any of the areas surveyed.

Survey for avian and mammalian pests of Oil palm was carried out in the Oil palm gardens of Krishna, West Godavari, Visakhapatnam, Vizianagaram, Srikakulam, East Godavari, Nellore districts of Andhra Pradesh. Incidence of avian pests was observed at moderate to heavy levels in Krishna, West Godavari and Nellore districts and low to moderate levels in the other districts of Andhra Pradesh. The percent infestation was observed at 40-45% in the scattered gardens. Glue sticky traps were tested and found ineffective in controlling the avian pest damage. Application of sticky glue on the petiole region of FFB leaf was also not found effective. Hanging of fishnets in between two palms at 3ft above ground at random places was found effective in controlling the bird menace.

Crows did not try to come into the orchard thus reducing the incidence. The percent

infestation, which was observed 88.9% before the initiation of the trial, receded to 19.8% within two months of the adoption of control measures. However the study also observed that there was a necessity to change the place of the nets at frequent intervals, which other wise the infestation, was again increased to 26.9%. This was mainly because that the birds were found not coming nearer to the net places because of suspicion. Sticky glue traps that were tied on the FFB base leaf were not found effective. The birds did not stick on the glue trap as they changed their position of eating. The size of the holes in the nets should be changed based on the species of birds available in the area with small sized ones for parakeets and mynahs and big sized ones for crows.

Among mammalian pests, rodents were observed as the major pest. However during the reported period incidence and infestation of rodents was observed very low in all the areas surveyed which could be due to the existence of drought.

Control Measures : Trials were laid to test the efficacy of different chemicals against slug caterpillar. But due to lack of sufficient population the trials did not yield any concrete results. All the chemicals were found superior over control and the pest was controlled effectively in all the treatments. This could be due to the efficacy of the chemicals or due to environmental conditions that were not conducive for the pest population. Similarly the trials on leaf eating caterpillars and mammalian pests couldn't be taken up because of lack of population.

Trials were carried out on the control of the pest using microbial agents namely *Metarhizium anisopliae* and *Beauveria bassiana* that cause green muscardine and white muscardine diseases against the pest species. *Beauveria bassiana* was found effective in controlling the pest after 7 days of the treatment. The infection was observed profuse even at 10^{-3} concentration. The multiplication rate of the fungus was observed highest in the Potato Dextrose broth (7.94 X 10^2 units/ml) followed by Groundnut broth (2.17 X 10^2). Spore count on Coconut water was found least and not fit to use for multiplication. Application of *Beauveria bassiana* spores extracted from PD broth and mixed with talc powder with a spore count of 5.05 X 10^2 showed good results in controlling the caterpillar compared to the green muscardine fungus.

Growth studies of green muscardine fungus on different media: Application of commercial formulation of green muscardine fungus on the crown region of the Oil palm plants using power sprayer proved effective in arresting the beetle incidence for six months. Application on FYM pits and coconut logs proved effective in reducing the pest population in the breeding sites. Application of Green muscardine fungus, *M. anisopliae* and *Trichoderma viride* to the vermicompost units to study their effect on the earthworms revealed that microorganisms did not cause any negative effect on the test species and were found on par with the control plots. Commercial formulation of the product was supplied to different Oil palm growers for further multiplication and spread into the plantations.

Compatibility studies with *Trichoderma viride*: Compatibility studies revealed that no antagonism was found in between *Metarhizium anisopliae* and *Trichoderma viride* when applied to PDA media indicating the compatibility of the fungi to each other. The effect of pH of the culture medium on the growth of the fungus was studied using different pH levels. It was observed that higher growth of the culture was found at neutral pH (7) followed by pH 6. No growth was recorded at pH level 2 and least was recorded at 12. Selectivity studies were carried out on the growth of the fungus in different insecticide and fungicide media to find out the effect of pesticides on the fungal growth. Percent cessation of the fungus was calculated using the formula C-T/CX100. From these studies it was found that all the fungicides tested except copper oxy chloride recorded 100 per cent cessation of fungus. Only copper oxy chloride was found relatively safe compared to all other fungicides.

Among insecticides tested, cypermethrin and fenvalerate were relatively safe compared to other insecticides.

Production of commercial formulations: Commercial formulation of fungi was prepared on both maize grains as well as on magnesium carbonate (talc powder). Spore count in talc formulation was carried out using plate count and spore count methods. In the plate count method it was observed that the number was increased from 2.8 X10 ^{4} at 30 days after inoculation to 3.1 X 10^4 at 60 days. This indicates that the spore number has increased in the base media from the date of inoculation up to 60 days period. In the other experiment carried out to find out the best age of the culture for commercial preparation in talc formulation, it was observed that 14 days old culture was found better producing higher number of spores compared to 7 days old culture. The spore count when observed using haemocytometer and plate count studies was found more in the 14 days old treatment irrespective of different media. Among various media compared, potato dextrose broth recorded highest number of spores followed by PDA media. The lowest was recorded in dextrose and sucrose broths with 14 days and 7 days old culture respectively. Similar results were also obtained in the plate count studies indicating the conformity of the results. Talc formulation was found cheaper and easy for application compared to maize grains. Commercial formulation of the product was supplied to different Oil palm growers to use it by mixing with vermi-compost. Data on results of the demonstration are yet to be collected.

Disease Management

Survey on diseases and disorders: Survey on diseases and disorders was carried out in few plantations of Goa, West Bengal, Assam, Tripura, Andhra Pradesh and Kerala. Significant observations were recorded at BSR at Mohitnagar and Rajahmundry. Monitoring disease incidence in different experimental fields at Palode revealed BSR incidence on three palms and SRD on three palms. Similar survey at Pedavegi revealed 11 orange spotting, 3 bud rot and four stem wet rot affected palms. Two out of four SWR affected palms recovered after treatments. The eleven treatments of the IPM trial on BSR involving – Trichoderma, calixin, Zinc Sulphate, Garlic and their combinations with three replications were continued on the BSR affected palms and the surrounding palms, which are more prone to soil borne diseases. Prepared trench to the BSR affected palms and evaluated sample of fallen BSR palms. The pattern of disease spread and symptoms remission/progression were recorded. Six *Ganoderma* isolates from oil palm garden (Palode) were maintained by sub-culturing. After *In vitro* biomass degradation studies last year, the isolates were subjected to DNA extraction and RAPD analysis with 29 primers.

Conducted survey on incidence of Basal Stem Rot (BSR) in Rajahmundry, Makinavarigudem, Jagannathapuram, Pedavegi of Andhra Pradesh, Regional Station of Palode of Kerala and Mohithnagar of West Bengal. The incidence was below 1% in most of the plantations. However in Mohithnagar plantation incidence of 2.08% (3/144) was observed probably due to the presence of viable inoculum of areca BSR.

Molecular characterization of *Ganoderma* isolates from oil palm: Six *Ganoderma* isolates from oil palm garden (Palode) were maintained by sub-culturing. The isolates were subjected to DNA extraction and RAPD analysis with 29 primers. A total of 203 polymorphic bonds (97.7%) are produced. The RAPD patterns were highly polymorphic and all the primers produced polymorphic bands. Representative photographs are shown in Fig.14.

Data analysed by UPGMA method and a wide variation was clear among the different isolates (Fig. 15 & 16). Maximum similarity was found only 77.1% between G1 and G2 isolates. The isolates did not any distinct cluster but showed their individuality. However the above two isolates (G1 &G2) were more similar to G6 followed by G2 and G3 isolates. G4 was far apart from others and

Fig. 14. Representative RAPD pattern of six *Ganoderma* isolates, using different random primers

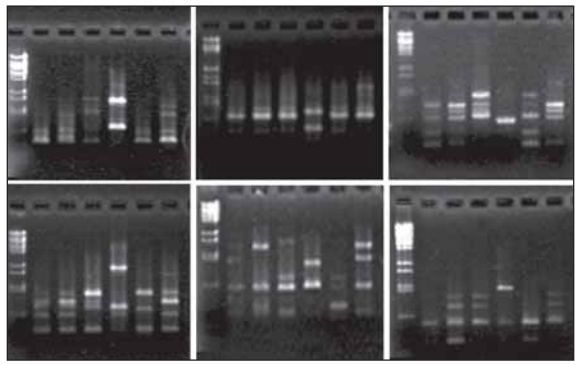


Fig. 15. Dendrogram derived from RAPD data of six isolates using UPGMA method

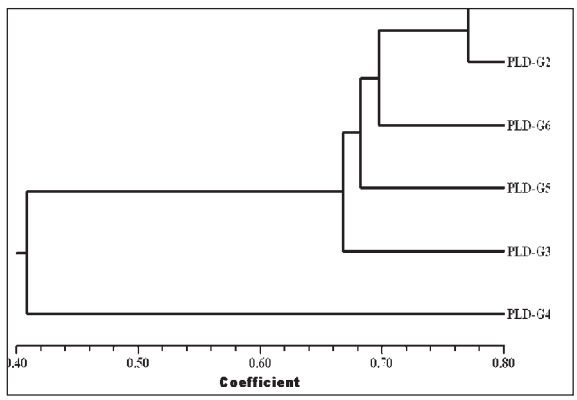
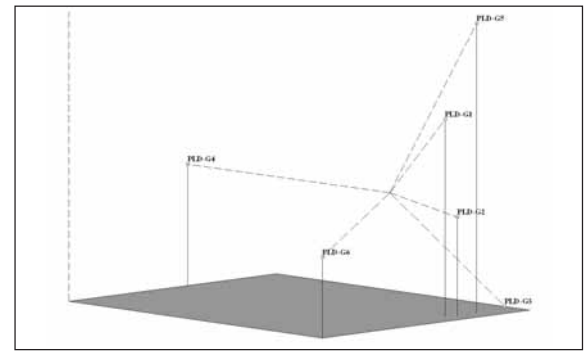


Fig. 16. PCA derived from RAPD data of six isolates using UPGMA method



the similarity percentages ranged between 34.4-45.0% (between G4 and other isolates).

These results of biomass degradation and RAPD study would be analysed with the previously conducted studies with 12 other isolates of Ganoderma, which would help in a better interpretation.

Brackets and tissues of roots and stem from affected palms were plated and the microorganisms were isolated. The six isolates of *Ganoderma* isolated from 11 samples are being identified by molecular studies. The six *Trichoderma* isolates from the infected samples are being identified.

4. Research Achievements

Post Harvest Management

कटाई-उपरान्त प्रौद्योगिकी

FARM MECHANISATION

Mobile Oil Palm Waste Shredding Unit : Oil palm waste shredder is a device, which cuts fronds as well as EFB into small pieces, and aid in their smooth handling and processing. A mobile oil palm waste shredding unit was designed and developed. The unit consisted of a chaff cutter with specially designed blades fitted to the trailer of a power tiller. The power from the power tiller flywheel was taken through a specially designed power take off mechanism and V belts. The discharge of the shredded waste is towards the rear side of the trailer while the feeding is done from the side. The machine was evaluated for its performance to shred oil palm fronds scattered in plantations and compared with that of a stationary unit (Table 41). The total cost of the machine along with a 12HP power tiller is Rs.1.5 Lakhs.

BY-PRODUCT UTILISATION

Briquetting, gasification, production of pulp and paper products *etc*. are some of the technologies for the utilization and disposal of agricultural wastes. These technologies not only help in environmental friendly disposal of wastes but also generate additional income to the farmers.

Briquetting of Oil Palm Empty Fruit Bunch (EFB): Briquetting is a process of converting loose wastes into compact agglomerates with or without addition of binder. The briquetted wastes are used as replacement for fire woods for domestic as well as industrial purposes. Briquettes can be stored and transported easily and economically since they occupy lesser volume than raw biomass. Briquetting of oil palm EFB to use as fuel is promising. A preliminary study was carried out in both screw type and piston type briquetting machines to assess the scope of the EFB briquetting process. The shredded EFB with and without mixing with cow dung were briquetted in a screw type briquetting machine without applying external heat. It was observed that even without the addition of cow dung as binder, briquettes were formed due to melting of lignin at higher temperature in the barrel due to frictional force. The shredded EFB samples were briquetted in a thermal jacketed piston by applying hydraulic force. Since the screw press process is fast and requires no external heating, this would be more suitable for continuous process. It was observed that the briquetting of shredded EFB is promising and studies need to be undertaken for design and developing a machine suitable for briquetting shredded EFB.

Paperboards from Oil Palm Wastes : A study was conducted on the pulping characteristics of EFB and frond wastes. The fronds and EFB were cut into pieces and 5 kg each of samples were soaked in water overnight in separate vessels. The soaked samples were cooked for 4 hours by adding 2% caustic soda. The cooked and digested samples were pulped in a baby beater by adding 2% rosin, 1% china clay and 1% sodium silicente. Pulps from cotton waste and waste paper were prepared in a similar way and mixed with the frond and EFB pulps in different proportions. Paperboards were made from these pulps in an autovating machine,

Table 41. Performance comparison of mobile and stationary shredding units

Parameters	Mobile shredding unit	Stationary shredding unit
Capacity	01ha/hr	0.1ha/hr*
Power requirement	12 hp	7.5hp
Operational cost	Rs.160/- per hour	Rs.225/-per hour
Fuel consumption.	3.0 liters/hr	2.5liters/hr

* If the unit is fixed within plantation.

dewatered in a hydraulic press and dried in sun for one day. The dried paperboards were pressed in a calendaring machine to get a smooth finish and cut into 10 cm x 10cm pieces. The thickness of boards was measured with micro gauge. The weight of unit area of the boards was found and based on this GSM was calculated. The pulp samples were analyzed for moisture content. The observations are tabulated in Table 42 and Table 43. Paper files were made from these boards cut into suitable size. It is concluded that smooth boards suitable for making paper files, cartons, packaging material etc. can be prepared from EFB wastes.

Gasification of Oil Palm Wastes: A preliminary study was conducted to assess the suitability of oil palm fronds and EFB for gasification. Oil Palm fronds are cut into a size of 5 cm and dried to a moisture content of 10 per cent (w.b). Empty fruit bunches were shredded into loose fibres and dried to a moisture content of 8 percent (w.b). The samples were loaded in a down draft gasifier and fired. The producer gas obtained in the burner attached to the gasifier was fired to get clear flame. The flow of the material inside the gasifier was assessed based on the combustion of the producer gas. Good material flow results in continuous gas flow and hence clear flame. The fronds of 5cm size were found flowing continuously in the down draft gasifier and resulted in a continuous and clear flame. But the shredded EFB due to its low density resulted poor flow and hence resulted interrupted flame. Hence it is concluded that fronds cut into a size of 5 cm is suitable for gasification in a down draft gasifier, while shredded EFB requires densification pre treatment to improve the flow characteristic.

Cooling Pad from Oil Palm EFB Fibre: Cooling pads are used in a variety of applications like control of temperature and humidity in green houses, living rooms, evaporative cooling chambers etc. The porous structure of cooling pad holds water and circulation of air through or around the pad causes evaporation of water. This in turn reduces temperature and enhances humidity. Natural fibers are preferred for the purpose due to less disposal

Table 42. Characteristics of EFB pulp

S. No.	Sample	GSM (g/m^2)*	Board Thickness, mm	Pulp moisture content % w.b
1	EFB 1 (100% EFB)	332.7	0.65	85.7
2	EFB 2 (75%EFB+12.5% Paper wastes+25% Cotton wastes)	424.9	0.62	88.9
3	EFB 3 (50%EFB+25% Paper wastes+25% Cotton wastes)	479.4	0.68	71.5

*7.2 liters pulp in 1.11m´0.75m area

Table 43. Characteristics of frond pulp

Sl.No.	Sample	GSM (g/m^2)*	Board Thickness, mm	Pulp moisture content % w.b
1	Frond 1	—	—	80.0
2	Frond 2	539.1	0.85	66.6
3	Frond 3	492.0	0.91	80.0

*4.8 liters pulp in 1.11m´0.75m area

-- Boards could not be formed.

Frond 1 : 100% Frond

Frond 2 : 75%Frond+12.5% Paper wastes+25% Cotton wastes

Frond 3 : 50% Frond +25% Paper wastes+25% Cotton wastes

problems. Oil palm EFB are cheap and available in bulk compared to other sources of natural fibers. Since the extraction of EFB fiber is mechanized, fiber production is easy and cheap. Hence a study was conducted to assess the performance of EFB cooling pad on concrete terraces to control the room temperature in summer months. Cooling pads were prepared from EFB fibres, extracted using EFB fiber extractor. Fibers were placed in between GI wire nets of 1 cm mesh size to form 3.0 cm thick pads. These pads were spread on building terrace to cover the area uniformly. The pads were wetted to saturation every day at 9.30 hrs. The temperature and humidity inside the room was monitored daily from 9.30 hrs to 18.30 hrs at an interval of 1 hour. The temperature and humidity inside a similar room without cooling pad covering along with atmospheric temperature and humidity were also monitored regularly during the same time. It was observed that the room temperature was reduced by 3°C and humidity was increased by 20 per cent by using the cooling pad. The EFB cooling pads (Fig. 17.1 & 17.2) have to be tested for their performance in environmental control in green houses in a similar way.

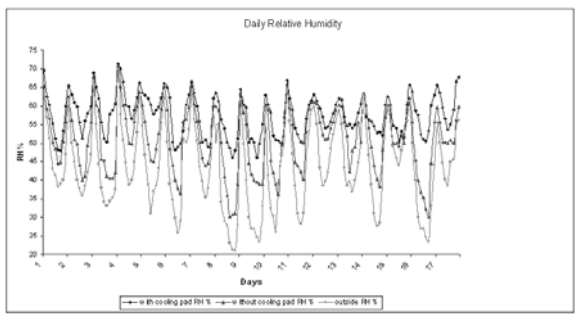


Fig. 17.1. Effect of cooling pad on relative humidity

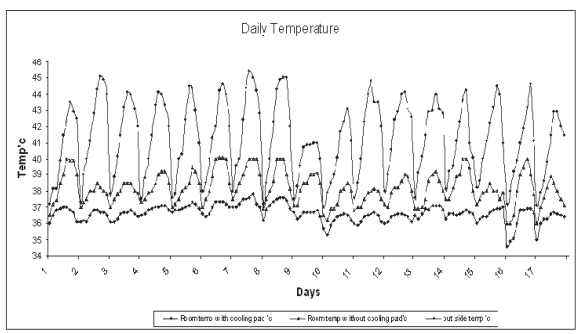


Fig. 17.2. Effect of cooling pad on room temperature

Stability study of the extracted carotenoids: Extracted pure carotenoids were concentrated and mixed with Rice Bran Oil and Olive Oil at a ratio of 1:2 (carotenoids: Oil) and stored at Deep Fridge (-20°C), Fridge (4°C), Room Temperature (Approximately 30°C) and In dark at room temperature. The samples kept in deep fridge and fridges were in dark condition. Pure carotene was also kept in these conditions along with the diluted samples.

The carotenoids content for each treatment was estimated every week for a period of 20 weeks. It was observed that the loss of carotenoids content per gram of material was minimum when it is stored at 'pure form'. Among the different conditions of storage for 'pure form', Deep fridge storage showed minimum degradation followed by 'in dark at room temperature". In the diluted samples, carotenoids degradation was minimum in diluted with Rice Bran Oil and stored in freeze. Except this sample, considerable amount of degradation was observed in all the other diluted samples at different conditions.

Gradual decrease in carotenoids content was normally observed, however, in case of pure carotene, it was not so in case of deep freeze storage mainly because crystal formation, which interfered the reading.

A cost and time saving indirect method of oil estimation developed: In the present study, known amount of oil palm mesocarp was put inside a pouch of Whatman No.3 filter paper and several such pouches were put in one big size Soxhlet apparatus for oil extraction as against putting single pouch in single soxhlet apparatus in the conventional direct oil estimation. Subsequently oil content was measured from the difference in weight of the pouch before and after extraction fifty from mesocarp samples (same sample) was extracted by the new and conventional methods.

No significant difference in percentage oil extraction was observed, even at 1% probability level, between the two methods of oil estimation (Fig. 18). A large size extractor of 2-litre size could

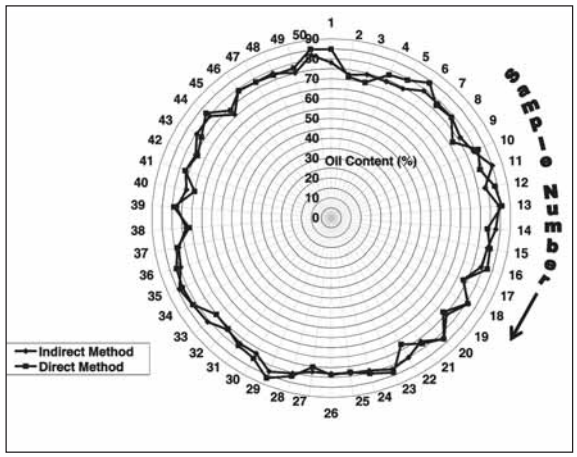


Fig. 18. Comparison between the direct and indirect methods of oil extraction

extract minimum 50 samples at a time and thereby reduced the time considerably. Moreover, since the mixture of oil from different samples collected with the solvent at the flask needed no attention, the solvent could be recovered by distillation and reused. The new process is being followed at present for extraction of oil to evaluate palms at this Centre and may be attempted for other oil seed crops also.

Reuse potentiality of better performing adsorbents: After recovery of the carotenoids, six best adsorbents were dried in oven at 100^{0}C over night and reused to estimate their efficiency. The adsorbents were Fuller's earth, Charcoal, Carbon granules, Kieselguhr white, Kieselguhr and kaolin. Fresh fuller's earth showed a significant higher adsorption than that of reused one. However, no significant difference in recovery from the adsorbents and net recovery was found between the Fresh and reused Fullers earth, though average recovery from the adsorbent was higher. In all the other cases there was no significant difference found between the Fresh and reused adsorbents. This experiment indicates that the Fuller's Earth can successfully be reused for extraction of carotenoids from Crude Palm Oil.

Use of synthetic adsorbents for extraction of carotenoids from CPO: Nine different synthetic adsorbents from Mitsubishi Chemical Corporation, Japan namely Diaion HP 20, Diaion UBK555, Diaion UBK530, Diaion PA308, Diaion PA408, Sepabeads Sp850, Sepabeads Sp825, Diaion HP2MG, Diaion HP20SS were used as in the case of other adsorbents for extraction of carotenoids. Fuller's earth, the so far best adsorbents for extraction of carotenoids was used as control. Adsorption from the oil was significantly higher in case of Fuller's earth than that of all the synthetic adsorbents. There were no significant differences in adsorption capacity among the synthetic adsorption.

Recovery from Diaion HP 20 was significantly higher than that of other adsorbents and this was followed by Diaion HP2MG, which was on par with Sepabeads Sp850 (58.58%). Lowest recovery was found in Diaion UBK555, which was on par with Diaion UBK530. Fuller's earth showed medium recovery value.

Net recovery was found highest with fuller's earth and it was significantly higher than the synthetic adsorbents mainly because of its adsorbing capacity. Among the synthetic adsorbents, Diaion HP 20 showed maximum net recovery followed by Diaion HP2MG and they were on par.

UTILISATION AND RECYCLING OF PALM OIL MILL EFFLUENT (POME)

Settling Characteristics of POME: Treatment plant for POME essentially requires balancing tank, settling tanks, intermediate tanks etc. for regulating the flow, to remove or recover oil and sludge particles, temporary storage etc. Settling and sedimentation characteristics of POME need to be studied for designing of these tanks. Hence a lab scale settling and sedimentation tank of 75 cm depth was designed and fabricated for conducting studies on the settling characteristics of POME. The total solid sludge and residual oil were estimated and percent oil and sludge removal/accumulation at different depths over different time intervals were recorded (Fig. 19.1 & 19.2).

Isolation and identification of Predominant Microorganisms from POME: Palm oil mill effluent is nothing but the oil palm fruit pulp

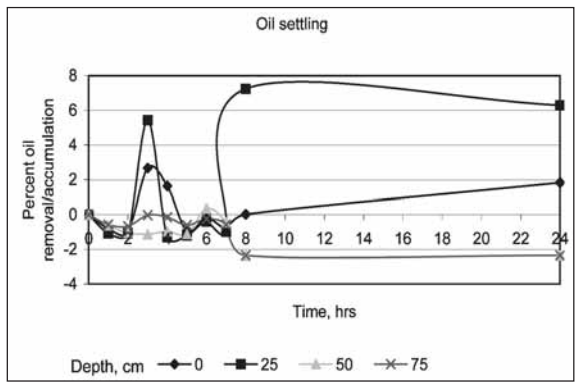


Fig. 19.1. Oil settling characteristics

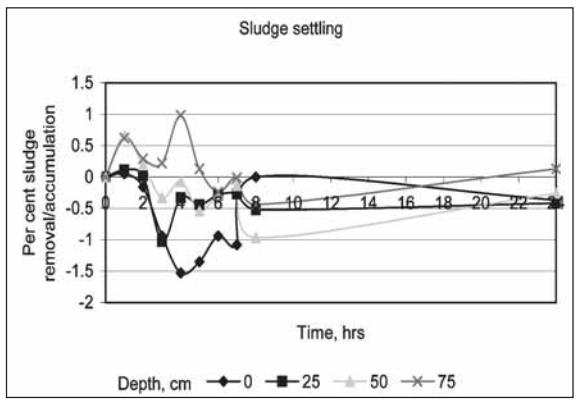


Fig. 19.2. Sludge settling characteristics

washout left after oil extraction and recovery. It greatly nourishes the microbial flora since it is rich in organic nutrients and contains no chemicals. Enumeration of bacteria and fungi present in the POME under treatment as well as raw effluent shows the organic strength of the effluent, which in turn affects the BOD values, which is an important parameter in defining the quality of the effluent. Further more their variation in population was noted in various stages of treatment process followed by the mills. The enumeration of microorganisms was performed by standard plate count method. Fungal and microbial load in POME collected from various treatment points is presented in Tables 43 and 44.

The predominant species of microorganisms including Fungi and Bacteria were isolated by means of serial dilution technique and were grown on Czapek- Dox agar and nutrient agar respectively. They were distinguished according to their morphological features and were subjected to identification. The fungal species identified from

Table 43. Fungal load in POME collected from various treatment points

S. No	Sample	Avg. colony forming units
1	Fresh POME, Mill-IV	11.43×10^3
2	Balancing tank, Mill-III	8.72×10^3
3	Holding tank, Mill-II	399.33×10^3
4	Aerobic pond, Mill-I	1295.33×10^3
5	Anaerobic pond, Mill-I	580.36×10^3
6	Facultative pond, Mill-I	574.72×10^3

Table 44. Bacterial load in POME collected from various treatment points

S. No	Sample	Avg. colony forming units
1	Fresh POME, Mill- IV	0.53×10^5
2	Balancing tank, Mill- III	296×10^5
3	Neutralization pond, Mill- II	102×10^5
4	Facultative pond, Mill- II	509×10^5
5	Aerobic pond, Mill-I	548.43×10^5
6	Anaerobic pond, Mill-I	63.43×10^5
7	Facultative pond, Mill-I	1173.66×10^5

Note : ETP in Mill- I consists of Anaerobic, Facultative and aerobic ponds only.
ETP in Mill- II consists of holding, Anaerobic, Facultative, aerobic and, Neutralization ponds.
ETP in Mill- III consists of balancing tank only.

POME are *Aspergillus flavus, Beavaria bassiana, Cladosporium cladosporioides, Cladosporium herbarum, Curvularia lunata var.aceria, Curvularia lunata* and *Fusarium equiseti*

The identification of bacteria is being made and it would helpful in selecting ideal microorganisms having rapid organic degradative capability.

Nutrient composition of Palm Oil Mill Effluent: In view of formulating fish and animal feed from POME, samples were collected from different treatment points in various mills and found that the decanter sludge, which is in solid form, can be incorporated in the feeds of the animals. These samples were subjected to proximate analysis. The solid portion of decanter sludge contained 17.25 % of crude protein on dry matter basis. Nutrient Composition of Decanter Sludge, Palm Kernel Cake and Palm Press Fibre are presented in Table 45. Higher level of iron was observed in sludge compared to PKC and PPF.

Formulation of POME based animal feeds: On the basis of crude protein content of POME, three concentrate mixtures have been formulated which contained the Palm kernel cake (PKC) also as one of the feed ingredients for feeding of ram lambs to study the acceptability and growth rate of lambs.

It has been observed that the weaned piglets are fed with rice bran based feeds locally. To reduce the cost of feeding of piglets, it has been planned to replace the rice bran with dehydrated POME at various levels in the diets of weaned piglets.

Table 45. Nutrient Composition of Decanter Sludge, PKC and PPF

S. No	Sample	P (%)	Ca (%)	Mg (%)	Cu (ppm)	Zn (ppm)	Fe (ppm)
1	D.C. Sludge, Mill-II	0.336	0.701	0.646	14.31	18.35	2361.28
2	D.C. Sludge, Mill-IV	0.313	1.262	0.500	17.05	33.29	2824.14
3	PKC, Mill-II	0.256	0.122	0.299	26.73	47.52	615.38
4	PKC, Mill-IV	0.384	0.137	0.335	30.97	28.19	670.14
5	PPF, Mill-II	0.134	0.293	0.186	16.44	32.68	107.18
6	PPF, Mill-IV	0.161	0.344	0.283	9.12	13.92	161.28

PPF- Palm Press Fiber; PKC- Palm Kernel Cake

OIL PALM POST HARVEST MANAGEMENT

Fig. 1. Mobile Oil Palm Waste Shredder

Fig. 2. Briquetting of shredded EFB

Fig. 3. File making from EFB paper boards

Fig. 4. Cooling pad from EFB fibres for environmental control over terraces

Fig. 5. Lambs feeding with POME based diet

Fig.6. Piglets feeding with POME based diet

Fig. 7. Gasification of oil palm wastes

Fig. 8. Settling profile of Palm Oil Mill Effluent

4. Research Achievements

Social Sciences

सामाजिक विज्ञान

TRANSFER OF TECHNOLOGY

CRITICAL ANALYSIS OF TRAINING OF TRAINERS PROGRAMME IN RELATION TO OIL PALM GROWERS KNOWLEDGE AND ADOPTION PATTERN

Cent percent of the trainees perceived that training is beneficial. Majority of them felt that subject matter taught is relevant; they are in medium to high knowledge category. Trainees are diffusing the technology either through individual or group contacts or using both. Trainers are organizing farmers group meetings, trainings, awareness campaigns, study tours and distributing literature/ publicity material to the farmers. Trainers perceived that they need refresher courses once or twice in a year for duration of three day to one month. They opined that training venue can be either at NRC for Oil Palm or local place or convenient place to them. Suggested topics for future training are oil palm production technology in detail, irrigation & nutrient management, intercropping, harvesting of oil palm FFB, leaf analysis, pest and disease management etc.

The majority of the trained farmers (74) were marginal farmers and reported that they were not much aware about oil palm before training, felt training is beneficial. Indicated that they learnt about oil palm in oil palm production technology training. They opined that extension officials are visiting their farms at monthly or fortnightly interval; they are in high knowledge category and in medium adoption category; getting low yields (<11.25 t/ha). Majority of trained farmers are not willing to go for area expansion due to lack of sufficient irrigation facilities and power problems. They perceived that irrigation, power supply and harvesting are the major problems in oil palm cultivation. They are partially satisfied with the training offered. Perceived that beneficial topics in the training are production technology, harvesting, irrigation & nutrient management, pest management and intercropping. They wanted to have refresher course on harvesting of oil palm FFB in tall plantations, intercropping, irrigation and nutrient management etc. Farmers felt duration of the training is sufficient. They indicated to have training at NRC for Oil Palm/oil palm garden/ factory site/in their village during January/February.

TECHNOLOGY ASSESSMENT & REFINEMENT THROUGH INSTITUTE VILLAGE LINKAGE PROGRAMME

High Yielding Varieties of paddy were introduced in place of low yielding local varieties. These varieties not only gave better yields but also reduced the cost of cultivation. Of the four varieties that were introduced, MTU 1001 was found promising and increased the yield 25% compared to local variety. This paved the path for seed village concept for the multiplication of varieties for their future use and this had created good impact in the farming community. Application of recommended doses of pesticides in paddy at right stage have reduced the pest & disease incidence and increased the yield by 16%. By adopting integrated nutrient management in paddy farmers got 22% more yield. Adoption of recommended pesticides against tobacco caterpillar and use of NPV reduced the pest incidence and got higher (20%) yields. The quality of the product was also good. Application of recommended dose of fertilizers in oil palm resulted in increase in FFB yield by 17% over the farmers practice. Health of the buffaloes was improved to a great extent after administering the vaccine, there was an overwhelming response from the farmers to this intervention. By using the fish fingerlings in the community pond in the recommended ratio the yield was increased by 5 times and the cost benefit ratio was doubled.

TRAININGS CONDUCTED

Training programmes on Oil Palm Production Technology, Oil Palm Hybrid Seed Production, Plant Protection in Oil Palm, Leaf Nutrient Analysis in Oil Palm and Oil Palm Cultivation were organised to officers belonging to Department of Agriculture, Horticulture, State Agricultural University, ICAR institutions and Oil Palm entrepreneurs. A total of 88 officers belonging to Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala and Mizoram participated in these training programmes (Table 46). In the training

programmes, series of lectures were delivered on different aspects of Oil Palm. Field visits were arranged to demonstrate method of planting, control of pests and diseases, correction of nutritional disorders etc. Literature distributed to the officers. Pre and post evaluations were made.

Sixteen one day training programmes on "Oil Palm Cultivation"(Table 47a & 48a), eleven one day training programmes on "Integrated nutrient and water management in oil palm" (Table 47b) and ten one day training programme on "harvesting of Fresh Fruit Bunches from tall palms" (Table 47c & 48b) were organised for 1529 farmers from Andhra Pradesh, Goa, Gujarat and Karnataka (Table. 49). In all the above programmes, lectures were delivered on respective subjects of Oil Palm. Field visits were arranged to demonstrate method of planting, control of pests and diseases, correction of nutritional disorders. Farmers were shown video film on Oil Palm cultivation and they were taken to Oil Palm gardens. The scientists clarified doubts during the field visits. Farmers were also taken to processing units to know about the harvesting standards, time of harvesting, quality aspects of FFB in processing and demonstrations were arranged on FFB harvesting from tall palms.

OTHER TRANSFER OF TECHNOLOGY ACTIVITIES

- Participation in Exhibitions
- Participation in AIR/TV programmes
- Er. Shinoj Subramannian demonstrated different models of oil palm frond cutters during December 2004 on request by The commissioner of Horticulture, Govt. of Andhra Pradesh.
- Regular Field visits by Scientists of the Institute in the states of Andhra Pradesh, Karnataka, Orissa and Goa were made and problems faced by the oil palm growers regarding pests, diseases and nutritional disorders were diagnosed and necessary remedial measures were suggested.
- Organised field day programme, Animal Health campaign, Training on Paddy cultivation and Training on oil palm cultivation in Pedakadimi village under TAR-IVLP.

RESEARCH CUM DEVELOPMENT PROJECT ON OIL PALM IN KARNATAKA

The project was takenup from November, 2004 with a view to support Oil Palm Development Programme in Cauvery, Thungabhadra and upper Krishna areas of Karnataka; To find out the causes for low productivity in target area and suggest measures for improving the oil palm productivity; and asses the potentiality and area under planting material from different sources.

Under this project, project assistants have been recruited, area for new planting of oil palm have been identified, survey had been conducted for assessing factors responsible for sup-optimal productivity and measures suggested for improving it and survey on oil palm pests.

DATABASE MANAGEMENT

Grower-wise data on area of oil palm and production of fresh fruit bunches was collected from M/s Palmtech India Ltd. and M/s Simhapuri Agrotech Ltd. (both from Karnataka), M/s Godrej Agrovet India Ltd (from Goa) and M/s A.P. Oil Fed Ltd. (from Andhra Pradesh). The data from Karnataka and Goa was analysed and the sample size is 354, 185 and 250 in the zones of Palmtech, Simhapuri and Godrej respectively. The majority of the plantations were in the yield range of 0 -7 tonnes and a few were also observed in 7-14 tonnes range.

OIL PALM INFORMATION SYSTEM

The CD on Oil Palm Seed Garden Information System was given to all the seed gardens and specialized training for 3 days was imparted to them in which two persons from every seed garden had participated. Also, one day training on the software was given to the trainees of Oil Palm Hybrid Seed Production training. Feedback was collected from the trainees to make the necessary modifications required in the software.

- The website of institute was redesigned and updated.

Table 46. Officers Training Programmes

S. No.	Title of the Training programme	Venue	Place of representation	Number of participants
1.	Oil Palm Production Technology	NRCOP, Pedavegi, A.P	A.P., Karnataka, Gujarat, Mizoram	13
2.	Oil Palm Cultivation	NRCOP, Pedavegi, A .P	A.P., Karnataka	48
3.	Plant Protection in Oil Palm	NRCOP, Pedavegi, A.P Pedavegi, A.P	A.P., Gujarat, Mizoram	16
4.	Leaf Nutrient Analysis in Oil Palm	NRCOP, Pedavegi, A.P	A.P., Goa, Mizoram	4
5.	Oil Palm Hybrid Seed Production	NRCOP-RS, Palode, Kerala	A.P., Karnataka, Kerala	7
			Total	88

Table 47a. Farmers Training Programmes on "Oil Palm Cultivation"

S. No.	Date	Venue	Place & state of representation	No. of Participants
1	May 2004	NRCOP-RS, Palode, Kerala	Kazhakootam,Kerala	25
2	17.12.2004	NRCOP, Pedavegi, A.P.	Navasari District, Gujarat	54
3	30.12.2004	NRCOP, Pedavegi, A.P.	West Godavari District, A.P	4
4	10.01.2005	NRCOP, Pedavegi, A.P.	Visakhapatnam District, A.P	36
5	11.01.2005	NRCOP, Pedavegi, A.P.	West Godavari District, A.P	36
6	04.02.2005	NRCOP, Pedavegi, A.P.	Nellore District, A.P.	35
7	22.02.2005	NRCOP, Pedavegi, A.P.	Krishna District, A.P	27
8	26.02.2005	NRCOP, Pedavegi, A.P.	West Godavari District, A.P	30
9	05.03.2005	NRCOP, Pedavegi, A.P.	Krishna District, A.P	40
10	08-09.03.2005	NRCOP, Pedavegi, A.P.	Belgaum, Karnataka	27
			Total	314

Table 47b. Farmers training programme on "Oil Palm Integrated Nutrient and Water Management" conducted at NRCOP, Pedavegi, A.P.

S. No	Date	Name of district of representation	No. of Participants
1	17.11.2004	Visakhapatnam	50
2	19.11.2004	East Godavari	46
3	23.11.2004	West Godavari	42
4	25.11.2004	Krishna	50
5	27.11.2004	East Godavari	30
6	04.12.2004	West Godavari	41
7	20.12.2004	West Godavari	35
8	21.12.2004	East Godavari	26
9	22.12.2004	Khammam	50
10	18.01.2005	Nellore	32
11	11.03.2005	West Godavari	19
		Total	421

Table 47c. On "Oil Palm Fresh Fruit Bunches Harvesting" conducted at NRCOP, Pedavegi, A.P.

S. No	Date	Name of district of representation	No. of Participants
1	12.10.2004	Khammam	50
2	14.10.2004	Krishna	52
3	19.10.2004	Nellore	48
4	25.10.2004	West Godavari	22
5	26.10.2004	Visakhapatnam	42
6	28.10.2004	East Godavari	26
7	08.11.2004	East Godavari	54
8	16.11.2004	West Godavari	6
		Total	300

Table 48a. Farmers training programmes "Oil Palm Cultivation" conducted at farmers places

S. No.	Date	Venue	Place & state of farmers represented	No. of Participants
1.	04.08.2004	Zonal Agricultural Office, Sanguem, Goa	Sanguem, Goa	32
2	05.08.2004	Govt. Primary School, Bomdamoii, Quepem, Goa	Quepem, Goa	48
3	06.08.2004	Godrej Agrovet Ltd, Sattari,Goa	Sattari, Goa	45
4	05.01.2005	TTDC Hall, Srikakulam, A.P	Srikakulam Dt., A.P	50
5	06.01.2005	Makkuva, Vijayanagaram District	Vijayanagaram Dt., A.P	150
6	07.01.2005	Sringavarapukota, Vijayanagaram District	Vijayanagaram Dt., A.P	50
			Total	375

Table 48b. Farmers training programmes on "Oil Palm Fresh Fruit Bunches Harvesting" conducted in Karnataka

S. No.	Date	Venue	Place & state of farmers represented	No. of Participants
1	30.03.2005	Ramanathapuram, Mysore district	Mysore and Coorg districts	61
2	31.03.2005	Bhadravathi,	Shimoga district,	58
			Total	119

Table 49. Training programmes organised to the farmers at a glance

S. No.	Training Programme	Venue	No of programmes	No of participants
1	Oil Palm Cultivation	NRCOP,Pedavegi, A.P.	10	314
2	Oil Palm Integrated Nutrient and Water Management	NRCOP,Pedavegi, A.P.	11	421
3	Oil Palm Fresh Fruit Bunches Harvesting	NRCOP,Pedavegi, A.P.	8	300
4	Oil Palm Cultivation	Different locations in Andhra Pradesh & Goa	6	375
5	Oil Palm Fresh Fruit Bunches Harvesting	Different locations in Karnataka	2	119
		Total	37	1529

TRAINING AND EDUCATION

Fig. 1. Field visit of trainers undergoing training on Oil Palm production technology

Fig. 2. Demonstrating Oil Palm planting in Oil Palm Production Technology

Fig. 3. Oil Palm Hybrid Seed Production training at NRCOP-RS, Palode

Fig. 4. Farmers training on Oil Palm Cultivation

Fig. 5. Farmers visiting laboratory of NRCOP during their study tour

Fig. 6. Field demonstration of nutrient deficiency disorders during training on Plant Protection in Oil Palm

5. TRAINING AND EDUCATION

TRAINING/REFRESHER COURSES/SUMMER SCHOOLS ETC ATTENDED

- Dr. M. Kochu Babu, Director attended the training on good governance in NARS held at NAARM, Hyderabad during 1-5, March 2005.
- Dr. R.K. Mathur, Senior Scientist (Plant Breeding) attended Training programme on "Intellectual Property Rights in Plant Genetic Resources Management" jointly organised by NAARM and NBPGR at Hyderabad during August 30 to September 02' 2004.
- Dr. R.K. Mathur, Senior Scientist (Plant Breeding) attended Training programme on "National Information Sharing Mechanism for Establishment of Global Plan of Action for PGRFA in India" at NBPGR Regional Station, Hyderabad during March 7-8, 2005.
- Dr. P.K. Mandal, Senior Scientist (Biochemistry) attended training on 'Recent Trends in Bioinformatics' at Central Plantation Crops Research Institute, Kasaragod, from 9-13 Aug, 2004.
- Dr. P.K. Mandal, Senior Scientist (Biochemistry) attended training on 'Micro satellites for genetic diversity assessment and Cultivar identification" from 28th January to 5th February 2005 at National Research Centre on DNA Fingerprinting (NBPGR), New Delhi.
- Dr. K Suresh, Scientist (SS) attended winter school on "Photosynthesis and Bio-productivity" from December 2-22, 2004, sponsored by ICAR, New Delhi at the Division of Plant physiology, IARI, New Delhi.
- Dr. P. Murugesan Senior Scientist (Seed Technology) attended training programme ERNET Training ON LAN/WAN Technologies (Sponsored by NATP) during August 2-6, 2004.
- Ms. K.L. Mary Rani, Scientist (Computer Applications) attended training programme ERNET Training ON LAN/WAN Technologies (Sponsored by NATP) during August 2-6, 2004.
- Mr. Shinoj Subramannian, Scientist (AS & PE) attended short term course on Innovative food processing technologies organized by IIT, Kharagpur during 4-15, October 2004.
- Mr. Shinoj Subramanian attended training on colour measurement techniques and data interpretation for quality evaluation of food and horticultural products at commercial level organized by CIPHET, Ludhiana during 25-29, December 2004.

TRAINING PROGRAMME ORGANISED

- Organized training programme on 'DNA extraction, quantification and PCR application' during 6th May to 5th June, 2004.

EDUCATION VISITS OF COLLEGE STUDENTS

Exposure visits (6 batches) to the students of Acharya N. G. Ranga Agricultural University, Acharya Nagarjuna University and Andhra University were organised. A total of 152 students visited the institute.

- Six PG scholors (Four in Biochemistry and two in Biotechnology) carried out project works at the institute.
- Acharya Nagarjuna University, Guntur (A.P.) recognised scientists of NRCOP for guiding M.Phil/ Ph.D. Scholors in Botany (Drs. M. Kochu Babu, V.M. Reddy, Dr. R.K. Mathur, Dr. P. Murugesan and Dr. K. Suresh).

6. AWARDS AND RECOGNITIONS

Received Second Best Poster Award in International Symposium on "PLANT INTRODUCTION: ACHIEVEMENTS AND OPPORTUNITIES IN SOUTH ASIA" at NBPGR, New Delhi, during February 15-17, 2005 on the article entitled "*OIL PALM GENETIC RESOURCES- INTRODUCTION, UTILIZATION AND FUTURE NEEDS*" authored by Mathur, R.K.; Murugesan, P.; and Pillai, R.S.N.

Dr. P. Kalidas, Senior Scientist (Ag. Entomology) received first prize for the research work carried out in NATP project entitled "Development of Integrated Pest Management Technology for palm based production system" in the National Symposium on enhancing productivity and sustainability in Coastal-Ecosystem held by office of the AED, NATP (Coastal) at CTCRI, Thiruvananthapuram during 9-11, June, 2004.

7. LINKAGES AND COLLABORATIONS

The National Research Centre for Oil Palm is maintaining linkages with the following National and International Institutes / Agencies:

A. National

- Technology Mission on Oil Seeds Pulses and Maize (TMOP&M)
- National Agricultural Technology Project (NATP)
- State Departments of Agriculture/Horticulture, Govt. of Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Goa, Gujarat, Orissa, Mizoram and Tripura
- State Agricultural Universities of oil palm growing states
- Entrepreneurs involved in oil palm development
- Agricultural Finance Corporation
- Oil Palm India Ltd (OPIL), Kottayam, Kerala

B. International

- Malaysian Palm Oil Board, Malaysia
- ASD Costa Rica
- IDEFOR, Ivory Coast
- DAMI, Papua New Guinea
- United Nations Development Programme (UNDP)
- CIRAD-CP, Montpellier, France
- BUROTROP - Paris, France
- UNIVANICH, Thailand

This centre has been providing technical advice to TMOP&M, and State Agriculture/ Horticulture Departments on all aspects of oil palm cultivation. The TMOP&M funds are being utilized for strengthening the training programme in which the lower level field staff involved in oil palm development are trained. A leaf nutrient analysis laboratory meant for analyzing the leaf samples for effective scheduling of fertilizers is also being funded by TMOP&M.

8. AICRP/CO-ORDINATION UNIT/NATIONAL CENTRES

The activities of Oil Palm under AICRP (palms) are being monitered by the Project Co-ordinator (palms) at CPCRI, Kasaragod.

9. LIST OF PUBLICATIONS

RESEARCH PAPERS

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- Kalidas, P., 2004, Susceptibility of Oil palm (Tenera hybrid) planting material for rhinoceros beetle, *Oryctes rhinoceros* L. *Journal of Plantation Crops*, 32 (Suppl.): 385-387.
- Kalidas, P., 2004, Stress management of insect pests on Oil palm, *Elaeis guineensis* Jacq. *Journal of Oilseeds Research*, 21(1): .220-223.
- Mandal, P.K.; Malliah, P.; Sireesha, K.; Shamila, S.; Aruna, C. 2004. The use of RAPD markers for molecular characterization of oil palm (*Elaeis guineensis* Jacq.) germplasm. *Journal of Plantation Crops*, 32 (Suppl.): 131-133.
- Mathur, R.K.; Murugesan, P.; and Pillai, R.S.N. 2005. Oil Palm genetic resources-introduction, utilization and future needs. *Indian J. Plant Genet. Resour.*18 (1): 112-113.
- Murugesan, P., Balachandran, C., Pillai, R.S.N. and Ravindran, P.S. 2004. Performance of indigenous and Costa Rican planting materials of oil palm (*Elaeis guineensis*, Jacq) in the Coastal district of Andhhra Pradesh. *Journal of Plantation Crops*, 32 (Suppl): 16-19.
- Murugesan, P.; Rethinam, P. Krishnamurthty, T.T.; and Ravi Kumar, M. 2005. Performance of exotic sources of Oil Palm hybrids in coastal Andhra Pradesh, India. *Indian Journal of Plant Genetic Resources.* 18(1): 121.
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- Panneerselvam, P.; Sunitha, S.; and Varghese, P.T. 2004. Effect of different potting mixtures and frequency of fertilizer application on growth and development of oil palm seedlings. *Journal of the Annamalai University-Agriculture*, 25-30.
- Prasad, M.V. and Rayapa Raju D.G.S. 2004. Critical analysis of trainers training programme on Oil Palm in relation to perception, knowledge gain, adoption and dissemination by trainees. *Journal of Plantation Crops*. 32 (suppl.): 502-504.
- Reddy, V.M., K.Suresh, M.S. Saraswathi, G. Bijimol, and Ch. Nagamani. 2004. Inter cropping in irrigated oil palm in India. J. Plantation Crops 32(Suppl.): 218-220.
- Sunitha, S.; and Varghese, P.T. 2004. Yield of Oil Palm as influenced by integrated nutrient management. *Journal of Plantation Crops*. 32(suppl.): 263-265.
- Suresh, K, Nagamani, Ch.; Sivasankar Kumar, K.M.; and Vinod Kumar, P. 2004. Variations in photosynthetic rate and associated parameters in the different dura oil palm germplasm. *J. Plant. Crops* 32(suppl.): 67-69.

POPULAR ARTICLES:

- Reddy, V.M., Sarma, K.N.; Prasad M.V.; and Suresh, K. 2004. "Thakuva Neetitho adhika Aadhayaniche oil palm" (in Telugu) (More profitable oil palm with less water). In Rythe Raju- Eenadu (Daily), West Godavari District, 5th April, 2004.

TECHNICAL BULLETINS/ FOLDERS/ BOOKS/ PROCEEDINGS *ETC*

- Invited Papers and Abstracts for National Seminar on Research and Development of oil palm in India held on 19-20th February 2005. (Edited by Pillai, R.S.N., Mandal, P.K., Suresh,

K., and Sivaramakrishna, V.N.P.). National Research Centre for Oil Palm, Pedavegi, Andhra Pradesh, India. pp 177.

- NRCOP Highlights. 2005. (Edited by Pillai, R.S.N.; Mathur, R.K.; Mandal, P.K.; and Suresh, K.) National Research Centre fro Oil Palm, Pedavegi, Andhra Pradesh, India.
- Oil Palm Empty Fruit Bunch Fibre Extractor. Technical Folder No.6. February 2005. Technical Contribution: Jayashree, E. and Mandal, P.K. National Research Centre fro Oil Palm, Pedavegi, A.P., India.
- Oil Palm Sagu. (Compiled and Edited by Prasad, M.V.; Reddy, V.M., Kalidas, P. and Rayapa Raju D.G.S.) 2004. National Research Centre fro Oil Palm, Pedavegi, Andhra Pradesh, India.
- Compendium of lectures on oil palm production technology. (Compiled and Edited by Prasad M.V. and Rayapa Raju D.G.S. 2004. National Research Centre for Oil Palm, Pedavegi, Andhra Pradesh, India.
- Proceedings of interface meet on Indigenous production and supply of Oil Palm sprouts (2005-06). (by Murugesan, P., Bijimol, G.; Mathur, R.K.; and Pillai, R.S.N.). Published by M. Kochu Babu, Director, National Research Centre for Oil Palm Pedavegi-534450, West Godavari district, Andhra Pradesh. p20.

PRESENTATIONS IN CONFERENCES/ SYMPOSIA/ SEMINARS/OTHER FORA:

- Balagopalan, C.; Bala Nambisan, Padmaja, G., Moorthy, S.N., Nanda, S.K., Mathew George, Sundaresan, S., Premkumar, T., Lila Babu, Sajeev, M.S., Jyothi, A.N., Vimala, B., Bosco, S.J.D., Shamina, A., Senthil, Amudan, John Zachariah, T., Jayashree, E. and Mandal, P.K. (2004). Integrated technologies for value addition and post harvest management in palms spices and tropical tuber crops. In National Symposium cum Exhibition on "Enhancing productivity and sustainability in coastal agro-ecosystem held at CTCRI, Trivandum from 9-10 June, 2004 (Abstract not published).
- Gandhi, P., Nagamangala U., Reddy V.M. and Prasad, M.V. 2005. Sustainable Oil Palm Production through balanced fertilizer application – A case study of Oil Palm grower in Andhra Pradesh. Invited papers and abstracts of National Seminar on Research and development of Oil palm in India.2005: P: 176-177.
- Kalidas, P. and Kochu Babu, M. 2004, Mixed farming systems for sustainability and economic boosting of Oil palm growers during Juvenile period. Abstract in Book of Abstracts of First Indian Horticulture Congress held during 6-9th November, 2004 at IARI, New Delhi. Pp 177-178.
- Kalidas, P. and M. Kochu Babu, 2004, Success story of commercialization of bioagents of insect pests and diseases of Oil palm. Resource material for *Directors National Workshop on Commercialization of Agricultural Technologies* held at NAARM, Hyderabad during 30th November to 3rd December 2004. pp 69-72.
- Kalidas, P. and Satyavani, V. 2004. Alternative technologies for pest control in Oil palm cropping system. Invited Special lecture delivered in the National Seminar on Bioprocesses and Production technologies held at Acharya Nagarjuna University, Guntur during 21-23rd December 2004.
- Kalidas, P., 2005, Pest management in Oil palm. A paper presented in the National Seminar on Research and development of Oil palm in India, February19-20 2005 held at the National research Centre for Oil palm, Pedavegi. pp73-81.
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Seminar on Research and development of Oil palm in India, February19-20 2005 held at the National research Centre for Oil palm, Pedavegi. pp 173.

- Kalidas, P. and Rajasekhar, P. 2005. Effect of pesticides on the pollinating weevils population. Paper presented in the National Seminar on Research and development of Oil palm in India, February19-20 2005 held at the National research Centre for Oil palm, Pedavegi. pp 174.
- Kalidas, P. and Rajasekhar, P. 2005. Efficacy of microbial organisms on the leaf eating caterpillar of Oil palm. A paper presented in the AP Science Congress held at Engineering College, Bapatla during March, 2005.
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- Nair, C.P.R.; Faleiro, J.R. Muthiah C.; Shyam Prasad, G.; Sujatha, A.; Mariamma Daniel; Kalidas, P.; Ponnamma, K. N. 2004. Development of Integrated Pest Management Technology for palm based production system. *In* National Symposium on Enhancing productivity and sustainability in Coastal Agro Ecosystem, 9-11, June, 2004, CTCRI, Thiruvananthapuram.
- Mandal, P.K., Yedukondalu, B. and Suresh K. 2005. Biochemical changes during water stress in the African accessions of Oil Palm. Paper presented in the National seminar on Research and Development of Oil Palm in India at Pedavegi during 19-20th February, 2005.
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- Mandal, P.K. and Mary Rani, K.L. 2005. Bioinformatics in Oil Palm. In the National Seminar on "Research and Development of oil palm in India"., NRCOP, Pedavegi – 534 450., Andhra Pradesh. February 19-20, 2005.
- Mandal, P.K. and Sree Ramya, S. 2004. Changes in Free Fatty Acids and Iodine Value of Palm Oil Extracted from Fresh Fruit Bunches Stored at Different Temperature After Harvesting. In the Indian Horticultural Congress 2004. Organized by the Horticultural Society of India, Indian Agricultural Research Institute, New Delhi. 6-9 November 2004.
- Mandal, P.K. and Gayathri, V. 2004. Estimation of Oil Content in the Mesocarp of Oil Palm (*Elaeis guineensis* Jacq.) by a Time and Cost Effective Method for Evaluation of Palms. In the Indian Horticultural Congress 2004. Organized by the Horticultural Society of India, Indian Agricultural Research Institute, New Delhi. 6-9 November 2004.
- Mary Rani K.L. and Prasad M.V. 2005. Impact of trade on oil palm cultivation. First Indian Horticulture Science Congress, Abstracts.
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- Mathur, R.K., Sivaramakrishna, Ramakrishna, P. and Suresh, K. 2005. Comparison of performance of oil palm hybrids collected from different countries. *In* Invited papers and abstracts, "National seminar on Research and Development of Oil Palm in India" held at National Research Centre for Oil Palm, Pedavegi, Andhra Pradesh during February 19-20, 2005. pp- 168-169.
- Mathur, R.K., Murugesan, P. and Usha Vani, D. 2005. Evaluation of African oil palm (*Elaeis*

guineensis Jacq.) germplasm for water stress conditions. *In* Invited papers and abstracts, "National seminar on Research and Development of Oil Palm in India" held at National Research Centre for Oil Palm, Pedavegi, Andhra Pradesh during February 19-20, 2005. pp- 169-170.

- Murugesan, P.; Mathur, R.K.; Pillai, R.S.N.; M. Ravi Kumar and G. Bijimol. 2005. Dormancy and sprouts abnormalities in oil palm (*Elaeis guineensis* Jacq.) *In* Invited papers and abstracts, "National seminar on Research and Development of Oil Palm in India" held at National Research Centre for Oil Palm, Pedavegi, Andhra Pradesh during February 19-20, 2005. pp- 168.
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- Pillai, R.S.N. Murugesan, P. Mathur, R.K. and Sharma, T.V.R.S. 2004. Collection and evaluation of oil palm (*Elaeis guineensis* Jacq.) germplasm in India. In Souvenir cum Abstracts International conference on "Multipurpose trees in the tropics: Assessment, growth and management" held at Arid Forest Research Institute, Jodhpur, Rajasthan during November 22-25, 2004. pp-277.
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- Satyavani, V. and Kalidas, P. 2005. Effect of antagonists on the pest management in Oil palm. Paper presented in the National Seminar on Research and development of Oil palm in India, February19-20 2005 held at the National research Centre for Oil palm, Pedavegi. pp 174.
- Shinoj, S. 2005. Mechanization in oil palm plantations and byproduct utilization. A invited paper presented in National Seminar on *Research and development of Oil palm in India*, during February 2005 at NRC for Oil Palm, Pedavegi.
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- Sunitha, S. and Varghese, P.T. 2005. Integrated nutrient management in oil palm plantations through nutrient recycling. National Seminar on New frontiers of Soil Science Research towards Sustainable Agriculture, NEFROSSA-2005, March 11th and 12th, 2005, Annamalai University, Tamil Nadu.
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- Suresh, K. and Ch. Nagamani. 2005. Stomatal characteristics of different African dura germplasm. Paper presented in the National seminar on Research and Development of Oil

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- Suresh, K. and Reddy, V.M. 2005 Photosynthesis and age of oil palm leaves under irrigated conditions. Paper presented in the National seminar on Research and Development of Oil Palm in India at Pedavegi during 19-20th February, 2005.
- Suresh, K., Reddy, V.M. and Sivasankara Kumar, K.M. 2004. Leaf Breaking in oil palm-Role of soil and leaf nutrients. Paper presented during First Indian Horticulture Congress-2004. 6-9 Nov. 2004, Pusa New Delhi. Book of Abstracts, P.224.
- Vikraman Nair, R. and Suresh, K. 2005. Intercropping and mixed farming in Oil Palm. Lead Paper presented in the National seminar on Research and Development of Oil Palm in India at Pedavegi during 19-20th February, 2005.

10. VISITS AND PARTICIPATION IN CONFERENCES, SEMINARS, SYMPOSIA *etc.*

Dr. M. KOCHU BABU

- Project Management Committee meeting of Tamil Nadu on 19th May, 2004.
- National Seminar on "Microbial Diversity – a source of innovation in biotechnology" organized by Tropical Botanic Garden and Research Institute, Palode on 28th and 29th May, 2004.
- Workshop on "Cultivation of Oil Palm in India – Constraints in area expansion and future strategies to be adopted" held during 2-3 June, 2004 at Hyderabad.

  Group meeting of AICRP on palms convened at NRCOP, Pedavegi on 15 June, 2004.
- Directors' Conference during 14-16 July, 2004 at New Delhi.
- First meeting of the ISOPOM held under the chairmanship of Director General, ICAR 3-5 August, 2004.
- Research Advisory Committee meeting held on 6th September, 2004 at NRC-OP Regional Station, Palode.
- Meeting to review the status of indigenous Oil Palm sprouts convened by DDG (Hort.) at New Delhi on 4th October, 2004.
- Workshop on "Utilization of plant genetic resources" held during 5-6 October, 2004 at NBPGR, New Delhi.
- Brain-storming Session for development of Network Project on "Use of wild species in crop improvement" held on 7th October, 2004 at New Delhi.
- Preliminary meeting to review the oil extraction ratio convened by the State Horticulture Department, Andhra Pradesh at Hyderabad on 14th October, 2004.
- Standing Committee of PLACROSYM-XVI held at CPCRI, Kasaragod on October 25, 2004.
- Meeting of the Standing Committee on fixing responsibility in case of project time and cost over runs in respect of construction of residential quarters on 23rd November, 2004.
- Indian Horticulture Congress-2004 held during November 6-9, 2004 at New Delhi.
- National Workshop on Commercialization of agricultural technologies held on November 30, 2004 at NAARM, Hyderabad.
- 144th Board Meeting of Oil Palm India Limited held on December 03, 2004 at Trivandrum.
- Meeting of the Internal Screening Committee constituted to review retention of ARS Scientists of NRC-OP on December 07, 2004 at New Delhi.
- Meeting on commercialization of technologies generated by ICAR Institutes held on December 08, 2004 at New Delhi.
- Oil Palm Awareness campaign inaugurated by Hon'ble Minister for Agriculture, Tamil Nadu at Trichy on December 09, 2004.
- PLACROSYM XVI - "Reorientation of Plantation Crops Research in the WTO Regine". December 14-17, 2004.
- Workshop on POME project held on 27-12-04 at NRCOP, Pedavegi.
- Oil Palm Seed Meet 2004 held on 28th December, 2004 NRCOP, Pedavegi.
- Meeting to discuss the Perspective Plans of Horticulture Institutes convened by DDG(Hort.) on 28th January, 2005 at New Delhi.
- National Seminar on "Research and Development of oil palm in India", NRCOP,

Pedavegi -534 450, A.P. during February 19-20, 2005.

Field visit:

- For conducting the Awareness Programme on "Plant Protection – management of pests and diseases in Oil Palm and cocoa at Nellore on 28th April, 2004.

Dr. R.S.N. PILLAI

- National Seminar on "Research and Development of oil palm in India", NRCOP, Pedavegi – 534 450, A.P. during February 19-20, 2005.
- Group meeting of AICRP on Palms convened at NRC Oil Palm, Pedavegi on 15 June 2004.
- Participated in Oil Palm Seed Meet 2004 on 28th December, 2004 at NRCOP, Pedavegi.

Dr. P. THOMAS VARGHESE

- Group meeting of AICRP on Palms convened at NRC Oil Palm, Pedavegi on 15 June 2004.
- PLACROSYM XVI-"Reorientation of Plantation Crops Research in the WTO Regime", December 14-17, 2004.

Dr. V. M. REDDY

- Attended National Seminar on "Research and Development of oil palm in India", NRCOP, Pedavegi – 534 450, A.P. during February 19-20, 2005.
- PLACROSYM XVI-"Reorientation of Plantation Crops Research in the WTO Regime", December 14-17, 2004.

Dr. P. KALIDAS

- First Indian Horticulture Congress-2004 on "Improving productivity, quality, Post-harvest management and trade in Horticultural crops" held at New Delhi during November 6-9, 2004.
- National Seminar on "Research and Development of oil palm in India", NRCOP, Pedavegi – 534 450, A.P. during February 19-20, 2005.
- National Seminar on Bioprocesses and Production technologies held at Acharya Nagarjuna University, Guntur during 21-23rd December 2004.
- AP Science Congress held at Engineering College, Bapatla during March, 2005.
- The Directors' National Workshop on Commercialization of Agricultural Technologies held at NAARM, Hyderabad during 30th November to 3rd December, 2004.
- National Seminar on Bioprocesses and Production technologies held at Acharya Nagarjuna University, Guntur (A.P.) during 21-23 December, 2004.
- Group meeting of Oil palm seed producers and Entrepreneurs on 28th December, 2004
- Brain storming session on Pheromones held during April, 2004 under the Chairmanship of DDG (Hort. & CS), ICAR, New Delhi.
- Brain storming session for finalization of net work project on Pheromones held at PDBC, Bangalore during May, 2004
- Brain storming session on Antagonists held in New Delhi during June, 2004 under the chairmanship of DDG (Hort. & CS), ICAR.
- Workshop on Palm Oil Mill Effluent project held on 29th December, 2004 at NRC for Oil Palm, Pedavegi (A.P.).

Dr. R.K. MATHUR

- Group meeting of AICRP on Palms convened at NRC Oil Palm, Pedavegi on 15 June 2004.
- First Indian Horticulture Congress-2004 on "Improving productivity, quality, post-harvest management and trade in Horticultural crops" held at New Delhi during November 6-9, 2004.
- International conference on "Multipurpose trees in the tropics: Assessment, growth and management" held at Arid Forest Research Institute, Jodhpur, Rajasthan during November 22-25, 2004.

- International Symposium on "Plant Introduction: Achievements and Opportunities in South Asia" at NBPGR, New Delhi, during February 15-17, 2005.
- National Seminar on "Research and Development of Oil Palm in India" held at National Research Centre for Oil Palm, Pedavegi, Andhra Pradesh during February 19-20, 2005.
- Project Management Committee meeting at Lal Bagh, Bangalore held on 29th July' 2004.

Dr. M.V. PRASAD

- National symposium cum exhibition on enhancing productivity and sustainability in coastal agro-ecosystem" during 9-11 June 2004 at CTCRI, Trivandrum
- Group meeting of AICRP on Palms convened at NRC Oil Palm, Pedavegi on 15 June 2004.
- Group meeting on Oil Palm on 29.7.2004.
- Interactive meeting at Directorate of Horticulture, Hyderabad on 17.11.2004.
- ZREAC meeting of north coastal zone at Agricultural College Naira, Srikakulam
- National Seminar on "Research and Development of Oil Palm in India" held at National Research Centre for Oil Palm, Pedavegi, Andhra Pradesh during February 19-20, 2005.

Dr. P.K. MANDAL

- Workshop on Cultivation of oil palm in India-constraints in area expansion, future strategies to be adopted held at Jubilee Hall, Hyderabad from 2-4 June, organized by TMOP&M, Ministry of Agriculture, Govt. of India.
- National Symposium cum Exhibition on "Enhancing productivity and sustainability in coastal agro-ecosystem held at CTCRI, Trivandum from 9-10 June, 2004.
- Indian Horticultural Congress 2004. Organized by the Horticultural Society of India, Indian Agricultural Research Institute, New Delhi. 6-9 November, 2004.
- Plantation Crops Symposium (*PLACROSYM-XXVI*) held at Central Plantation Crops Research Institute, Kasaragod, Kerala, India from 14-17 December 2004.
- National symposium on "Biotechnological interventions for improvement of horticultural crops: Issues and Strategies". Held at College of Horticulture, Kerala Agricultural University, Thrissur – 680 656, Kerala, India from 10-12 January 2005.
- National Seminar on "Research and Development of oil palm in India", NRCOP, Pedavegi-534 450., Andhra Pradesh. February 19-20, 2005.

Dr. S. SUNITHA

- National Seminar on New frontiers of Soil Science Research towards Sustainable Agriculture, NEFROSSA-2005, March 11th and 12th, 2005, Annamalai University, Tamil Nadu.
- National Seminar on "Research and Development of oil palm in India", NRCOP, Pedavegi - 534 450, A.P. during February 19-20, 2005.

Dr. K. SURESH

- National Symposium cum Exhibition on "Enhancing Productivity and sustainability in Coastal Agro-ecosystem" held at Central Tuber Crops Research Institute, Trivandrum from 9th to 11th June, 2004
- First Indian Horticulture Congress-2004. 6-9 Nov. 2004, Pusa New Delhi
- PLACROSYM XVI-"Reorientation of Plantation Crops Research in the WTO Regime", December 14-17, 2004.
- National seminar on Research and Development of Oil Palm in India at Pedavegi during 19-20th February, 2005.

Dr. P. MURUGESAN

- First Indian Horticulture Congress-2004. 6-9 Nov. 2004, Pusa New Delhi.

- PLACROSYM XVI-"Reorientation of Plantation Crops Research in the WTO Regime", December 14-17, 2004.
- National seminar on Research and Development of Oil Palm in India at Pedavegi during 19-20th February, 2005.
- International conference on "Multipurpose trees in the tropics: Assessment, growth and management" held at Arid Forest Research Institute, Jodhpur, Rajasthan during November 22-25, 2004.
- Oil Palm Seed Meet on 19th March, 2004.
- Group meeting of AICRP on palm convened at NRC oil palm, Pedavegi on 15th June, 2004.
- Interactive workshop on Palm oil Mill Effluent management strategies December 29, 2004 held at NRC for Oil Palm, Pedavegi, A.P.
- Oil Palm Seed Meet 2004 on "indigenous oil palm seed production & distribution" on December 28, 2004 at NRC for Oil Palm, Pedavegi, A.P.
- First National shareholders workshop of project on "Establishment of information sharing mechanism for monitoring the implementation of Global Plan of Action during Feb 24-25, 2005 at National Bureau of Plant Genetic Recourses, New Delhi.

Ms. K.L. MARY RANI

- First Indian Horticulture Congress-2004. 6-9 Nov. 2004, Pusa New Delhi.
- PLACROSYM XVI-"Reorientation of Plantation Crops Research in the WTO Regime", December 14-17, 2004.
- National seminar on Research and Development of Oil Palm in India at Pedavegi during 19-20th February, 2005.

Er. SHINOJ SUBRAMANNIAN

- National seminar on Research and Development of Oil Palm in India at Pedavegi during 19-20th February, 2005.
- National working group meeting on mechanization of Horticulture and Hill agriculture during 16-17 April, 2004 at CIAE, Bhopal, Madhya Pradesh.

COMMITTEE VISITS

- The committee consisting of Drs. P. Kalidas, R.K. Mathur and K. Suresh visited Nellore on March 21-22, 2005 for looking into the problem of non-fruit setting in some of the plantations in Nellore.
- A committee comprising Dr. M. Kochu Babu, Drs. R.S.N. Pillai, R.K. Mathur and P. Murugesan visited Bheemankoli Oil Palm Plantation near Mysore during 22-29 April, 2004 to assess the progress made in the evaluation of Costa Rican hybrids with respect to yield and other characteristics.

11. LIST OF APPROVED ONGOING PROJECTS

	Name of Project	Name of PI /Co-PI (S)
OIL PALM GENETIC RESOURCES		
GEN I.	Collection, conservation, cataloguing and evaluation of oil palm germplasm	R.S.N. Pillai, R.K. Mathur & P. Murugesan
GEN V.	Evaluation of stress tolerant germplasm	R.S.N. Pillai, R.K. Mathur, P. K. Mandal & P. Murugesan
OIL PALM BREEDING & SEED PRODUCTION		
GEN II.	Indigenous hybrid seed production of oil palm	R.S.N. Pillai, R.K. Mathur & P. Murugesan
GEN IV.	Production and improvement of oil palm hybrids	R.S.N. Pillai, R.K. Mathur, P. K. Mandal & P. Murugesan
GEN VI.	Studies on performance of different oil palm planting materials	R.K. Mathur & P. Murugesan
PHY I.	Studies on the photosynthetic efficiency, dry matter production and partitioning in different oil palm hybrid cross combinations	K. Suresh
BIO I.	Biochemical analysis of palm oil	P.K. Mandal
BIO II.	DNA fingerprinting of oil palm	P.K. Mandal, R.S.N. Pillai & R.K. Mathur
SST I.	Acceleration of germination of oil palm Hybrid seeds	P. Murugesan, R.S.N. Pillai R.K. Mathur & P.K. Mandal
GEN III.	Research-cum-demonstration of oil palm genotypes under varied environment (TMOP&M funded scheme)	M. Kochu Babu, R.S.N. Pillai R.K. Mathur & P. Murugesan
	Indigenous production of oil palm hybrid seeds (Revolving Fund Scheme)	R.S.N. Pillai
OIL PALM MANAGEMENT		
AGR.II.	Fertilizer requirement of oil palm during pre-bearing stage	S.Sunitha, P. T. Varghese & K.Suresh
AGR IV.	Studies on water and nutrient management in oil palm	K. Suresh & V.M. Reddy
AGR V.	Nutrient recycling of oil palm wastes in oil palm plantations	P. T. Varghese & S.Sunitha
AGR VI.	Studies on mixed farming in the irrigated oil palm plantations of Andhra Pradesh	M. Kochu Babu & P. Kalidas
AGR VII.	Development and evaluation of soil and water conservation measures and land use systems for sustainable crop production in Western Ghat regions- Agro-techniques and land use systems for soil, water and nutrient conservation in oil palm plantations of hill slopes	P. T. Varghese & S.Sunitha
AGR VIII.	Intercropping of Cocoa in oil palm	V.M. Reddy & K. Suresh

Name of Project		Name of PI /Co-PI (S)
	Establishment of leaf analysis laboratory- Studies on nitrogen and potassium management in adult oil palm- on farm trial (TMOP&M funded scheme)	V.M. Reddy & K. Suresh
OIL PALM PEST & DISEASE MANAGEMENT		
PATH II.	Studies on diseases of oil palm and their management	M.Kochu Babu & P.K. Mandal
ENT I.	Studies on insect, avian and mammalian pests of oil palm and their management	P. Kalidas
ENT II.	Management of leaf eating caterpillar on oil palm in Coastal Andhra Pradesh	P. Kalidas
ENT III.	Development of integrated management practices for avian and mammalian pests of oil palm using the modern devices	P. Kalidas
ENT IV.	Commercial production of green muscardine fungus *Metarhizium anisopliae* for the control of insect pests	P. Kalidas
	Wilt of crops with special reference to cultural, morphological, molecular characterization and pathogenic variability of isolates in India (Net Work Project)	M. Kochu Babu
OIL PALM POST - HARVEST TECHNOLOGY		
PHT V.	Mechanization of oil palm plantations and farm level processing	S. Shinoj
PHT VI.	Utilization of oil palm plantation and industry wastes	S. Shinoj
	Integrated technologies for value addition and post harvest management of palm, spices and tropical tuber crops (NATP funded)	P.K. Mandal
	Utilization and recycling of oil palm mill effluent (ICAR Cess Fund)	M. Kochu Babu & S. Shinoj
SOCIAL SCIENCES		
CA I.	Oil palm data base management system	K.L. Mary Rani & M.V. Prasad
CA II.	Oil palm information system	K.L. Mary Rani
CA III.	Design and development of NRCOP website	K.L. Mary Rani
EXT II.	Training of extension, research workers and farmers involved in oil palm production under Strengthening of Training on oil palm Production (TMOP&M funded)	M.V. Prasad & P.T. Varghese
EXT III.	Critical analysis of training of trainers programme in relation to Oil Palm growers knowledge and adoption pattern	M.V. Prasad
	Institute Village Linkage Programme for Technology Assessment and Refinement in coastal agro-ecosystem in West Godavari district of Andhra Pradesh (NATP funded)	M.V. Prasad, V.M. Reddy, P. Kalidas, K. Suresh & K.L. Mary Rani
	Research - cum - Development project on oil palm in Karnataka (OPDP funded through govt. of Karnataka)	M. Kochu Babu, P. Kalidas, R.K. Mathur & M.V. Prasad

12. CONSULTANCY, PATENTS AND COMMERCIALISATION OF TECHNOLOGY

The Consultancy Processing Cell of NRC for Oil Palm gives broad guidelines for consultancy work, brings out consultancy information system, prepares and processes the Training / Consultancy /Contract Research/ Contract Service proposals, identifies the team for assignments, coordinates the work related to consultancy assignment and monitors the progress of work assigned. The following facilities offered by the Consultancy Processing Cell at NRC for Oil palm are as under.

1. Training Programmes (National and International)

Training programmes are organised in the following areas in oil palm to the officers involved in oil palm development.

- Oil palm nursery management
- Oil palm production and processing technology
- Harvesting of oil palm FFB
- Oil palm seed production
- Plant protection in oil palm

2. Consultancy services

- Feasibility reports
- Project reports
- Techno - advisory services
- Setting up of oil palm nurseries and their management
- Plant health centre for Pest & Disease management
- Project evaluation and management

3. Contract Research

- Testing of Agro-chemicals, Fertilizers, Biofertilizers, Biopesticides, and Growth regulators suitable for oil palm.
- Projects on all aspects of water, nutrient, Pest and Disease Management in oil palm /oil palm based cropping system.

4. Contract services

- Analysis of water and soil to test the suitability for oil palm
- Leaf nutrient analysis
- Lab and field evaluation of fertilizers, herbicides, agro-chemicals/plant protection against fungi, bacteria and insect pests of oil palm
- Diagnosis of damages caused by insect pests and diseases in oil palm plantations and suggest control measures
- Oil analysis
- Bunch analysis
- OER estimation in palm oil mills.

13. RAC, SRC, IJSC, MANAGEMENT COMMITTEE, MEETINGS WITH SIGNIFICANT DECISIONS

STAFF RESEARCH COUNCIL MEETING

The seventh staff research council meeting of the National Research Centre for Oil Palm was held during 17-18th June 2004 at Pedavegi. Dr. M. Kochu Babu, Director and Chairman of the staff research council welcomed all the experts and scientists for the meeting. There were five sessions namely crop improvement, crop production, crop protection, post harvest technology and transfer of technology/ Computer applications. Twenty-five institute funded and six externally funded projects were presented in the five technical sessions. Two new projects were proposed in the meeting. The technical programme for the current year 2004 was discussed and finalized.

RESEARCH ADVISORY COMMITTEE MEETING

The sixth Research Advisory Committee meeting was held at the Regional Station Palode from 06-09-04 to 08-09-04 under the Chairmanship of Dr. K. L. Chadha, former Deputy Director General (Hort.), ICAR & Ex-National Professor.

14. WORKSHOPS/ SEMINARS/ SUMMER INSTITUTES/ FARMERS' DAY AND OTHER MEETINGS ORGANIZED AT THE INSTITUTE

1. ORGANIZATION OF INTERNATIONAL GROUP MEETING

Organised International group meeting on oil palm breeding at NRCOP, Pedavegi on 21.02.2005. The meeting was chaired by the Director, NRCOP, Pedavegi which was attended by Dr. N. Rajanaidu, Oil Palm Breeder, MPOB, Malaysia, Dr. M.K. Nair, Dr. R.D. Iyer and other Plant breeders and scientists of the institute. In the meeting deliberations were made on germplasm situation in world and India, plant breeding techniques being employed in Malaysia and elsewhere, future strategies for oil palm improvement etc .

2. REVIEW MEETING ON OIL PALM HYBRID SEED PRODUCTION

Review Meetings on Oil Palm Hybrid Seed Production were conducted on 19th March 2004 and December 28, 2004 at National Research Centre for Oil Palm, Pedavegi (A.P.). The seed production activity was reviewed, a stock of account of production and supply of oil palm hybrid seeds was taken and necessary instructions were issued.

3. INTERACTIVE WORKSHOP ON PALM OIL MILL EFFLUENT

An Interactive workshop on Palm Oil Mill Effluent was organised on December 29, 2004 at NRCOP, Pedavegi to discuss the strategies for utilization and eco-friendly disposal of POME in palm oil factories in India.

4. NATIONAL SEMINAR ON RESEARCH AND DEVELOPMENT OF OIL PALM IN INDIA

To commemorate a decade of Oil Palm research under irrigated conditions, the National Research centre for Oil Palm has conducted a National Seminar on "Research and Development of Oil Palm in India" at Pedavegi during 19-20th February 2005. The seminar was inaugurated by Mr.Srinivas, Hon. Minister of Horticulture, Government of Karnataka and presided over by Mr. Kanna Laxminarayana, Hon. Minister for Cooperation, Government of Andhra Pradesh. Dr. Gautam Kalloo, Deputy Director General, (Horticulture & Crop Sciences) ICAR, Mr. K. Sambasiva Rao, Member of Parliament, Eluru, A.P. and Mr. M. Venkateswara Rao, Member of Legislative Assembly, Denduluru, A.P., also graced the occasion. The seminar had two sessions namely Research and Development. A series of invited lectures were delivered by experts belonging to ICAR and State Agriculture Universities in the research session. The research session was chaired by Dr. Raja Naidu, Oil Palm Breeder, MPOB, Malaysia and co-chaired by Dr. R. Vikraman Nair, Former Dean, Kerala Agricultural University while Dr. Radha, Managing Director, AP Oilfed and Dr. M Kochu Babu, Director, NRCOP chaired and co chaired the development session respectively. During the session on Development, lectures were given, briefing the Oil Palm development scenario in India. A total of about 90 delegates consisting of scientists, development officials, entrepreneurs and farmers attended the two-day meet. In the plenary session, which was chaired by Dr. G. Kalloo and co chaired by Dr.M.Kochu Babu, valuable recommendations finalised. Dr.R.S.N. Pillai, Scientist in-charge, NRCOP, RS, Palode & Organizing Secretary formally proposed the vote of thanks.

NATIONAL SEMINAR

Address by the Chief Guest

Technical Session in progress

Research paper presented by Dr. R.S.N. Pillai, Organising Secretary

Felicitation to Dr. N. Rajanaidu, eminent oil palm breeder, MPOB, Malaysia

Plenary session in progress

Entertainment of delegates through cultural programme

15. कार्यालयीन भाषा क्रियान्वयन गतिविधियाँ
OFFICIAL LANGUAGE IMPLEMENTATION ACTIVITIES

राजभाषा अधिनियम 1963 धारा 3(3) एवं राजभाषा नियम 1976 के अनुपालन पर राजभाषा विभाग, गृह मंत्रालय एवं भारतीय कृषि अनुसंधान परिषद की ओर से जारी किये नये दिशा-निर्देश एवं वार्षिक कार्यक्रमों के कार्यान्वयन हेतु इस केन्द्र की राजभाषा क्रियान्वयन समिति का गठन किया गया जो इस प्रकार है-

1.	डा. एम. कोच्चु बाबु, निदेशक	अध्यक्ष
2.	डा. रवि कुमार माथुर वरिष्ठ वैज्ञानिक	सदस्य एवं सम्पर्क अधिकारी (राजभाषा)
3.	श्री के.वी.वी. सत्यनारायण निजी सचिव	सदस्य
4.	श्री खासिम सैदा एस.एस.ग्रेड-1	सदस्य
5.	श्री बी. सतीश सहायक प्रशासनिक अधिकारी	सदस्य-सचिव

प्रतिवेदित वर्ष 2004-05 की अवधि में निदेशक महोदय की अध्यक्षता में केन्द्र की राजभाषा कार्यान्वयन समिति की त्रै मासिक बैठकें नियमित रूप से बुलाई गई। बैठकों में राजभाषा के अनुपालन की अनिवार्यता पर विशेष बल दिया गया और सरकारी काम काज में अधिकाधिक हिन्दी का प्रयोग करने के लिए भी जोर दिया गया। वर्ष 2005 में तेल ताड अनुसंधान एवं विकास नामक शीर्षक पर एक राष्ट्रीय संगोष्ठी आयोजित करने के लिए प्रस्ताव पारित किया गया। इसके अतिरिक्त राजभाषा नीति के कार्यान्वयन के संबन्ध में कार्यालय द्वारा किये गये प्रयासों की समीक्षा की गयी।

भारत संचार निगम लिमिटेड, एलूरू द्वारा गठित की गयी नगर राजभाषा कार्यान्वयन समिति की बैठकों में भी केन्द्र के कर्मचारियों ने भाग लिया।

राजभाषा विभाग के वार्षिक कार्यक्रम के अनुसार दिनांक 14 सितंबर, 2004 को हिन्दी दिवस मनाया गया। इस अवसर पर राजभाषा संबन्धित प्रतियोगितायें जैसे अंग्रेजी से हिन्दी में अनुवाद, प्रश्नोत्तरी, निबंध लेखन, हिन्दी कविता एवं गीत आदि आयाजित किये गये। इस अवसर श्री एम. प्रसाद, अधिशाषी अभियन्ता, आन्ध्र प्रदेश बिजली निगम, एलूरू मुख्य अतिथि थे जिनके कर कमलों के द्वारा प्रतियोगिताओं के विजेताओं को पुरस्कार वितरित किये गये। आज का हिन्दी शब्द कार्यक्रम का अनुपालन भी समयनिष्ठा से किया जा रहा है।

16. DISTINGUISHED VISITORS

S. No.	Name and Designation of the Visitor	Date of visit
1.	Dr. Y.R. Sarma, Retd., Director, IISR, Calicut	21.04.2004
2.	Dr. K.L. Chadha, Former DDG (Hort.), ICAR	19.06.2004
3.	Dr. A. Sathyanarayana, Director of Extension, ANGRAU, Hyderabad	-do-
4.	Prof. T.V.K. Raju, Former Director of Research, TNAU, Coimbatore	-do-
5.	Dr. V.G. Rao, Professor (Extension Management), EEI, Hyderabad	-do-
6.	Dr. (Ms.) Anitha Jhamtani, Pr. Scientist (Ag. Ext.), IARI, New Delhi	-do-
7.	Dr. G.P. Srivastava, Visiting Professor, CSA Uni. Of Agri. And Tech., Kanpur	-do-
8.	Dr. L.V. Sastry, Retd. Pr. Scientist, IARI, New Delhi	-do-
9.	Dr. (Ms) Malvika Dadlani, IARI, New Delhi	-do-
10.	Dr. A.N. Maurya, Ex-Director, BHU, Varanasi	28.06.2004
11.	Dr. Mohd Basri Bin Wahid, Dy. Director General, (R&D), MPOB, Malaysia	-do-
12.	Dr. A. Kushairi Din, Director of Biological Research, MPOB, Malaysia	-do-
13.	Dr. Norman Haji Kamarudin, Head of Crop Production, MPOB, Malaysia	-do-
14.	Dr. Idris B. Abu Seman, Group Leader (Pl. Pathology), MPOB, Malaysia	-do-
15.	Dr. Condro Utomo, Phytopathologist, IOPRI, Indonesia	-do-
16.	Prof. M.A. Singaracharya, Kakatiya University, Warangal, A.P.	02.07.2004
17.	Dr. Rajmannar, Pr. Scientist, ARS, Maruteru, ANGRAU, West Godavari Dt., A.P.	31.08.2004
18.	Shri B.S. Parsheera, IAS, Agriculture Production Commissioner	27.12.2004
19.	Shri Anil Puneetha, IAS, Commissioner of Horticulture, Hyderabad	-do-
20.	Dr. N.V. Patel, Director, Directorate of Oilseeds Development, Hyderabad	-do-
21.	Dr. A. Abdul Ravoof, Retd. Professor, University of Malaya, Cuddalore, Tamil Nadu	01.01.2005
22.	Sh. Srinivas, Hon. Minister of Horticulture, Govt. of Karnataka	19.02.2005
23.	Mr. Kanna Lakshminarayana, Hon.ble Minister for Cooperation, Government of Andhra Pradesh	-do-
24.	Dr. Gautam Kalloo, DDG (Hort. & CS), ICAR, New Delhi	-do-
25.	Mr. Kavoori Sambasiva Rao, Hon'ble Member of Parliament (Eluru)	-do-
26.	Mr. Maganti Venkateswara Rao, Hon'ble Member of Legislative Assembly (Denduluru)	-do-
27.	Dr. N. Raja Naidu, Oil Palm Breeder, MPOB, Malaysia	-do-
28.	Dr. R. Vikraman Nair, Retd. Dean, KAU, Trivandrum	-do-
29.	Dr. T. Radha, Vice Chairman & MD, AP OilFed, Hyderabad	-do-

GENERAL ACTIVITIES & VISITS BY DISTINGUISHED VISITORS

Sadbhavana Diwas celebrated at NRCOP, Pedavegi

Institute Foundation Day celebration

National Agricultural Technology Day (ICAR foundation day) celebrated at NRCOP, Pedavegi on 16th July 2004

Inauguration of Mixed farming experiment by Dr. G. Kalloo, DDG (H&CS), ICAR

Inauguration of Mini Palm Oil Mill by Dr. G. Kalloo, DDG (H&CS), ICAR

17. PERSONNEL

RMP

1.	Dr. M. Kochu Babu	Director

STAFF POSITION AT HEAD QUARTER - PEDAVEGI

Scientific Staff

2.	Dr. V.M. Reddy	Pr. Scientist (Agronomy)
3.	Dr. P. Kalidas	Sr. Scientist (Ag. Entomology)
4.	Dr. R.K. Mathur	Sr. Scientist (Plant Breeding)
5.	Dr. M.V. Prasad	Sr. Scientist (Ag. Extension)
6.	Dr. P.K. Mandal	Sr. Scientist (Bio-Chemistry)
7.	Dr. P. Murugesan	Sr. Scientist (Seed Technology)
8.	Dr. K. Suresh	Scientist, Sr. Scale (Plant Physiology)
9.	Mrs. K.L. Mary Rani	Scientist Sr. Scale (Computer Applications)
10.	Er. Shinoj Subramannian	Scientist (AS&PE)

Administrative Staff

11.	Sri T. Ashok Kumar	Assistant Administrative Officer
12.	Sri B. Satish	Assistant Administrative Officer
13.	Sri T.D.S. Prakash	Assistant Finance & Accounts Officer
14.	Sri K.V.V.S. Narayana	Private Secretary
15.	Sri K.S.N.D. Mathur	Assistant
16.	Sri P. Gowrishankar	Assistant
17	Mr. T.V. Rama Krishna	Personal Assistant
18.	Mr. K. Ravindran	Upper Division Clerk
19.	Mr. A. Lakshmana Rao	Lower Division Clerk
20.	Mr. Dharma Raju	Lower Division Clerk

Technical Staff

21.	Mr. V.G. Sasidharan	T-4
22.	Mrs. A. Bhanusree	T-4
23.	Mr. K. V. Rao	T-4
24.	Mr. J. Mohan Rao	T-1-3
25.	Mr. M. Ananda Rao	T-2
26.	Mr. V.V.S.K. Murthy	T-2
27.	Mr. Ch. Subba Raju	T-2 (Driver)
28.	Mr. P.R.L. Rao	T-2 (Driver)
29.	Mr. E. Perayya	T-2 (Driver)
30.	Mr. A. Papa Rao	T-1 (Tractor Driver)
31.	Mr. M. Rambabu	T-1

Supporting Staff

32.	Mr. K. Ananda Rao	SS Gr.II
33.	Mr. G. Raju	SS Gr.II
34.	Mr. I.V. Sundar	SS Gr.II

35.	Mr. G. Venkateswara Rao	SS Gr.II
36.	Mr. A. Dhana Raju	SS Gr.II
37.	Mr. A. Joji Showri	SS Gr.II
38.	Mr. U. Rama Rao	SS Gr.II
39.	Mr. A. Ganga Raju	SS Gr.II
40.	Mr. S. John	SS Gr.II
41.	Ms. Y. Chaitanya	SS Gr.I
42.	Mr. S.K. Saida	SS Gr.I
43.	Mr. A. Nagarjuna Rao	SS Gr.I
44.	Mr. G.S.N. Babu	SS Gr.I
45.	Ms. N.V.V. Sathya Lakshmi	SS Gr.I
46.	Mr. M. Satyanarayana	SS Gr.I
47.	Mr. Ch. Venkata Durga Rao	SS Gr.I

NRCOP, REGIONAL STATION, PALODE

Scientific Staff

1.	Dr P.T. Varghese	Pr. Scientist (Agronomy) & Scientist I/C
2.	Dr R.S.N. Pillai	Pr. Scientist (Plant Breeding)
3.	Mrs. S. Sunitha	Sr. Scientist (Agronomy)

Administrative staff

4.	Mrs. E.J. Mary	Assistant
5.	Mrs. V. Satyabhama	Upper Divisional Clerk
6.	Sri P. Prasad	Personal Assistant

Technical Staff

7.	Mrs. N. Sujatha Kumari	T-5
8.	Mrs. I.C. Rajamma	T-4
9.	Mr. C.K. Devadathan	T-4
10.	Mr. V. Sunil Duth	T-2
11.	Mr. G.C.S. Nair	T-1-3
12.	Mr. K. Soman	T-3
13.	Mr. B. Muralidharan Pillai	T-1

Supporting Staff

14.	Mr. G. Rajappan	SS Gr. II
15.	Mrs. N. Indira	SS Gr. II
16.	Mrs. A. Radha	SS Gr. II
17.	Mrs. M. Rebecca	SS Gr. II
18.	Mrs. A. Raceena	SS Gr. II
19.	Mr. H. Dasan	SS Gr. II
20.	Mr. P.K. Rethnakaran	SS Gr. II
21.	Mr. S. Sudhakaran Nair	SS Gr. II
22.	Mr. P. Anil Kumar	SS Gr. II
23	Mrs. C. Shantha	SS Gr. II
24.	Mrs. P. Rema	SS Gr. II
25.	Mr. C. Ravi	SS Gr. II

18. METEOROLOGICAL DATA

Weather data 2004 - 2005

At NRCOP, Pedavegi, (Andhra Pradesh)

	Temp (oC)		RH(%)		Sunshine	Rain fall(mm)
Min	Max	Min	Max			
April-04	NA	NA	NA	NA	NA	NA
May	26.18	37.77	25.97	80.12	6.86	38.6
June	26.18	34.93	37.02	81.32	6.17	97.4
July	25.13	31.75	55.58	85.41	4.06	169.4
August	25.23	32.24	49.95	85.10	4.84	169.2
September	24.55	32.48	50.40	88.44	4.17	113.4
October	23.24	31.10	52.92	89.68	3.97	149.2
November	19.70	30.88	32.47	89.94	5.46	3.8
December	NA	NA	NA	NA	NA	NA
January-05	NA	NA	NA	NA	NA	NA
February	19.13	31.63	35.89	92.87	6.25	0
March	21.96	38.55	38.76	92.40	6.29	0

At NRCOP-RS, Palode, (Kerala)

S. N.	Parameters	Months											
		Apr.	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Jan	Feb.	Mar.
1	No. of rainy days	18	20	20	22	7	12	19	9	1	3	1	7
2	Total rainfall (mm)	459.8	547	397.8	243.2	181.4	291.6	343.4	174.4	2.4	33.2	15.0	115.4
3	Highest max. Temp. (^{0}C)	36.5	35	33.5	32	32.5	33	33	34	35	36	37	38
4	Lowest max. Temp. (^{0}C)	30.5	27	26	27	27.5	25.5	26	26.5	31	31.5	34.5	34.5
5	Highest min. Temp. (^{0}C)	25	19	19	23	24	24	24	23	25	24	24	26
6	Lowest min. Temp. (^{0}C)	16	15.5	14	14	20	22	20	18	15	16	18	19
7	Avg. max. Temp. (^{0}C)	35.4	30.7	29.6	29.8	30.8	30.5	30.8	31.6	33	32.5	35.6	36
8	Avg. Min. Temp. (^{0}C)	21.2	17.4	16.8	17.1	22.8	22	22.9	22.4	19.4	19.8	19.9	21.9
9	Avg. Pan evaporation (mm)	3.0	2.5	2.0	1.9	3.0	2.5	2.1	2.5	3.1	3.5	4.0	3.9
10	Av. Relative Humidity(%)	81.0	82.0	81.8	85.8	81.1	84.2	78.3	76.2	68.2	70.1	71.0	67.2

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