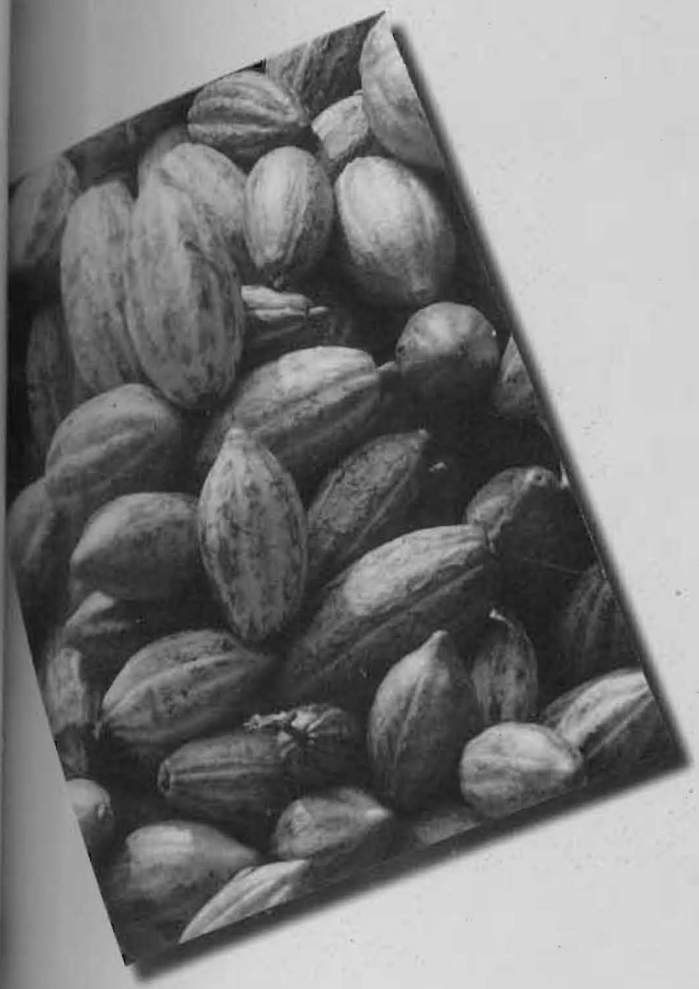
RESEARCH HIGHLIGHTS



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CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
KASARAGOD 671 124 KERALA

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

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INTRODUCTION

The Central Plantation Crops Research Institute established in 1970 is vested with a mandate to carry out problem oriented research programmes on coconut, arecanut, oil palm and cocoa under different agro-climatic conditions. In addition to the research work undertaken at 11 centres, multi-location programmes are taken up with the co-operation of Universities in 17 centres under the All India Co-ordinated Research Project on Palms. The Institute Village Linkage Programme and the Krishi Vigyan Kendra also help in strengthening the technology transfer programmes.

During the year, Institute witnessed the successful finale of many of the important events such as Group meeting of Nematologists (Hortinema '98), two Group meetings on leaf rot and root (wilt) disease of coconut, Summer school on Harvest and post harvest technology and hosting of the ICAR Interzonal sports meet. Besides, Research Advisory Committee and Quinquennial Review Team successfully conducted their reviews.

On the research front few of the notable achievements are, enrichment of the coconut and arecanut germplasm, selection of high yielding cocoa progenies, standardization of organic farming technology, standardization of fertilizer requirement of arecanut, finding out remedial measures for eriophyid mite problem, management of fruit rot of arecanut through novel method etc.

I am presenting with great pleasure, the Research Highlights 1998 of CPCRI which contains the salient achievements for the nine month period (April to December 1998). The efforts taken by all of my colleagues in bringing out the publication promptly is commendable.

Kasaragod
Date: 20 January, 1999

(KUK Nampoothiri)
Director

CROP IMPROVEMENT

COCONUT

Germplasm enrichment

Coconut germplasm was enriched with 21 collections (10 from Orissa and 11 from West Bengal). Morphological, reproductive, yield and fruit characters were recorded in source population. Clustering using PC scores showed Orissa Giant and Bana to be very divergent among the Orissa ecotypes and Chandran Nagar Tall and Jaguly Yellow Dwarf to be very distinct among the West Bengal collections.

Growth and yield studies

Analysis of yield components in 16 cultivars planted in 1972 revealed that the cultivar Laccadive Micro produced significantly more number of female flowers (289) as well as higher number of nuts per palm (157). However, the cultivar Cochin China had significantly more copra (18 kg/palm/year).

Seventy cultivars were subjected to analysis of divergence by Mahanobis generalized distance (D2) for fruit components. Fortysix cultivars formed one cluster at lower level. Three clusters were found at the broadest level with cluster size, 6, 37 and 3. From the remaining 24 cultivars, three clusters of two cultivars each and one cluster of size 4 were obtained. Husk related characters were found to contribute more to the divergence.

Estimation of leaf polyphenols and OD phenol were undertaken in four cultivars. OD phenols ranged from 25.3 mg/FW to 63.1 mg/FW, while the total phenol content (as chlorogenic value) varied from 13.7 g/gFW to 32.2 mg/gFW.

At WCGC, Andamans, yield of nuts was highest in Acc. No. 18 (Hari Papua Dwarf from French Polynesia) with 63 nuts per palm. Intra popular diversity and double spadix (cover) was noticed in Acc. No. 5 (Niu Leka Dwarf from Fiji Islands). Double spadix (cover) and fused leaflet was noticed in palm No. 5/35.

Tender nut studies

Tender nut water analysis in four accessions showed that Acc. No. 18, tree No. 100 had higher sugar content (7.3%) while Acc. No. 2, tree No. 1 (Solomon Tall from Solomon Islands) had the maximum quantity of tender nut water (581.5 ml/nut)

Breeding for high yield

Two hybrid evaluation trials were laid out at CPCRI Seed Farm, Kidu in Randomised Block Design with a plot size of six palms. One trial involves eight new TxT combinations along with two checks and the second involves cross combinations screened for drought stress.

In hybrid evaluation trial III planted during 1972, WCT x COD gave higher yield under rainfed condition due to the drought tolerant nature. Analysis of the cumulative nut yield for four years (1992-1996) in the diallel experiment planted during 1972, revealed Laccadive Ordinary to be the best general combiner and LO x GB as the best specific combiner among the 36 combinations evaluated.

Embryo culture

Seventysix *ex vitro* established plantlets

belonging to different accessions collected from Indian Ocean Islands were transferred to net house for future planting.

***Ex vitro* established plantlets collected from Indian Ocean Islands**

Sucrose as carbon source resulted in highest germination (51%) of embryos followed by glucose (42%) and sorbital (27.5%). Mannitol inhibited embryo germination indicating their use in *in vitro* conservation.

Leaf culture

Somatic embryogenesis could be induced in leaf cultures. Callus was induced in leaf cultures by co-culturing the coconut leaf explants with the callus of *Holostemma*. Roots can be maintained in slow growth condition in both solid medium as well as stationary liquid medium. The roots which were maintained since Feb. 1997 have reverted the growth pattern to that of the roots cultured fresh when transferred to media containing IBA. Callus was found to develop from the vascular region of the roots cultured.

Molecular markers

Partial genomic library of coconut was constructed by cloning 1-2 kb EcoRI fragment of WCT DNA into plasmid PVC 18 and transforming to *E. coli* DH5x.

ARECANUT

Exploitation of dwarfing gene of Hirehalli Dwarf

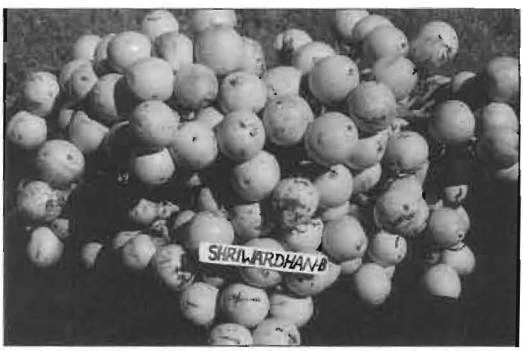
Among the eight hybrid combinations involving H.Dwarf and released varieties of arecanut, which are under evaluation for high yield and dwarfness at Vittal, the hybrid Mohitnagar x H.Dwarf exhibited its potential to yield four buches with 386 ripe nuts per palm in the first year of bearing (six years after planting). Morphologically, the palm is intermediate, as far as height is concerned

Mohitnagar x H. Dwarf hybrid

and possesses medium thick stem and well spread and partially drooping crown. The ripe nuts are oval to elongated and light yellow in colour which is comparable to Mohitnagar variety.

Shriwardhan - Bold arecanut accession

A collection of germplasm from Konkan region helped in adding 15 more ecotypes to the existing germplasm bank making the total holdings to 128 at Vittal. Among the collections, Shriwardhan - an accession with bold nuts (70g) collected from Raigad district of Maharashtra was found to be very promising. Colour of the nut is light yellow and kernel is red in colour and round in shape. Highest recovery of about 30% chali is reported.



Shriwardhan - Bold arecanut accession

COCOA

High yielding cocoa clone

A Nigerian clone (NC 55) had a high degree of precocity, bearing pods by 18 months after planting. It yielded more than 50 pods in the second crop when attaining a canopy size of only 0.83m^3.

High yielding cocoa progenies

Six best cocoa hybrid combinations

Grafted cocoa NC-55 with heavy pod bearing in $2^1/_2$ year of planting

were identified from three progeny trials viz. Na 33 x ICS 89 (Progeny I), I-56 x II-67, I-14 x I-56, III-35 x IV-20, I-14 x NC 42/94 and I-56 x IV-20 (Progeny II) and two best Nigerian clones in NC 45/53 and NC 38/119. All these have recorded an average annual dry bean yield of more than one kg per plant with a CV value less than 30% over the years.

OIL PALM

Embryo rescue

Embryo rescue of self-pollinated *pisifera* was successfully carried out. 32% embryos could be rescued in Eeuwen's Y_3 basal medium supplemented with 0.5 mg/ l NAA and 0.5 mg/ l BAP.

COCONUT

Vermicompost - An ideal carrier for biofertilizer

Vermicompost prepared from coconut wastes and coir pith was found to be an ideal carrier material to prepare biofertilizers of nitrogen fixing *Beijerinckia indica* and phosphate solubilising bacteria.

Organic farming technology

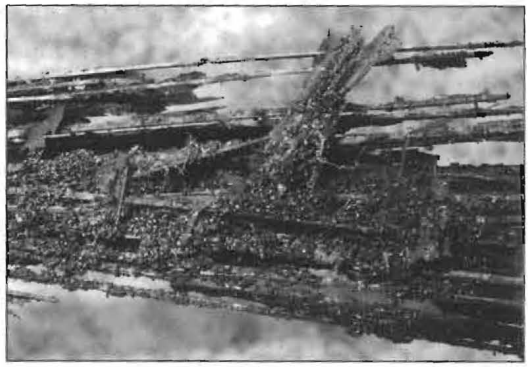
The local earthworm capable of composting coconut palm wastes has been identified as a new race of *Eudrilus* and can be differentiated from the strain from Africa by its much darker pigmentation and hard cocoon case. The local race is highly active and is capable of forming burrows in soft bedding materials.

In situ vermicomposting in coconut palm basins and heaps in the interspaces of palms has been standardised using the local race of *Eudrilus*.

Yet another locally collected earthworm belonging to epi-anecic group and identified as *Amynthas alexandri* has been found suitable along with the local race of *Eudrilus* for composting for coir pith.

Alley cropping of *Glyricidia*

In coastal sandy soil, growing of *Glyricidia* in three rows between two rows of coconut palms resulted in the production of 10655 kg fresh leaf matter with three prunings per year (February, June and October) after three years of planting. By recycling this green matter in to the coconut basin, it is possible to substitute the entire nitrogen and 20% of phosphorus and potassium requirement of coconut palms.



Coconut leaf in advanced stage of vermicomposting

Drip irrigation studies

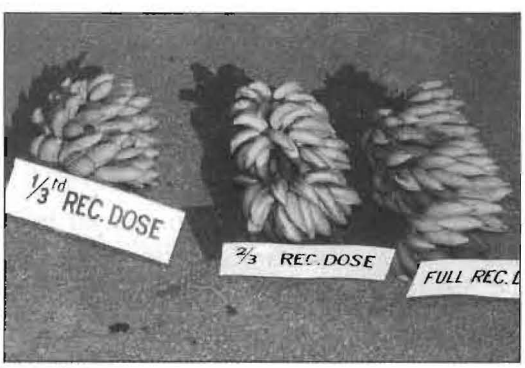
Drip irrigation at the rate of 66% of open pan evaporation (Eo) proved to be the best method of irrigation in littoral sandy soil with a water saving of 34% compared to 100% of Eo of basin and drip method and the nut yield (75 nuts/palm/year) was on par with 100% (78 nuts/palm/year) and 133% of Eo (67 nuts/palm/year) through drip and 100% (71 nuts/palm/year) basin. Irrigation along with mulching resulted in significantly higher yield. The benefit cost ratio for drip irrigation was higher (2.02) compared to basin irrigation (1.68) and rainfed control (1.07).

In the cultural cum manurial trial under red sandy loam soil, the treatment combination of all management practices (cultivation+organic+inorganic) continue to give maximum yield (114 nuts/palm/year) in rainfed conditions and it was 300% more than the yield in the neglect plot.

Coconut based cropping systems

The total output from 1.2 ha area coconut based HDMSCS model during the period July 1997 to June 1998 was 28,429 coconuts, 13.83 kg dry clove buds, 412.1 kg of pineapple fruits, 285.7 kg of banana bunches, 98.2 kg of bread fruits and 93.0 kg of jack fruits. The total cost of cultivation was worked out at Rs. 42,000/year with gross return of Rs. 1,20,724 and net returns of Rs. 78,724 from the entire system.

With respect to response of system graded levels of fertilizers, coconut yield decreased gradually with reduction in fertilizer level below two-third dose. The lowest yield was recorded in control treatment (130 nuts/palm/year), which increased gradually with increase in fertilizer dose and recorded the highest yield of 170 nuts/palm/year in two-third dose. The component crops yield also varied substantially under graded levels of fertilizers. The results show that for sustainable production of coconut as well as that of component crops in this system, a minimum of two-third dose of recommended fertilizer of individual crops is required.



Banana (Kadali variety) bunches grown under different levels of recommended fertilizers in HDMSCS

Soil and plant samples were collected from both the main as well as component crops and analysed for their N, P and K content. Palms in one third, two-third and full dose treatments recorded higher leaf N, P and K contents over control, than those in one-fourth and one-fifth treatments in both main as well as component crops. Soil available P and K status increased with fertilizer doses, at both the depths. Nutrient exhaust studies carried out in coconut indicated that from full dose of fertilizer treatment, around 14.6 tonnes of biomass/ha in the form of dried leaves, spathes, bunches and husk is available for recycling. Based on their nutrient content, the extent of N, P and K that can be supplied through the recycled coconut wastes are 74.26, 10.74 and 115.84 kg/ha respectively.

Nursery techniques

Sowing in potting mixture either in polybag (T-4) or in cement tank (T-8) led to production of more vigorous seedlings, exhibited by way of early germination, higher seedling height, girth, number of leaves, better root system and higher drymatter production/seedling. The mean recovery of vigorous seedlings indicated higher recovery in polybag with potting mixture T-4 (82.5%) and lowest in conventional field nursery i.e., T-1 (55.4%). The cost of production for 100 seednuts ranged from Rs. 740 in T-1 (conventional) to Rs. 1688 in T-4 (polybag with potting mixture). Considering the advantages of polybag seedlings in reducing field transplanting shock and early flowering and nut bearing, which sufficiently compensates for higher production cost at later stage, racing of seedlings in polybag with potting mixtures should be preferred over conventional nursery technique.

WCT coconut seedlings grown in polybag with different growing media

Fertilizer requirement of high yielding coconut

The results of the experiment regarding the fertilizer response of WCT, COD x WCT and WCT x COD under rainfed as well as irrigated conditions for three levels of fertilizers, namely M_0 (No fertilizer), M_1 (500g N + 500 P_2O_5) and M_2 (1000g N + 100g P_2O_5 + 2000g K_2O / palm / year) indicated that mean nut yield / palm / year during 1997-98 differed significantly due to fertilizer levels and irrigated / rainfed condition. The nut yield did not differ significantly due to variety / hybrids. Interactions of both variety vs fertilizers and variety vs irrigation / rainfed condition were not significant. The mean nut yield of two years (1996-98) showed significant variation only due to fertilizer levels.

The mean nut yield under M_0, M_1 and M_2 levels were 106, 114 and 133 nuts / palm respectively, in 1997-98. The nut yield in M_2 was significantly higher compared to M_1 and M_0. However, nut yield between M_0 and M_1 levels did not differ significantly. Similar trend was observed from the average of two years (1996-98) yield data also.

Among the coconut variety / hybrids, the hybrids COD x WCT gave relatively higher yield (126 nuts) compared to WCT x COD (111 nuts) and WCT (116 nuts / palm). Between irrigation and rainfed conditions, nut yield / palm under irrigated condition was significantly higher (127 nuts / palm) compared to rainfed (108 nuts / palm) during 1997-98. However, two year average did not show significant variation in nut yield between irrigation and rainfed condition.

NPK fertilizer experiment on major soil types

NPK fetilizer experiment on WCT in littoral sandy soil revealed that none of the main effects of N, P and K and their interactions resulted in significant variations on nut yield / palm among different levels of nutrients. However, different levels of NPK fertilizer application recorded a mean nut yield of 36 nuts / palm in 1997-98 compared to only 11 nuts / palm / year in the unfertilized control ($N_0P_0K_0$) in side treatment. Further, application of Ca and Mg in conjunction with $N_3P_3K_3$ level of fertilizers gave a mean nut yield of 54 in 1997-98 and 44 nuts / palm / year in 1996-98 as against only 25 and 28 nuts / palm / year in 1997-98 and 1996-98, respectively in $N_1P_1K_1$ + Ca and Mg treatment.

Organic manures for increased productivity

From the field experiment started in 1992 with 252 one year old WCT seedlings, it became evident from the growth characters recorded upto six years that application of organic manures along with inorganic fertilizers was effective in increasing the vegetative characters like girth at collar,

number of leaves produced and height of the seedlings.

Addition of FYM + Neem cake + Chopped husk + Bonemeal increased the yield of palms by seven per cent. The yield increase is mainly due to the production of higher number of bunches per palm per year and partly due to the increased production of female flowers per bunch. The above treatment was also effective in decreasing the yellowing of the palms.

Oyster mushroom production

A higher biological efficiency of 86.3% was obtained when coconut bunch waste mixed with paddy straw at 1:1 ratio was used as substrate for oyster mushroom production, followed by 73% in leaf stalk + paddy straw mixtures. Cropping period was extended when coconut wastes were used as substrate. The protein content of mushroom samples of six *Pleurotus* spp. cultivated on coconut bunch waste varied from 18.1% to 29.3% on dry weight basis. Analysis of spent substrate revealed nutrient enrichment with respect to nitrogen and phosphorus levels in spent substrate when compared to the base materials used as substrates.

Stress and production Physiology

Evaluation of the seedlings of four tall viz. WCT, LO, AO and PO as well as one dwarf viz. CGD and their cross combinations revealed the stress tolerant characteristics of LO and CGD x WCT than the others. These seedlings maintained higher leaf water potential and lower transpiration rate during stress period, thus maintaining higher leaf water status. The highly affected crosses AO x CGD and CGD x PO tended to show better recovery when rewatered after stress.

A 10% increase in button retention was observed in the bunches sprayed with 2 mM Salicylic acid as compared to untreated bunches. Dry matter production characteristics among WCT, LO, Benaulim (Talls), LO x COD, LO x GB, COD x WCT and WCT x GB (Hybrids), revealed higher stem dry weight in the talls (5.8 to 6.4 kgs) than the hybrids (3.8 to 4.5 kgs).

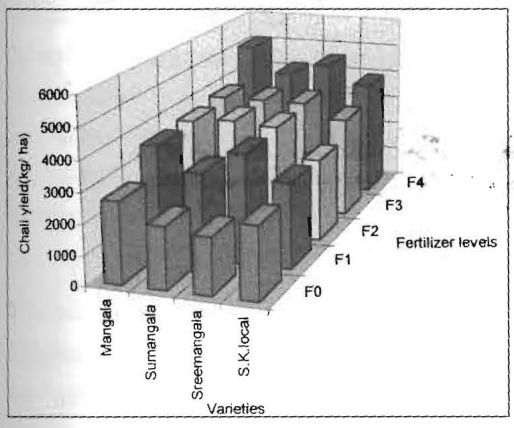
Among the six AICRP centres selected for characterization of drought, Arsikere centre reported relatively low rainfall and high temperature and higher relative humidity resulting in the occurrence of moisture stress compared to other Centres. The data on nut yield also reflected on the apparent impact of moisture stress at Arsikere. In general, the nut yield was 65 nuts/palm/year at Arsikere as against 125 nuts, 102 nuts and 100 nuts/palm/year respectively at Veppankulam, Ratnagiri and Ambajipeta centres.

ARECANUT

Fertilizer requirement of arecanut

A field study was conducted for thirteen years to determine the fertilizer requirement of High Yielding Varieties of arecanut. The treatments included varietis such as Mangala, Sumangala, Sreemangala and South Kanara Local. Sub treatments consisted of five fertilizer levels of 0:0:9(F_0), 50:20:70(F_1), 100:40:140(F_2), 150:60:210(F_3) and 200:80:280(F_4)g of $N:P_2O_5:K_2O$/palm/year, respectively. Pooled analysis of five year

data revealed that there were significant yield differences both among varieties and fertilizer levels. Interaction effect was also found significant. There was linear and significant response up to F_4 level in case of Mangala. In case of Sumangala and Sreemangala, the response was linear but there were no significant yield differences between F_2, F_3 and F_4 levels, while the response was not consistent in case of S.K. Local which is a predominantly cultivated local variety.



Response of varieties and fertilizer levels on yield of arecanut

Economic analysis indicated that there was appreciable increase in net income with increased fertilizer levels. Benefit - cost ratio ranged from 2.52 in control (F_0) to 4.25 in F_4 level suggesting investment on fertilizer input being financially sound. Net income (Rs. 2,31,773/ha) and benefit - cost ratio (4.25) were highest with F_4 level among different fertilizer levels. The findings of this study are suitable for arecanut belt of coastal Karnataka. However, from economic point of view, it is financially profitable to apply 200g N : 80g P_2O_5 : 280g K_2O/palm/year to high yielding varieties as it resulted in appreciably higher net income and benefit - cost ratio.

COCOA

Pruning and training trials

The studies on effect of space and canopy pruning treatments in seedling trial has indicated significant interactions. Highest yields of 640 kg/ha (pooled data for 6th and 7th year after planting) were recorded in S_2 (2.7 x 5.4 m spaced) and P_3 (16.43 m^2 canopy) treatment. Net photosynthesis rate, transpiration and stomatal conductance were higher at P_2 canopy level (13.71 m^3 canopy).

Drought tolerance

Abscisic acid (ABA) concentration in relation to stomatal resistance in cocoa lines with contrasting drought sensitivities were studied. Maximum ABA accumulated in drought tolerant lines viz., NC 42/94 and I-21 x NC42/94 as compared to susceptible ones. This was accompanied by higher stomatal resistance showing a direct relationship to ABA contents in leaves.

OIL PALM

Fertilizer requirement for nursery

A fertilizer dose of 10g N + 10g P_2O_5 + 10g K_2O applied in split doses of @ 10, 15, 20, 25 and 30 percent of the dose during the 1st, 3rd, 5th, 8th and 11th month respectively was found optimum for oil palm nursery.

COCONUT

Root (wilt) disease

Phytoplasma specific antiserum has been prepared against phytoplasma fractionated from spear leaves of root (wilt) diseased coconut palms by discontinuous density gradient centrifugation. The antiserum reacts specifically only against extracts of root (wilt) diseased sample and no reaction was noticed against healthy samples.

Breeding for resistance/tolerance to root (wilt) disease

Fresh surveys were conducted in hot spots of Kottayam, Alappuzha and Pathanamthitta districts and a total of 210 WCT, 90 CGD and 10 COD disease-free elite mother palms were identified so as to employ them in the crossing programme. A total of 368 and 50 artificially pollinated seedling progenies were planted at CPCRI (RC) Farm at Kannara and Coconut Development Board's Farm at Neriamangalam, raising the total number of seedlings planted to 1205 and 398 respectively for establishing nucleus seed gardens in the disease endemic areas.

Assisted pollination involving high yielding and disease-free WCT (69), CGD (80) and COD (10) mother palms in hot spots was continued mainly to generate planting materials for establishing nucleus seed gardens in the disease endemic districts.

Management of leaf rot disease and pests on root (wilt) affected palms

Pouring of Contaf (2 ml) or Dithane M-45 (3 g) dissolved in 300 ml water in the well around the base of the spindle after cutting off the rotten portions of the spindle and the two innermost leaves was found to reduce the intensity of leaf rot. Simultaneous application of Phorate - 10 G (20 g)mixed with 200 g sand in April/ May and October/November guards the palms against infestation of pest. Thus 80% cost of labour and 74% cost of plant protection measures per year can be saved compared to the existing recommendation of separate application of fungicides and insecticide three times in a year.

Two flourescent *Pseudomonas* isolated from the rhizosphere and two phylloplane isolates of bacteria were found to be effective as bio control agents against the leaf rot pathogens as indicated by laboratory trials.

Integrated pest management

For the maintenance of Baculovirus culture *in vivo*, coir waste was found to be a better alternative feed material for *Oryctes* grubs as compared to sterilized cow dung because of its high water retention capacity, better porosity, aeration and relative freedom from weeds and pathogens.

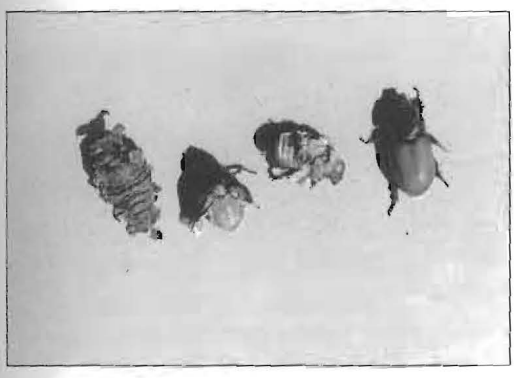
Aspergillus flavus Link at spore concentraions of 10^5-10^6 and 1^6 spores/ml

produced 100% mortality on *Opisina* larvae and *Stephanitis* nymphs respectively within 6 days period, in laboratory trials.

Eriophyid mite infestation has been observed at varying intensities in six districts of Kerala and simultaneous occurrence of the pest has been recorded from Pollachi, Theni in Tamil Nadu and around Bangalore city in Karnataka.

Root feeding with 10 ml Monocrotophos diluted with 10 ml water given 3 times at monthly interval has been found to be very effective in controlling the pest. This is useful in cases when a few palms are to be treated in isolated areas of new infestation. However, harvest should be done only 45 days after the last treatment.

Clerodendron infortunatum Linn. (Verbenaceae) produced 80% mortality of *Oryctes* grubs when mixed with the natural food of the grubs at 4-6% w/w concentration. Lower doses caused insect growth regulatory (IGR) activity producing larval - pupal intermediates and adultoids.



Abnormality caused in *Oryctes* adults due to *Clerodendron infortunatum* treatment

Endochus inornatus, Euagorus plagiatus and *Rhinocoris fuscipes* were recorded as predators on lace bug.

Integrated nematode management

Introduction of arbuscular mycorrhizal fungi, fungus *Paecilomyces lilacinus* and the bacterium, *Pasteuria penetrans* at nursery level and again into the planting pits was found to reduce the *Radopholus similis* population and rotting of roots significantly on coconut, arecanut and black pepper which had resulted in increased growth of plants under field conditions. Application of pongamia cake at the rate of 1.5 kg/plant twice in a year brought down the *R. similis* population in arecanut, banana and pepper in arecanut based cropping system.

ARECANUT

Management of fruit rot

Fruit rot (Kole roga) is one of the major diseases of arecanut palm caused by *Phytophthora* spp. (*P. arecae* and *P. meadii*). Disease is seasonal and occures during South West monsoon. The present control measure is prophylactic spraying of one per cent Bordeaux mixture before the onset of monsoon. Besides the chemical method, mechanical method of control of the disease by protecting the bunches through covering with polythene is found to be very much effective in checking the incidence and spread of the disease. A multilocation trial on fruit rot of arecanut at different localities of Dakshina Kannada, Uttara Kannada and Shimoga districts of

Karnataka indicated that, by covering the bunches with 125 gauge of polythene (24 x 30 inches), a 100 per cent control could be achieved as compared to Bordeaux mixture spray. The cost of plastic covering per hectare (1300 plants) ranged from Rs. 6350 to Rs. 8695 and Bordeaux spray varied from Rs. 7420 to Rs. 8938. Further, yield loss even after spraying with Bordeaux mixture spray gardens was about 185 to 850 kg/ha amounting to Rs. 16,650 to Rs. 76,500. Thus, covering the bunches with polythene is a simple cheap and efficient method for controlling fruit rot of arecanut.

OIL PALM

A new caterpillar on seedlings

A microlepidopteran caterpillar was found infesting the one-year old oil palm seedlings under the nursery experiment. The caterpillars remain in galleries on the under surface of leaves and scrape the chlorophyll. Out of 232 seedlings, 33.19% of the seedlings were infested, percentage leaf damage ranging from 5.6-72.7 with an average of 9.86%.

Covering fruit bunches with polythene to prevent fruit rot

Nature of damage by the lepidopteran caterpillar on oil palm seedling. Inset-catarpillar

Water harvesting studies

The lateritic soils of west coast region is highly porous in nature. For the same reason the harvested water in water harvesting structures depletes after the rainy season mainly by percolation. In order to prevent percolation of the harvested water and to make available irrigation water throughout the dry season, four lining materials were tested. These are lining with clay, soil-cement mixture, HDPE film and soil compaction. Among these materials only soil-cement mixture with 10% cement and HDPE film were found to be effective. Economic analysis showed laying cost of HDPE lining as Rs. 25/- per square meter and laying with soil cement mixture as Rs. 5/- per square meter.

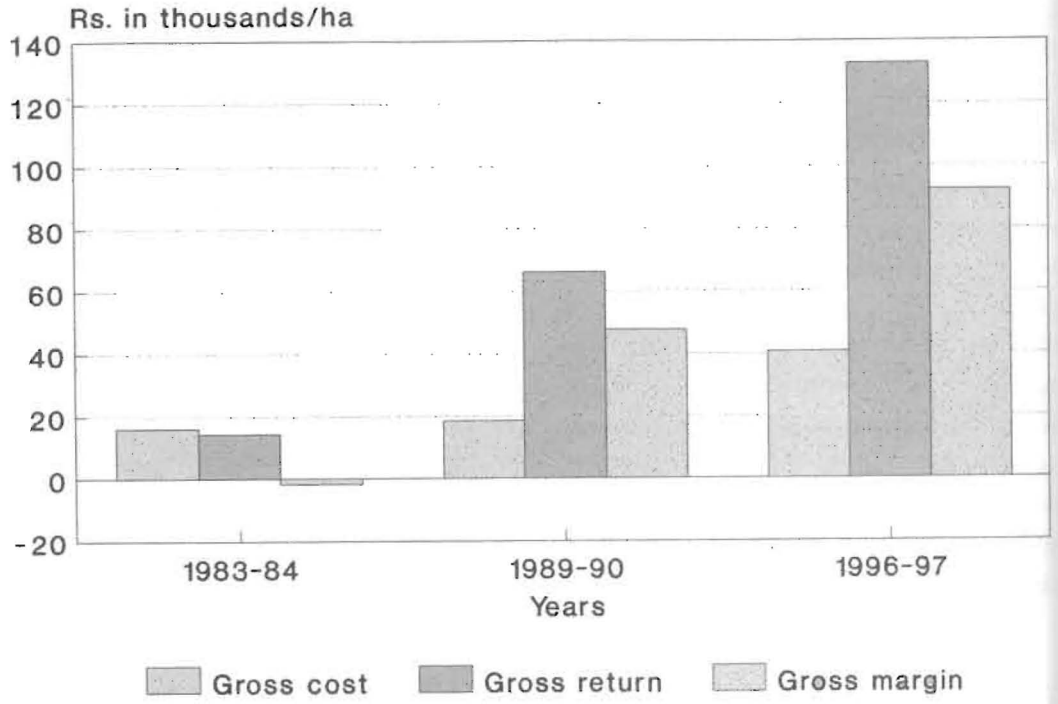
Design and development of small scale palm oil extraction unit

India has been importing palm oil for past several years. It is proposed to cultivate this crop by small and medium land holders under irrigated condition. At present only few palm oil extraction units are available which can cater to the needs of about 150 ha plantaion. Factors such as over maturity of fruits while harvesting, transporting and delay in processing beyond 24 hours, result in bad qualtiy oil and economic loss. Therefore, the palm oil extration unit should be located amidst plantation. A small scale palm oil extracting unit of capacity 200 kg FFB/hr has been developed which could cater to the need of oil palm plantation of 10 ha to 30 ha. A non-IBR mini boiler with plantation wastes as fuel is used for steam generation. A horizonal type sterilizer with a capacity of 200 kg FFB/batch has been developed to sterilize the FFB at steam pressure of 2.3 to 2.6 kg/cm^2 for a period of 45-60 minutes. A mechanical bunch stripper to loosen the fruit from the sterilized bunches has been developed which will take about 5 minutes to strip the fruits from 200 kg of sterilized bunches. To convert the loose fruit into pulp/mash, a digester has been developed which can digest about 50 kg of fruit in 5 minutes. Hydraulic press of 30 tonnes capacity is used to extract the oil-water mixture from the hot mash obtained from the digester. Clarifier, a vertical cylindrical vessel of 230 liter capacity with steam coil has been developed to separate the crude red palm oil from the oil-water mixture. The extraction efficiency of the mill is 18.2% and the process efficiency of the mill is 83%. The free fatty acid content of the oil is less than 3.0%. The cost of processing one kg of FFB is Rs. 0.31 and the cost of extraction of one kg of crude red palm oil is Rs. 1.68.

Cash flow analysis of HDMSCS

The cash flow analysis of input-output data for the period 1983-84 to 1996-97 of coconut based high density multispecies cropping systems under experimental conditions with full dose of fertilizers involving banana, clove and pineapple as component crops realized a Benefit-Cost Ratio of 3.44. The variable capital requirements for the system ranged between Rs. 8,200/ha during 1984-85 to Rs. 40,570/ha during 1996-97. Labour alone contributed to 46-72% of the annual maintenance cost. The gross margin realized from the system ranged between Rs. 1,750/ha during 1983-84 to Rs. 92,230/ha during 1996-97.

A field survey in 400 arecanut gardens of Kasaragod district revealed that the marginal (<0.2 ha), small (0.21 to 1.00 ha), medium (1.10 to 2.00 ha) and large (>2.0 ha) holdings respectively accounted for 19.3, 65.3, 11.8 and 3.5 per cent. The study further indicated that altogether 37 types of arecanut based farming system models are being practised by the farmers. Out of this only six models viz., Arecanut + Coconut + Dairy, Arecanut + Banana + Dairy, Arecanut + Coconut + Banana + Dairy, Arecanut + Coconut + Pepper and Arecanut + Banana + Pepper + Dairy are widely adopted.



Economics of coconut based high density multispecies cropping systems

Refinement of experimentation techniques in plantation crops

The present method of indexing the severity of root (wilt) disease of coconut palms was modified by incorporating the symptoms for leaf rot disease. The resultant formula for index is :

8.8F+6.0Y+5.8N+1.2LR+0.2, were:

F-Average score for flaccidity (0 to 5), Y-Average score for yellowing (0 to 5), N-Average score for necrosis (0 to 5) [For the leaves in the third whorl], and LR-Average score for leaf rot (0 to 5) [For the inner leaves].

The results obtained from non parametric analysis of data have indicated that interpretations of experimental data are likely to be wrong when assumptions for usual parametric analysis are not satisfied. A complete programme for analysis of divergence was developed in Borland C++ to incorporate multivariate analysis, computation of D^2 statistics, heirarchical grouping and canonical analysis.

TRANSFER OF TECHNOLOGY

Training of extension research workers and farmers

During the year the scheduled training programmes listed below were conducted.

Sl.No.	Location	Title of the programme
1.	Kasaragod	Production technology of coconut
2.	-do-	Hybridization technique in coconut
3.	-do-	Coconut based farming system
4.	Kayangulam	Identification of burrowing nematode *R. similis* and *H. oryzicola*
5.	-do-	Etiology and management of coconut diseases
6.	-do-	Biological suppression of pests of coconut
7.	-do-	Integrated pest management in coconut
8.	-do-	Serological techniques for identification of sub microscopic plant pathogens
9.	Vittal	Arecanut and cocoa production technology

Familiarisation visit programmes were organised for seven farmers from Maldives from 13th to 15th October and for a scientist from Coconut Research Institute, Sri Lanka for five days from 21st December.

Field Experience Training programme of five ARS trainees from NAARM was organised during the period 2nd September to 30th October.

One day training programmes were conducted for 795 farmers, 305 officials and 2133 students at Kasaragod and 375 students, 142 farmers and 40 extension/research workers from various states at Kayangulam. Lab visits, field visits and lecture classes were arranged.

Kisan Mela

A Kisan Mela was organised in connection with the Field Experience Training Programme of ARS trainees at Vedikunnu UP School, Bare village of Kasaragod Dist. on 18th September, 1998. ARS trainees presented the Participatory Rural Appraisal Report of the village.

Summer School

A Summer School on Harvest and Post Harvest Technology of Plantation Crops was held at Kasaragod from 23rd July to 12th August. The course was designed to impart latest knowledge on various aspects of plantation crops such as coconut, oil palm, arecanut, cocoa, cashew, spices, rubber, coffee and tea.

Adoption of package of practices recommendations by the coconut cultivators

A survey was conducted among 570 coconut farmers selected randomly from 38 panchayats of Alappuzha district. The level

Dr. SB Kadrekar, Chairman, QRT releasing the publiation on Harvest and Post Harvest Technology of Plantation Crops. Also seen are Dr. KUK Nampoothiri, Director, CPCRI and Sri PK Thampan and Dr. Gopal Swarup, Members, QRT

of knowledge and adoption of recommeded practices among coconut farmers were mainly assessed in the study.

Major constraints perceived by the farmers were: Non-availability of quality hybrid seedlings in adequate numbers, small size of holding, scarcity of irrigation water, attitudinal difference towards farming in general and absentee farming, high labour cost and scarcity of climbers for plant protection operations and timely harvesting, and fluctuating coconut price.

Simplicity and observability of results of the technologies encouraged adoption by coconut farmers. Eventhough plant protection aspect in general showed low adoption of recommendations, majority of the farmers are adopting modified practices like pouring fungicide-pesticide mixture around spindle in the crown.

INSTITUTE VILLAGE LINKAGE PROGRAMME

During the kharif season, nine interventions for small production system and one for green revolution system covering 252 families were carried out. Four interventions for small production system were carried out during the rabi season covering 154 farm families. Besides, 21 farmers were taken on a visit to the Regional Station at Vittal.

The On Farm trial (OFT) conducted in the farmers field on paddy proved consecutively for the second time that the variety Aishwarya was best suited for this region during the kharif season. From the OFT conducted in 14 farmers paddy fields, on the performance of biofertilizers it was found that application of biofertilizers helped in better growth in Kayama and IR-20 varieties. Another OFT on the performance of green manure in coconut and arecanut basins revealed that among the green manure crops tried, *Mimosa invisa* showed better growth followed by *Calapagonium mucunoides*, while *Peuraria phasoliodes* showed comparatively lower germination percentage and lesser growth.

Dr. P. Das, DDG (Extn.), ICAR having discussion with scientists and farmers

The OFT conducted during the previous year on the balanced application of fertilizer nutrients for arecanut gardens showed an average yield of 2.82 kg chali/palm. But the full effect of fertilizer nutrients on the arecanut yield can be known only in a couple of years time.

One hundred and thirty three families were supplied with the grafts of mango and guava and air layers of Sapota for planting on the homesteads.

OFT were also carried out to assess the performance of different control measures against stem bleeding disease of coconut at mild, medium and advanced stages of infestation. OFT on intercropping of coconut with tapioca and banana and verification trials on intercropping of coconut with ginger and turmeric and to assess the beneficial effects of vermicomposting were also carried out.

During the year a total of 112 training programmes (44 on campus and 68 off campus) were conducted for farmers, rural youths and extension functionaries. Eight of the trainees have started small scale units. Three field days, three mass campaigns in plant protection, 18 farm science/Mahila Mandal meetings etc. were organised during the period. KVK faculty members also attended 38 seminars.

On farm testing on problems like 'Management of rhinoceros beetle in coconut' 'Management of stem bleeding in coconut' and 'Management of important pests of vegetables' were conducted.

Front-line demonstrations in cereals and horticultural crops has been started in Cheralu-Bayar village. It covers varietal trials and plant protection in paddy, black gram, green gram etc. Plant protection in arecanut was also taken up. Introduction of new paddy varieties was taken by 12 farmers.

Under watershed development programme, two new watersheds are selected at Malenkai of Bellur panchayath and Manadukkam of Bedadka panchayath, Constant monitoring is done in the Yethadka watershed.

An orientation training programme for KVK staff of Zone VIII was conducted at Kasaragod which was organised by the Zonal Co-ordinating Unit, Bangalore for a period of three days during the reported year.

With a view to enhancing self-employment opportunities for women, a Women's Cell was constituted during the year under report. Under this, nine training programmes were conducted for a total of 73 women farmers.

The KVK administrative building was formally inaugurated by Padmashree Dr. RS Paroda, the honourable Director General of ICAR and Secretary, DARE on 6th December, 1998. Dr. P Das, DDG (Extn.) and Dr. K Gopakumar, DDG (Fisheries) were also present on the occasion.

After the inauguration of KVK building (L to R) : Dr RS Paroda, Dr KUK Nampoothiri, Dr K Gopakumar and Sri AS Sukumaran

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

COCONUT

CROP IMPROVEMENT

Among the 20 tall genotypes maintained at Veppankulam centre, West Coast Tall (WCT) recorded an annual yield of 135 nuts/palm, followed by Spicata and Guam (134 nuts each). Among the eight dwarfs, Gangabondam gave the highest annual yield of 130 nuts/palm and cumulative mean yield of 62 nuts/palm/year with copra out-turn of 8.7 kg/palm.

At Aliyarnagar, Arasampatti Tall continued to perform well and gave the highest yield of 263 nuts/palm during 1997-98. Malayan Green Dwarf also performed well with 214 nuts/palm during the same period.

Evaluation of germplasm at Ratnagiri showed that Laccadive Ordinary produced the highest yield of 151.66 nuts/palm followed by Pratap with 128.88 nuts/palm. The same trend was observed in cumulative yield also. Banawali Green Long produced the highest yield of 143 nuts/palm during 1997-98, whereas Banawali Yellow Round produced the highest cumulative yield. In terms of copra (3.9 t/ha) and oil out-turn (2.7 t/ha), the variety Philippines Ordinary performed better than others.

At Ambajipeta, the variety Philippines Ordinary recorded the maximum cumulative mean yield of 100.65 nuts/palm/year over 19 years followed by Laccadive Ordinary (85.91 nuts/palm/year).

In Jagadalpur (a non-traditional area), the new cross combinations planted for evaluation has entered into reproductive phase. Hybrid combinations ECT x GB and WCT x GB produced 20 and 15 nuts/palm/year, respectively. Heavy button shedding was observed in other cross combinations resulting in no yield.

At Mondouri, Jamaican Tall produced 80.2 nuts/palm/year during 1997-98 with a mean nut yield of 80.35/palm over 10 years.

In the evaluation trial on promising cultivars at Aliyarnagar since 1988, the variety Straight Settlement Green (SSG) yielded 143 nuts/palm/year during 1997-98 followed by the hybrid WCT x COD with 140 nuts/palm.

At Mondouri, Laccadive Micro recorded a maximum yield of 103.2 nuts/palm and mean yield of 66.96 nuts/palm in seven years. The average nut weight was highest in SSG (1907 g) while the copra weight was maximum in Laccadive Ordinary (283 g/nut).

CROP PRODUCTION

In the NPK trial on WCT in littoral sandy soil at Kasaragod, a mean nut yield of 36 nuts/palm/year was obtained compared to 11 nuts/palm/year in the control. Application of Ca + Mg in conjunction with N1500, P1750, K1750 gave a mean yield of 54 nuts/palm/year as against only 25 nuts/palm/year in N500, P250, K750 + Ca + Mg treatment.

In a similar trial at Ambajipeta, the highest cumulative mean yield of 66.13 nuts/palm/year over 14 years was recorded in N1500:P250:K750 g/palm/year followed by 58.90 nuts/palm/year in N1500:P750:K1250 g/palm/year.

In the NPK trial on sandy loam soil types on Local Tall variety at Mondouri, maximum yield of 78 nuts/palm was recorded in the treatment N1000:P500:K750 g/palm/year followed by 76.5 nuts/palm with N1000:P250:K1750 g/palm/year.

At Veppankulam, application of 1000:250:2000 g NPK/palm/year to ECT x MYD hybrid produced the highest yield of 174 nuts/palm/year as compared to 88 nuts in unmanured control. The same trend was observed in cumulative yield also.

The COD x WCT palms at Aliyarnagar responded well to N application at two splits by producing more number of bunches, female flowers and nut yield. Application of N @ 1000 g/palm/year yielded 147 nuts/palm compared to 134 nuts/palm/year with 500 g N.

At Arsikere, COD x WCT hybrid yielded only 45.4 nuts/palm/year when N0:P500:K2000 g/palm/year was applied followed by 37 nuts/palm/year with N0:P250:K1000 g/palm/year indicating the importance of N in the nutrition.

At Ratnagiri the treatment N1000:P500:K2000 g/palm/year produced the maximum yield 108.80 nuts/palm/year and cumulative mean yield of 88.28 nuts/palm/year when yield data of eight years was examined.

In a similar experiment at Mondouri on COD x WCT, the treatment N0:P250:K1000g/palm/year produced maximum yield of 117.5 nuts/palm/year followed by 116.5 nuts in the treatment N1000:P250:K1000/palm/year. Interestingly, $N_0P_0K_0$ also produced 71.5 nuts/palm/year.

At Veppankulam, the coconut yield increased continuously due to inter cropping over the years. The pretreatment yield of 67 to 74 nuts/palm in different models increased to 150 to 163 nuts/palm after four years of initiation of the experiment.

In the coconut based high density multispecies cropping system experiment at Arsikere, coconut yield improved considerably in both the models recording 105.7 nuts/palm in Model-I and 77.4 nuts/palm in Model-II as compared to 74.8 nuts/palm in control. The gross returns also showed a similar trend with Rs. 80,433/ha compared to control with Rs. 60,747/ha.

In a similar trial at Ratnagiri, the yield of coconut increased gradually after mixed cropping. After four years of mixed cropping, the average nut yield of coconut increased considerably (25.08 to 93.93%) compared to pre-treatment yield.

At Aliyarnagar, basin irrigation at IW/CPE ratio of 1.0 at 4 cm depth and drip irrigation at 100% Eo were at par yielding 135 and 138 nuts/palm/year, respectively. The palms which were given even life saving irrigation yielded only 57 nuts/palm/year.

At Veppankulam, drip irrigation at 100% Eo recorded the maximum yield of 142 nuts/palm/year while in basin irrigation the yield was 133 nuts/palm as compared to 92 nuts in control.

At Arsikere, basin irrigation at IW/CPE ratio of 1.0 gave a coconut yield of 52 nuts/palm/year followed by 50 nuts/palm/year in drip irrigation at 100% Eo treatment.

CROP PROTECTION

In the management trial on *Ganoderma* at Aliyarnagar, a disease incidence of 2.31% only was recorded in the palms receiving soil application of neem cake @ 5 kg/palm/year + root feeding (RF) of Kitazin @ of 0.3%. The minimum disease incidence of 1.0% was recorded in the treatment with soil application of neem cake 5kg/palm/year + 2% Tridemorph (RF). Another treatment with neem cake 5kg/palm/year + 2% Aureofungin-sol (RF) + 1% Cu SO_4 (RF) was also effective. The disease index recorded was 2.55% compared to control of 35%.

Inoculative and inundative release of parasitoids viz. *Bracon hebator* and *Goniozus nephantidis* in epidemic areas around Aliyarnagar, resulted in a decrease in the population of *Opisina arenosella* from 327 per palm to 36 per palm. The per cent parasitisation by braconids increased from 6.38 to 23.66, bethylids from 2.48 to 10.46 and eulophids from 0.26 to 3.42.

At Ratnagiri, field release of larval parasite (*Goniozus nephantidis*) at the rate of 20.5% helped to reduce the population of leaf eating caterpillar from 105.01 to 12.35.

At Ambajipeta, the braconid parasitation on leaf eating caterpillar increased from 0 to 3.3% and 80% of the pest population was suppressed one month after the release of parasitoides.

Rhinolure pheromone trap for rhinoceros beetle and Ferrolure pheromone trap for red palm weevil were effective in attracting the pests at Aliyarnagar centre. Interestingly more females of rhinoceros beetle and red palm weevil were seen trapped than males.

The natural incidence of baculovirus infected grubs observed at Ratnagiri was 11.96 per cent. Augmentative release of baculovirus infected beetles reduced the leaf damage from 13.08 to 2.34 per cent, spathe damage from 15 to 2.5 per cent and spindle damage from 5 to 0 per cent.

At Ambajipeta among the different treatments, minimum leaf damage (12.7%) by rhinoceros beetle was recorded in the treatment Carbaryl 5% dust followed by Lindane dust (13%). In case of spindle damage, Folidol 2% proved effective (11.1% damage) followed by sand (22.2% damage).

OIL PALM

CROP IMPROVEMENT

At Vijayarai, the oil palm hybrid combinations 128 d x 291 p and 148 d x 98 p are promising.

At Mulde, the hybrid combinations of oil palm 109 d x 291 p gave the highest yield of 69.242 kg FFB/palm/year followed by 65 d x 111 p with 66.974 kg FFB/palm/year.

CROP PRODUCTION

Irrigation cum fertilizer studies at Aduthurai revealed that basin irrigation gave significantly superior FFB yield (14.93 t/ha/year) than drip irrigation (10.72 t/ha/year) and no irrigation (6.21 t/ha/year). Among the nutrient levels, 1200:600:2700 g NPK/

palm/year produced the maximum FFB yield (11.62 t/ha/year).

At Gangavathy, FFB yield was not affected by various irrigation and fertilizer treatments independently. Among the fertilizer treatments, maximum yield was recorded with N1200:P600:K2700 g/palm/year (4.76 t FFB/ha) followed by application of N 400:P200:K900 g/palm/year with 4.17t FFB/ha. The interaction effect was significant and highest yield was recorded in irrigation coupled with application of N1200:P600:K2700 g/palm/year (5.34 t FFB/ha).

At Vijayarai, the effect of irrigation and fertilizer levels were highly significant with regard to FFB yield. Maximum yield of 15.98 t/ha/year was recorded in drip irrigation with 800:400:1800 g NPK/palm/year which was 138% higher than no irrigation and no fertilizers which gave 6.72 t/ha/year.

At Mulde, the maximum productive inflorescence (50.75%) was recorded in basin irrigation which was at par with drip irrigation. Maximum yield of 138 kg FFB/palm/year was obtained in the drip irrigation treatment with 1200:600:2700 g NPK/palm/year which was at par with basin irrigation at the same level of NPK.

PALMYRAH

CROP IMPROVEMENT

Pandirimamidi centre has planted 54 accesions of palmyrah so far and they are at different stages of evaluation. Variability in terms of plant stature, leaf production and palm girth were recorded. At Killikulam, 46 accessions are under evaluation for dwarfism, precocity and neera q

Analysis of neera from 11 accessions at Killikulam showed in Vitamin-C (7.87-15.74 mg/1 sugar contents.

At Killikulam, soaking t Gibberellic acid (500 ppm) resulte germination (76 %) as against soaking (68%). Seednuts sown af of storage recorded the highest g (78%) compared to seed n immediately after harvest (30% mixture and sand were better n tank silt for germination of seed

CROP PROTECTION

At Killikulam, incidence o disease (*Stigmina palmivora*) wa be restricted to young palms (14. and leaf blight (*Pestalotia palmarum* was mostly recorded in older p 28.2%).

At Killikulam, tuber rot *Rhizoctonia solani* was controlled the seed nuts in Carbendazim f drenching the same chemical. Th resulted in the lowest incidence (15.7%) compared to control (4 enhanced germination.

In Tirunelveli and Tuticorin Tamil Nadu, incidence of *Oryct* (3.0-9.8%) and *Opisina arenosella* was recorded in three grooves.

During field surveys in Godavari District of Andhra infestation of rhinoceros beetle, as rot and leaf rot were noticed.