



RESEARCH HIGHLIGHTS
1991-92

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

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INTRODUCTION

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CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
KASARAGOD 671 124, KERALA, INDIA

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West Coast Tall x Chowghat Orange Dwarf hybrid 'Kerasankara'



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'MOHITNAGAR' - An improved arecanut variety

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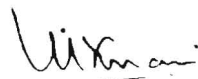
INTRODUCTION

The current mandate of the Institute is to develop appropriate production, protection and processing technologies for coconut, oilpalm, arecanut and cocoa through basic and applied research. Besides this, the Institute also co-ordinates research on these crops within the country, executes the research programmes under the All India Co-ordinated Research Project on Palms and generates parental lines and breeders' stock for establishing seed gardens and supplying to Co-ordinating Centres and other agencies including farmers. The Institute also provides consultancy services towards increasing the production and productivity of these crops through the co-operation of developmental departments by sponsoring training programmes, workshops, demonstrations and publishing extension literature.

The major research achievements of the Institute during the year 1991-92 are briefly mentioned below :

1. Chowghat Orange Dwarf has been recommended for release for tender nut purpose, based on quality characteristics and organoleptic tests.
2. In arecanut, the indigenous cultivar 'Mohitnagar' has been recommended for release for North Bengal and Coastal Karnataka, in view of its higher yield (15 kg/palm/year) than Mangala (8.8 kg/ palm/year), and early yield stabilization.
3. In oilpalm, 5,500 *tenera* sprouts of 52 cross combinations received from ASD, Costa Rica have been planted in a quarantine nursery at CPCRI, Kasaragod.
4. Coconut embryos of 8, 9 and 11 months age were field collected and cultured in Y-3 media successfully without any contamination loss, and 60% of these have germinated.
5. Twelve cocoa accessions received from the University of Reading, U.K. were added to the germplasm bank during the year bringing the total collections maintained at CPCRI Regional Station, Vittal to 105.
6. A total of 3,48,497 *tenera* sprouts were produced and distributed for commercial and experimental plantings in oilpalm.
7. Inoculation studies with four VAM fungi at the nursery stage revealed that *Gigaspora* species increased the growth of coconut seedlings at the initial period.
8. High yielding coconut genotypes (WCT, COD x WCT and WCT x COD) responded only upto the lower levels of fertilizer (500g N, 500g P₂O₅ and 1000 K₂O/palm/year) under both rainfed and irrigated conditions.
9. Drought-tolerant coconut cultivars showed significantly low lipid peroxidation levels as compared to drought susceptible palms.
10. A comprehensive survey was conducted in five districts of Karnataka with the help of Department of Agriculture & Dept. of Horticulture, Karnataka which revealed that 769340 arecanut palms are affected by YLD causing an annual loss of 508 tonnes of chali.
11. The Institute also produced and distributed large number of parental materials and breeder's stock in coconut, arecanut and oilpalm.

Kasaragod
10 April, 1992



(M.K. Nair)
Director

भूमिका

संस्थान का वर्तमान विधिक आदेश (मैनुडेट) नारियल, तेल ताड़, सुपारी तथा कोको के उत्पादन, सुरक्षा तथा कटाई उपरांत की तकनीकियों का विकास मौलिक तथा व्यावहारिक अनुसंधानों द्वारा करना है। इसके अतिरिक्त, संस्थान इन फसलों पर देश में हो रहे अनुसंधानों का समन्वयन करता है तथा अखिल भारतीय ताड़ की समन्वयित परियोजना के अन्तर्गत अनुसंधान कार्यक्रमों का निष्पादन करना तथा नारियल के बीज बागानों को स्थापित करने तथा समन्वयन केन्द्रों एवं अन्य एजेन्सियों तथा कृषकों को बीज उपलब्ध कराने हेतु पैत्रिक एवं प्रजनक बीजों का उत्पादन करना है। संस्थान इन फसलों के उत्पादन तथा उत्पादकता बढ़ाने हेतु परामर्श सेवाएं विकास विभागों को प्रशिक्षण, कार्यशालाओं, परीक्षणों तथा प्रसार साहित्य छपवाकर सहयोग भी प्रदान करता है।

संस्थान की वर्ष 1991-92 की अनुसंधान की प्रमुख उपलब्धियाँ संक्षिप्त में निम्नलिखित हैं।

1. गुणवत्त तथा 'आरगैनेलेप्टिक टेस्ट' के आधार पर चौघाट अरिन्ज ड्वार्फ को मृदुफल (टेन्डर नट) हेतु अनुमोदित किया गया।
2. सुपारी की देशी प्रजाति 'मोहित नगर' जो मंगला (8.8 कि०/ताड़/वर्ष) की अपेक्षा अधिक उत्पादन (15 कि०/ताड़/वर्ष) तथा उपज में शीघ्र स्थिरता लाती है, की दृष्टि से उत्तरी बंगाल तथा तटीय कर्नाटक में उगाये जाने हेतु विमोचन के लिए अनुमोदित की गई।
3. ए०एस०डी०, कोस्टा रिका से प्राप्त तेल ताड़ की टेनरा प्रजाति के 52 गर्भाधान किए हुए मिश्रणों के 5500 अंकुरित बीजों का के०रो०फ०अ०स० कासरगोड की क्वारेन्टाइन पौधशाला में रोपण किया गया।
4. नारियल के 8, 9 तथा 11 माह के भ्रूणों का बगानों से एकत्रीकरण तथा Y-3 माध्यम में बिना दूषित हुए, सफलतापूर्वक कल्चर किया गया जिस में 60% अंकुरण हुआ।
5. यूनाइटेड किंगडम के रेडिंग विश्व विद्यालय से प्राप्त कोको की 12 उप-प्रजातियों को इस वर्ष जीव द्रव बैंक में सम्मिलित किया गया जिससे के०रो०फ०अ०स० कासरगोड के क्षेत्रीय स्टेशन विट्टल में कुल संग्रह 105 हो गया।
6. तेल ताड़ के टेनरा प्रजाति के कुल 3,48,497 बीज अंकुरण तैयार कर व्यापारिक तथा प्रयोगात्मक रोपण हेतु वितरण किया गया।
7. पौधशाला में नारियल की पौध को वी. ए. एम. फफूँद से उपचारित करने से ज्ञात हुआ कि गैगास्पेरा प्रजाति नारियल की पौध का प्रारंभिक अवस्था में वृद्धि करती है।
8. नारियल की अधिक उपज देने वाली प्रजातियाँ (डब्ल्यू सी टी, सी ओ डी x डब्ल्यू सी टी तथा डब्ल्यू सी टी x सी ओ डी) उर्वरक की केवल निचली मात्रा (500 ग्रा० न०, 500 ग्रा० फास्फोरिक पेन्टा ऑक्साइड तथा 1000 ग्रा० पोटेशियम ऑक्साइड ताड़/वर्ष) सिंचित तथा अंसिंचित दोनों अवस्थाओं में उपज बढ़ाने में सहायक होती है।
9. सूखा रोधक नारियल की प्रजातियों में सूखा सुग्राही प्रजातियों की अपेक्षा लिपिड पेरोक्सिडेशन का स्तर कम होता है।
10. कर्नाटक के पाँच जन पदों में कर्नाटक राज्य के कृषि विभाग तथा उद्यान विभाग की सहायता से गहन सर्वेक्षण से ज्ञात हुआ कि राज्य में 769340 सुपारी के ताड़ पीत पर्ण रोग (वाई एल डी) से ग्रसित हैं जिससे प्रति वर्ष 508 टन चाली की क्षति होती है।
11. संस्थान ने नारियल, सुपारी तथा तेल ताड़ के पैत्रिक तथा प्रजनक स्टॉक बढ़ी संख्या में उत्पादन कर वितरित किए।

(हस्ताक्षर)

(एम. के. नायर)

निदेशक

केन्द्रीय रोपण फसल अनुसंधान संस्थान
कासरगोड

कासरगोड

10 अप्रैल, 1992

CROP IMPROVEMENT

GENETIC RESOURCES

Chowghat Orange Dwarf (Fig. 1) has been recommended for release for tendernut purposes. This cultivar has a total sugar content of 7.09g/100ml, and reducing sugar content of 4.7g/100ml. It had low sodium and potassium contents of 20 and 2003 ppm respectively. Descriptors using 15 morphological, 18 reproductive and 8 fruit characters were completed on 13 cultivars. Leaf polyphenol analysis in 23 cultivars belonging to 6 geographic regions revealed that the cultivars collected from Guam Islands, had a minimum phenol content (5.3mg/g FW) compared to the ones from Ivory Coast (9.8 mg/g FW in



Fig. 1. Chowghat Orange Dwarf

Cameroon Red Dwarf).

Out of 810 palms of South Pacific collections maintained at World Coconut Germplasm Centre, Andamans, 756 palms have flowered so far. Time taken for flowering was minimum (50.6 months) in Hari Papua Dwarf from French Polynesia. Among tall, it varied from 56.9 months in Niu Ui from Tonga Islands, to 85.5 months in Rangiroa Tall from French Polynesia.

One indigenous oil palm *dura* accession, as well as another *E. oleiferax E. guineensis* collection and a clonal material from Costa Rica were planted in the main field. Five thousand five hundred *tenera* sprouts representing 52 cross combinations were procured from ASD, Costa Rica for Genotype x Environmental studies. Selfed and *inter se* crossed progenies of seven *tenera* palms were planted during the year to regenerate desirable *pisiferas*.

In arecanut, nine more exotic accessions along with the indigenous collection from Sirsi were planted in the alternate germplasm bank at Mohitnagar (West Bengal) bringing the total holdings to 32. Hirehalli Dwarf is a potential donor of dwarfing genes for arecanut improvement. Floral biology of this mutant was found to be distinct, as the male (32 days) and female phases (5 days) were shorter as compared to that of Mangala, which has a male phase of 37 days and female phase of 21 days (Fig. 2).

Twelve cocoa accessions received from the University of Reading, U.K. were added to the germplasm during the year, bringing the total collection maintained at Vittal (Karnataka) to 105. Twenty two cocoa ac-

cessions were planted in the alternate cocoa germplasm bank at Kannara (Kerala).

Evolving high yielding varieties by selection and hybridization

The comparative performance of MAWA with three other hybrids and WCT planted in 1981 under rainfed condition indicated that WCT (98 nuts) and COD x WCT (80 nuts), out-yielded MAWA (48 nuts) in the total number of nuts produced since 1987. MYD crosses with Kenya Tall and Zanzibar maintained their superiority in terms of the total number of leaves produced so far. The hybrid WCT x COD exhibited 100 percent flowering compared to only 13 percent in WCT, six years after planting.

'Mohitnagar', an indigenous cultivar of arecanut has been recommended for release during 1991 for North Bengal and coastal Karnataka. The striking features of this variety are, its greater uniformity, wider adaptability, loosely arranged bunches, early stabilization, and a higher yield of about 15.0 kg of ripe nuts/palm/year, as compared to 8.8 kg/palm/year in Mangala, at Kidu Farm in Karnataka.

The cocoa hybrid I-14 x IV-20 continued to outyield the other hybrid combinations with a cumulative yield of 89.5 pods/tree. The hybrid II-67 x IV-20 was also promising with an yield of 36.6 pods/tree/yr.

All the three combinations involving the Nigerian *pisifera* 30.103 p with 65d, 125d and 120d gave the best yields of 164, 157 and 142 kg ffb per palm respectively, among the 11 *dura* x *pisifera* combinations planted in 1976 under rainfed conditions. Adequate *tenera* x *tenera* progenies have been planted



Fig. 2. Hirehall dwarf arecanut - 1992

to recover this pollen parent.

A total of 3,48,497 *tenera* sprouts were produced for commercial and experimental plantings. Palms raised in Kari lands of Kerala did not show any set-back even after three months of submersion (Fig. 3).

Tissue, Cell and Anther Culture Research

a) Coconut

Coconut embryos from 8, 9 & 11 month-old nuts were collected, field-sterilized under the palm and inoculated in liquid Y-3 culture medium, using a simple portable inoculation hood. After a storage period of three days at room temperature, these embryos were



Fig. 3. Healthy oil palm growing under submerged condition

transferred to solid medium supplemented with BAP and NAA and incubated in dark till they sprouted. No contamination was observed so far, and 60% of the embryos germinated after one month of inoculation.

Field collected embryos of 3 exotic accessions (No. 16-7 Nos, No. 17 - 1 No. and Acc. No. 19-7 Nos) brought from WCGC Andamans were surface-sterilized with 50% chlorine water and inoculated aseptically in Y-3 agar media and kept in dark for germination.

A 17 year-old Markham Tall coconut palm from G-Block was sampled non-destructively and 1000 cultures were inoculated in various concentrations of BAP and NAA, and kept under 16 hr photoperiod for further

development.

b) Oilpalm

Leaf base tissues of an eight year old mature palm of *tenera* produced profuse callus on MS medium, where KH_2PO_4 was replaced with NaH_2PO_4 (170 mg/l).

Callus derived from tender leaf tissues of 2½ year old Indonesian *tenera* seedlings (Fig. 4) when planted for organogenesis on MS media with high BAP and Zip exhibited prominent root formation.



Fig. 4. Oil palm - Two and half year old seedling callus with somatic embryos

The seedling tissue culture-raised oilpalm clones, planted in field at Kasaragod during 1989 have now started producing female bunches.

CROP PRODUCTION

Soil fertility, nutrient dynamics and crop productivity

The integrated fertilizer management in coconut has resulted in an annual yield of 79 and 72 nuts/palm at 500 g N as urea + P + K annually, and 500g N as ureaform + P + K once in 3 years, respectively. In the studies conducted on the role of common salt as a supplement to potassium application, 81.0 per cent yield increase was recorded with 100% K application followed by 75% K + 25% Na. Leaf concentration in respect of Na and K were higher in treated palms when compared to control. Magnesium field trial showed effectiveness equally with two different sources ($MgSO_4$ & $MgCO_3$). Coconut yield was higher with 250g MgO than with other doses, and control. Plots deprived of magnesium application showed lower available magnesium content at 0-25 cm depth of soil. $MgSO_4$ recorded higher Mg content in all the depths of soil than soil treated with $MgCO_3$. The K-Mg antagonism was not clearly demonstrated in foliar analysis.

Increasing nutrient availability and disease alleviation by microorganisms

Significant increase in nitrogenase (C_2H_2 reduction) activity was obtained in sandy loam soil in response to *Beijerinckia* inoculation when soil was amended with *Mimosa invisa* to provide 1% C (W/W) under incubated conditions.

Inoculation studies with four VAM fungi at the nursery stage revealed that *Gigaspora* species enhanced the growth of coconut seedlings at the initial period. VAM inoculated seedlings when transplanted in the sandy soil

showed that the field establishment and survival were better in seedlings which received the inoculation of *Glomus macrocarpum* and *G. versiforme*. Among the nine exotic VA mycorrhizal cultures tested on oil palm seedlings under pot culture conditions, *Glomus* sp. was the most effective in enhancing seedling growth and P-uptake, with a higher level of colonization in roots.

Nutritional requirement and crop management

The high yielding coconut genotypes (WCT, COD x WCT, and WCT x COD) responded only upto the lower (m_1) level of fertilizers (500g N + 500g P_2O_5 + 1000 K_2O /palm/year) under both rainfed and irrigated conditions. The mean yield during the period 1989-90 and 1990-91 was 103, 143 and 149 nuts/palm/year, respectively under m_0 (no fertilizer), m_1 and m_2 (double of m_1) levels of manuring.

Stress and production physiology

The drought tolerant tall coconut cultivars WCT, Fiji and hybrids WCT x WCT, WCT x COD showed significantly low lipid peroxidation levels as compared to drought susceptible palms of MYD, GB, COD x WCT and COD x COD. This is well correlated with the activities of superoxide dismutase (SOD), catalase, polyphenol oxidase (PPO) and peroxidase (PO) enzymes. Drought tolerant groups were characterized by an increase in the activities of SOD, catalase and PPO, with a decrease in PO. This indicates the protective role of these enzymes in maintaining the membrane integrity of drought tolerant groups.

The superiority of the hybrid MYD x WCT over MOD x WCT, MOD x WCT and COD x WCT was maintained both in terms of growth characters and relative tolerance to drought.

The F_1 hybrid seedlings of cocoa were obtained from crossing four high yielding trees (female parent) and four drought tolerant trees (male parent). The clonal material from parents and F_1 seedlings (10 hybrids) were screened for drought tolerance using the rapid screening method. The hybrid combinations I-21 x NC 42/94, I-29 x NC 23-94 retained higher leaf water potential in excised leaves in the screening method as compared to others indicating their relative drought tolerance.

In oilpalm, FFB yield recorded for the different fertilizer levels viz. F_0 (no fertilizer) F_1 (600:300:600), F_2 (1200:600:1200) and F_3 (1800:900:1800) were 103, 125, 165 and 153 kg/palm/year respectively. The F_2 level was significantly superior recording an yield increase of 60% over F_0 and 32% over F_1 levels.

Cumulative yield for 2 years with irrigation treatments showed that the I_2 level (90 l/palm/day) recorded significantly higher FFB yield of 150 kg/palm/year compared to 125 and 135 kg for I_0 (no irrigation) and I_1 (45 l/palm) levels.

Irrigation x Fertilizer interaction was not significant.

Perennial crop based farming systems

Among the various vegetable intercrops raised in a middle-aged coconut garden, brinjal (6120 kg/ha), snake gourd (4920 kg/ha) and amaranthus (4680 kg/ha) gave satisfactory yields during kharif season. In the rabi season

under irrigated condition, bottle gourd gave the highest yield of 6,610 kg/ha.

Soybean varieties PK-472 (980 kg/ha) followed by MACS 58(827 kg/ha) and Gaurav (795 kg/ha) gave significantly higher seed yields than the other nine varieties raised as intercrops in coconut garden.

The total output from the second generation mixed farming unit started in 1989, was 21,347 coconuts, 12,719 litres of milk, 169 kg banana, 319 kg poultry birds, 45 kg rabbits and 20 kg quails (all live weights), 1929 hens' eggs and 3948 quails' eggs. The total revenue from the system was Rs. 1,58,503 giving a net income of Rs. 52,693.

Drip irrigation with 20 l/tree/day and application of 100:40:140g N, P_2O_5 , K_2O /tree/year was found to be optimum for the initial growth of cocoa as intercrop in arecanut garden.

At Mohitnagar (N. Bengal), system consisting of arecanut, banana, cinnamon and betelvine gave the highest net return of Rs. 95,359/- per ha compared to only Rs. 36,044/ per ha in the arecanut monocrop. The annual recycling of biomass was found to be maximum (17 t/ha) in the system involving arecanut, black pepper and cocoa.

The net return for the coconut + cassava cropping system at the present price level was found to be Rs. 15,200/ha as against Rs. 5,250/ha from the coconut monocrop. The estimated Income Equivalent Ratio (IER) for the coconut + cassava system was 1.65. The return to labour in the case of coconut + cassava system was Rs. 60.60/manday, while it was Rs. 43.60 for coconut monocrop.

During 1983-84, banana, pineapple, pepper, cocoa, coffee and clove were introduced in a mature arecanut garden, and the gross margin was negative (—Rs. 1300/ha) due to the establishment cost of the component crops. In the following year, banana and pineapple started yielding, and as a result of increased yield and higher price of arecanut the gross margin shot upto Rs. 35,000. The gross margin increased in the next year to Rs. 1,16,450. In 1987-88 all the component crops attained full bearing stage except clove.

The gross margin was however, reduced to Rs. 96,550 due to low return from arecanut. The yield and price of arecanut, improved remarkably during 1988-89 and gross margin reached Rs. 1,17,500 in spite of lower returns from component crops. During 1989-90, due to fall in arecanut yield by 40 per cent the gross margin was reduced to Rs. 75,350. The gross margin was further reduced to Rs. 66,900 in 1990-91 due to a significant decline in the yield of main crop as well as component crops.

PRODUCTION OF PARENTAL MATERIALS AND BREEDERS' STOCK

In coconut, 31,862 seednuts of promising cultivars and hybrids were produced during the year, of which 29,794 were utilized for sowing and the remaining 2068 seednuts were distributed to farmers. Over 2466 hybrid seedlings and 8425 seedlings of different varieties were supplied to co-ordinating centres, government institutions and farmers. A compact block of Andaman Ordinary (319 seedlings) and Benaulim (178 seedlings) was established at Kidu Seed Farm.

In arecanut, 5,26,710 seednuts and 31,070 seedlings of four released varieties and South Kanara local were supplied to farmers and other government agencies, and 8050 sprouts of local variety were also supplied.

A new biclinal orchard of cocoa has

been established at Kidu farm with the clones I-14 and IV-20.

A total of 3,48,497 oil palm seeds were produced by crossing 40 selected *duras* with 12 selected *pisiferas* at the Oil Palm Station, Thodupuzha and at Palode. Out of these, 2,29,130 sprouts/seedlings were distributed to various agencies. In addition to the above, 28,144 seeds were also obtained from 12 *dura* inflorescences (open, self and *inter-se*). Out of the sprouts obtained from these crosses, 520 d x d sprouts were supplied to A.P. Oilseed Growers Federation, and the remaining 23,402 were used for experimental purposes. A Cess Fund Scheme entitled "Indigenous production of oil palm hybrid seeds" was sanctioned by the ICAR for the production of oil palm seeds.

CROP PROTECTION

Root(wilt) disease of coconut

Observations of Mycoplasma-like organisms in the brain tissue of *Proutista moesta* having 38 days of acquisition and incubation period of root(wilt) affected palms (Fig. 5) is a very critical lead in the transmission of root(wilt). This assumes great significance since *P. moesta* is a proven vector of the Yellow Leaf Disease of Arecanut and also that it flocks in great numbers on oil palm.

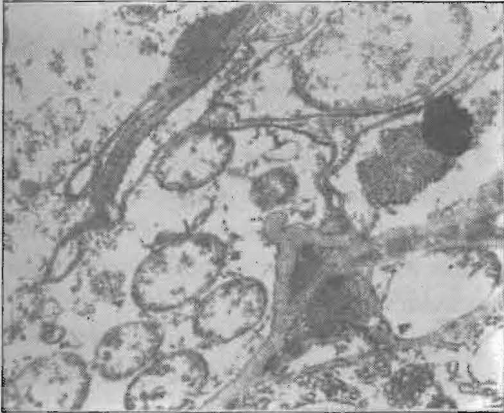


Fig. 5. MLOs in brain tissue of *Proutista moesta*

Breeding for resistance/tolerance to root(wilt) disease in 'hotspots' has been further intensified with the addition of 37 more high yielding and disease-free palms during the year. A total of 700 progenies have been raised from inter-se, selfing and CGD x WCT crosses for further field testing in hot spots.

A comprehensive survey conducted in 10 villages of the belt area in Thrissur District during July-August 1991, revealed the recurrence of root(wilt) disease in 217 gardens (669 palms) out of the 358 gardens observed, and fresh incidence (2533 palms) was noticed

in 840 gardens. Out of the total number of 55,709 palms observed, only 5.75% palms were found to be diseased, during the past ten years thus giving testimony to the effectiveness of the eradication programme.

Constant association of more than one fungus namely, *Colletotrichum gloeosporioides*, *Exserohilum vermoeseni*, *Fusarium solani*, *F. moniliforme* var. *intermedium*, *Thielaviopsis paradoxa*, *Cylindrocladium scoparium*, *Rhizoctonia* and *Pythium* sp., were recorded with varying frequencies in leaf rot affected tissues. Pathogenicity of nine species of fungi were established by a detached leaf inoculation technique. This observation suggests the involvement of one or more fungi in the development of leaf rot symptoms. Four genera of fungi viz. *Colletotrichum*, *Exserohilum*, *Gliocladium* and *Fusarium* were the dominant groups of pathogens isolated.

Stem bleeding disease of coconut

Field control trials involving Bavistin (Carbendazim) and Calixin (Tridemorph) applied to the stem bleeding affected palms indicated that the treatments with Bavistin (5%) applied through root feeding, and Calixin (5%) applied through stem injection, were better in reducing the rate of spread of the lesion and also in increasing the yields of the affected palms.

Studies carried out on translocation and persistence of tridemorph (Calixin) in coconut stem using bioassay method showed that Calixin, when applied through root feeding @ 2ml, 5ml, 10ml/palm left residues both on

feeding and opposite sides upto 3m height in the coconut stem, for a period of 45 days. No detectable levels of tridemorph were found in the nut water samples from 4, 6 and 10 months old nuts of the treated palms.

Carbendazim (Bavistin) at 1000 ppm concentration was fungicidal to *Trichoderma harzianum* and fungistatic to *T. viride*, whereas Tridemorph (Calixin) was only fungistatic even at 500 ppm, to both these promising antagonists of *Thielaviopsis paradoxa* - the incitant of stem bleeding.

Studies on Thanjavur wilt/Ganoderma wilt

A fluorescent antibody technique has been standardized for the early detection of *Ganoderma* infection in coconut. (Figs. 6 and 7). This facilitates the adoption of plant protection measures in the initial stage of the disease itself. *Trichoderma viride* and *T. harzianum* were found to suppress *Ganoderma* in potculture studies.

Yellow Leaf Disease of Arecanut

Further evidence on the vector role of the plant hopper *Proutista moesta* have emerged from transmission experiments. Of the 15 healthy *Areca* seedlings inoculated with *P. moesta* in August 1986, nine showed the characteristic symptoms of the disease, and MLOs have been located in three of them. In another experiment, out of nine seedlings inoculated with *P. moesta* since 1990, six exhibited symptoms of the disease.

Experimental transmission of the disease from diseased to healthy areca seedlings was achieved through the dodder laurel, *Cassytha filiformis*. Detection of MLOs in the source palm, connecting dodder laurel, and in the recipient areca seedlings conclu-

sively established the transmission of the disease.

Among the cross combinations screened for their field tolerance against the disease, 'Saigon' x 'Mangala' continued to give maximum yield with minimum disease intensity. 'Mangala' and its segregants showed better field tolerance than South Kanara variety.

Spear rot and other diseases of oilpalm

Electron microscopic examination of rachillae of unopened inflorescences, and submeristematic tissues from six spear rot affected oil palms revealed the presence of Mycoplasma-like Organisms (MLOs) in the sieve tubes (Fig. 8). The diseased palms studied were in the early stage of disease and were 2-9 year old. Structural changes like phloem necrosis, compression of sieve cells and presence of large number of cell organelles in cells adjoining the vascular tissues were also evident.

In a 15-year old oil palm plantation under Forest and Plantation Development Corporation, Little Andamans, upper stem rot disease was recorded in 42 out of 20,000 palms. Symptoms of the disease are, gum exudation, stem bleeding and rotting (Fig. 9) which result in snapping of upper portions of the stem (Fig. 10).

Black pod disease of cocoa

Natural incidence of black pod disease caused by *Phytophthora capsici* Leonian was observed in addition to *Phytophthora palmivora* in Devikulam and Udumbanchola taluks of Idukki district. *P. capsici* grew well on carrot agar medium and exhibited a petaloid pattern of growth with white fluffy aerial mycelium (Fig. 11). The sporangia are caducous, ellip-

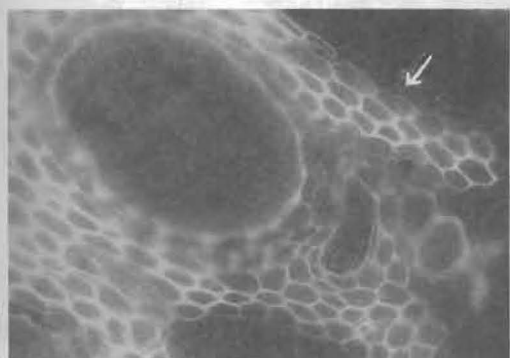


Fig. 6. Diseased : Infected root (transverse) section showing *Ganoderma* infection (apple green fluorescence) in phloem cells.

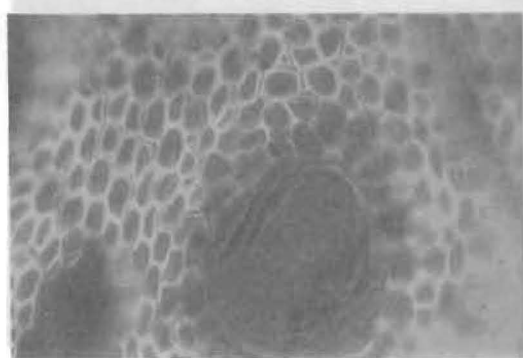


Fig. 7. Control : Root (transverse) section of coconut showing normal fluorescence.

soid with a tapered base and have characteristically long pedicel (Fig. 11). This is the first record of *P. capsici* on cocoa in India.

Crown choking disease of coconut in Assam/ West Bengal

The survey conducted in Assam showed that the disease incidence is maximum (14.4%) in Kamrup district. In Rangia sub-division of Kamrup district, the incidence is 18.9%. The total loss in yield due to the disease in Assam is estimated at 6.38 million nuts. The disease is caused by boron deficiency. The boron level

in diseased leaves ranges from 5.4 ppm to 7.4 ppm as against 9.4 - 10.2 ppm in leaves of healthy palms. Field control trials revealed that palms in the early and middle stages of disease recovered when borax is applied even at lower doses in the basin at half-yearly intervals.

Pest Management

The baculovirus of *Oryctes* introduced into Androth Island, Lakshadweep in 1988, has established there within 4 years and nearly 85 percent of the pest population has been infected by the pathogen. As a result of the establishment of the pathogen on the pest population, the pest damage on coconut palm has been brought down from 7.5 per cent to 0.3 per cent in the case of spathe and from 24.3 per cent to zero in the case of the spindle.



Fig. 8. MLOs in sieve tube of rachilla of Spear rot affected oil palm.

The plant hopper, *Proutista moesta* was found to be parasitized by a hymenopteran in the field. More than 45 per cent of YLD-affected gardens in Dakshina Kannada, Chickmagalur and Shimoga districts of Karnataka lodged the population of plant hopper.



Fig. 9. Upper stem rot of oil palm - Initial rotting beneath the bleeding patches on stem.

The biology of *Chilocorus nigritus*, a predator of scale insects was studied in the laboratory culture of *Aonidiella orientalis*. The life cycle is completed in 23-28 days. About 120-125 scale insects were consumed by one adult in a single day.

The adult beetles of the coconut white grub *Leucopholis coneophora* were found feeding on tender leaves of mango in laboratory cages. The white grub species *Anomala chlorocarpa* were regularly collected from light-trap catches besides a few *Leucopholis coneophora*. Observational trial and pot culture studies indicated the superiority of Phorate 10g in controlling the *L. coneophora* grubs:



Fig. 11. Sporangia of *P. capsid*



Fig. 10. Snapping of the upper portion of the stem.

Arecanut white grub survey in Chickmagalur and Uttara Kannada districts revealed the occurrence of white grubs viz., *Holotrichia* sp., *Leucopholis burmeistri* Brenske, and *L. lepidophora* Bum. Under laboratory conditions, the adults of *L. lepidophora* were noticed feeding on *Ficus glomerata*. A survey was conducted to assess the white grub damage to coconut gardens in Kasaragod and Kannur districts of Kerala.

Search for natural enemies of the cocoa defoliating caterpillar *Lymantria ampla* has revealed the presence of two larval parasites, a pupal parasite, and a fungal pathogen.

Vertebrate pest management

The natural food habits of *Rattus rattus wroughtonii* Hinton, in coconut and cocoa gardens were studied by stomach content analysis. The observations revealed the presence of both plant and animal matter in their diet. So far, 15 plant and 10 animal materials were identified. Among them, the male flowers of coconut (rudimentary pistil and staminodes) were found to be the most common food both in terms of their frequency of occurrence (65%) as well as the quantity

(41%) consumed. Cocoa, tender coconut shells, wild grass seeds, small ants, grubs and certain insects were the other common food materials of these rats. Mosses, fruits of *Physalis minima* and oil palm, coconut kernel, beetles, ground roaches, caterpillars, etc. were also found occasionally.

Integrated Nematode Management

Residues could not be detected using GLC method 40 days later, in water and meat of tender coconuts, and in water, meat and copra, coconut oil and oil cake of mature nuts of palms treated with carbofuran, phorate and ebufos @ 3g a.i./palm in the crown and also ebufos @ 10g. a.i./palm in the basin. But in the case of carbofuran and phorate @ 10g a.i./palm in the basin, the residues detected were below tolerance limit. The treatments were repeated after three months on the same palms. Second set of samples collected 40 days after the treatment also did not show residues

beyond the tolerance limit. The GLC analyses were done at Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, Bayer (India) Limited, Bombay, and Rallis India Ltd., Bangalore.

Growth and yield of mycorrhizal (*Glomus mosseae*) and non-mycorrhizal banana (cv. Njalipoovan) were compared under field conditions at CPCRI, Kayangulam. The mycorrhizal plants recorded an increase of 18,31,36,40 and 30 per cent over non-mycorrhizal plants in respect of height, leaf area, bunch weight, number of hands, number of fingers and shoot weight respectively.

Application of phorate or Furadan or neem-oil cake, alone or in combination with each other, twice a year, have significantly brought down the nematode population and increased the yield of arecanut in the yellow leaf disease affected arecanut palms.

HARVEST AND POST HARVEST TECHNOLOGY

Processing of ball copra

The cost benefit analysis of the preparation of ball copra by heat treatment and control reveals that the profit by the former

method over the latter is Rs. 6.45/kg of ball copra only (cost of ball copra taken as Rs. 3600/quintal as on 1-1-1992).

REFINEMENT OF EXPERIMENTATION TECHNIQUES IN PLANTATION CROPS

A new method is proposed to analyze the data obtained from observational trials which are hitherto not treated statistically. The method consists of working out estimates of error obtainable and generating a distribution for each treatment under the assumption of normality for error. A non-parametric test (Mann Whitney) is then used to compare different treatments. This method will help interpretation of data from observational plots in an objective manner.

In Kannur District, 1671243 palms were affected causing a loss of 1365.08 tonnes of chili.

A comprehensive survey conducted in five districts of Karnataka, viz. Dakshina Kannada, Kodagu, Chikmagalur, Shimoga and Uttara Kannada with the help of Departments of Horticulture and Agriculture, Karnataka, has revealed 7,69,340 areca palms affected by YLD causing a loss of 508 tonnes of chili annually. (Table 1)

Estimation of crop losses

The survey completed in Kasaragod and Kannur districts of Kerala showed that 4903 palms were affected by stem bleeding disease in Kasaragod district causing a loss of 1.05 lakh nuts annually and in Kannur district 7363 palms are affected causing a loss of 1.75 lakh nuts annually.

In another survey carried out in Kasaragod and Kannur districts with the help of the Department of Agriculture, Kerala, 4494 palms were found affected by YLD in Kasaragod district with a loss of 2.76 tonnes of chili.

Table 1. YLD affected arecanut palms and estimated yield loss in Karnataka.

District	No. of palms YLD	Loss in yield in tonnes (Estimated)
D. Kannada	13,027	7.28
Kodagu	46,857	7.86
Chikmagalur	5,15,269	404.58
Shimoga	1,92,040	86.81
U. Kannada	2,147	1.72
TOTAL	7,69,340	508.25

AGRICULTURAL ECONOMICS

Seasonal behaviour of coconut prices :

The monthly wholesale prices of coconut and its products for the year 1986 to 1990 exhibited a distinct seasonal pattern. The coconut prices ruled high during December-May and low during June-November. The trend of monthly wholesale price of copra as

well as coconut oil which always moved together, was different from that of coconut and was high during October-February and low during April-September. It was seen that a third degree polynomial fits very well to the average wholesale prices of coconut, copra and coconut oil (Fig. 12).

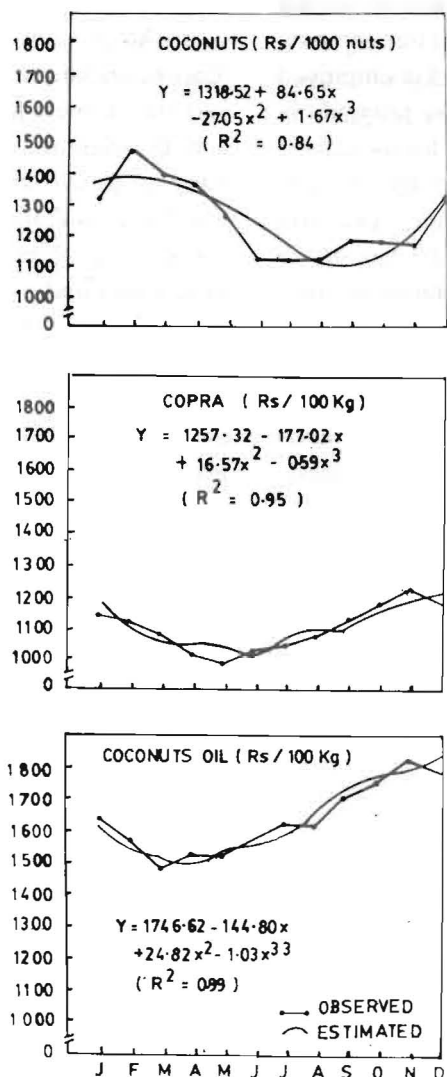


Fig. 12 Monthly whole sale price in Calcut Market (1970-90)

TRANSFER OF TECHNOLOGY

Eight training courses were organized during the year for 48 officials from eight states and Lakshadweep on various production technologies of Plantation Crops Management. A special training on biological suppression of coconut caterpillar, *Opisina arenosella* was arranged for the staff from different Parasite Breeding Stations in Kerala. In addition, training on plant protection and coconut tree climbing were given at Kayangulam for 25 unemployed youths. At Kasaragod, a 2-day programme was organized in two batches for 54 Subject Matter Specialists sponsored by the Department of Agriculture, Assam. One day training were also given to 20 farmers of Andhra Pradesh and 198 farmers from Karnataka, on Oilpalm cultivation at CPCRI (RC) Palode.

In the 16 Research-cum-Demonstration plots maintained in farmers' fields, coconut yield increased by 2-73% over control.

Yellow leaf disease recurrence was noticed in 13 arecanut palms in two gardens in the ORP village where the affected palms were removed earlier. Fresh incidence of YLD was also noticed in two 6-year old palms in an adjacent garden.

An All India Exhibition on the theme "Coconut in India" was organized in connection with the Platinum Jubilee of Coconut Research and Development in India held at CPCRI, Kasaragod from 26-30 November, 1991, in which 24 organizations participated. In addition to this, the Institute also participated in 7 other exhibitions and brought out 14 extension publications. A Kisan Meala was organized during the Platinum Jubilee Celebrations on 30-11-1991 and a total of 490 farmers from six different states attended. Scientists of the Institute gave 19 radio talks on Plantation Crops' technologies.

ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS

Crop Improvement

At Veppankulam MYD and MGD gave an average annual yield of 100 and 86 nuts per palm respectively. Among the tall, Andaman Giant and Lakshadweep Ordinary gave an average yield of 121 and 114 nuts per palm per year. The hybrid ECT x MYD (VHC-2) gave an average yield of 105 nuts/palm/year which is 123% more than that in ECT. At Ratnagiri, Lakshadweep Ordinary and Pratap (Banawali Green Round) produced an average of 133 and 104 nuts per palm per year. The 13-year cumulative mean yield for these two varieties are 151 and 149 nuts/palm/year respectively. At Mondouri (Kalyani) Jamaican Tall produced an average annual yield of 67 nuts per palm followed by B.S. Islands (65 nuts/palm). At Ambajipeta, maximum nut yield was recorded in Laccadive Ordinary (140 nuts/palm/year) followed by COD x WCT (137), and maximum copra content was in Cochin China (235 gm/nut). At Kahikuchi, Tall x Gangabondam exhibited more tolerance to crown choking disease.

Crop Production

At Veppankulam the treatment combination $N_2P_2K_3$ (1000 N + 500 P_2O_5 + 1750 K_2O gm/palm/year) recorded the highest cumulative nut yield over ten and a half years (829 nuts/palm), which represents a 206% increase over control. At Mondouri (Kalyani) the maximum cumulative yield (183 nuts/palm) and maximum copra weight (180 g/nut) were recorded in the treatment $N_3P_1K_1$ (N:P:K = 1500, 250, 750 gm/palm/year). At Ambajipeta also, the above treatment gave an average annual yield of 106 nuts/palm.

Turmeric was found to be the most promising intercrop at Andamans. At Ambajipeta, the yield of coconut has increased considerably after imposition of mixed cropping. At Kahikuchi, the coconut based high density multispecies cropping models I and II gave a gross annual return of Rs. 23,562/ha and Rs. 26,717/ha, as against Rs. 8,666/ha in coconut monocrop. At Ratnagiri, the yield/palm has increased gradually after mixed cropping, from 24.25% to 93.13% at the end of 9th year in different intercropped blocks. At Veppankulam, button-shedding was less in palms which received irrigation and fertilizer.

Crop Protection

From a trial initiated during 1980, the following events in chronological order were observed in 'Tatipaka' disease symptom development.

1. Appearance of translucent chlorotic spots, reduction of leaf, twisting of fronds with slightly pale green foliage, in early stages of disease development.
2. Appearance of fasciation of leaflets, reduction in number of leaves, small round nuts admixed with atrophied nuts in bunches in later stages.
3. The palms finally become barren, unproductive, with few leaves and tapered trunks, in severely diseased condition.

Light microscopy studies established the presence of MLOs in Tatipaka disease-affected palms. The survey of these palms

in East Godavari district of Andhra Pradesh was completed, and till now, 5188 disease-affected palms have been eradicated. The management and varietal screening trials are in progress at Ambajipeta centre. At Ambajipeta and Veppankulam all fungicidal treatments in combination with neemcake are effective in increasing cumulative nut yield of infected palms and also in reducing the disease-severity of Thanjavur/Ganoderma wilt.

After inundative release of larval parasitoids of coconut leaf-eating caterpillar, *Bracon heletor* and *Goniozus nephantidis* in

a pest-affected coconut garden at Ambajipet, the parasitization increased from 0.1% to 15.92% and from 0.6% to 7.96% respectively. A steep fall in the mean pest population, from 2381 to 235 insects per palm, was recorded after release of parasitoids.

Brachymeria nosatoi, pupal parasite of coconut leaf-eating caterpillar, was mass multiplied in the laboratory and inoculated first time in the field. The parasite was well established in the field with 45% recovery and pest population was suppressed by 70%.

