RESEARCH HIGHLIGHTS 1982

Central Plantation Crops Research Institute
Kasaragod 670 124, Kerala, India

Front cover: Mycoplasma like organisms (MLOs) in tissues of root (wilt) disease affected coconut palm

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INTRODUCTION

Central Plantation Crops Research Institute conducts and coordinates research on coconut, arecanut, cashewnut, cocoa, oil palm and spices. The spices consist of pepper, cardamom, ginger, turmeric, nutmeg, clove and cinnamon. The activities of the Institute are spread over 16 research units in India. During the 10th Annual Research Council meeting of the CPCRI, 159 projects were discussed, 13 projects were concluded and 18 new projects were approved. In each crop, thrust was on improvement, management and protection. Emphasis was also laid on screening the available germplasms for disease/pest resistance. In major problem areas like root (wilt) disease of coconut, yellow leaf disease of arecanut, wilts of pepper and katte of cardamom, time bound research projects on management practices as a short term remedial measure were formulated.

The highlights of the research findings of CPCRI during 1982 are covered in the following pages of this publication.

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CROP IMPROVEMENT

Coconut

Collection, conservation, cataloguing and evaluation of coconut germplasm

During the collection survey in Lakshadweep, a variant form of Laccadive Micro having regular bearing habit was located in Androth Island. Among the 24 accessions collected from six South Pacific Ocean Island Territories, Niuleka from Fiji and Niu Hako from Tanga showed highest germination (89% and 87% respectively), while the collections from Solomon Islands had lowest germination. Analysis of seedling progenies generated under three different mating systems, viz. *inter se*, open pollination, and selfing has revealed that girth at collar is not influenced by the mating system thereby indicating the reliability of using this parameter in classification and selection.

Breeding for high yield and disease resistance in coconut

General and specific combining ability of nine parents and their 36 hybrid combinations were analysed from their 360 seedling progenies. The *gca* differences were significant for girth, height, total leaf production and leaf production during the year, whereas *sca* was significant only for total leaf production. The cultivars Laccadive, Jamaica, Java, Fiji and San Ramon proved to be superior as Tall parents. Hybrids involving Gangabondam as Dwarf parent generally flowered early.

A seedling score for prepotency

Twenty one high yielding West Coast Tall palms were screened for prepotency based on seedling characters, viz. leaf number, girth at collar, height of seedling, length of petiole, length and breadth of leaf, using their 582 seedling progenies and selecting for high mean and low CV. The top four families based on cumulative ranking method are (1) 39.2-1/205, (2) 41/588, (3) SB/22, (4) 2/27. The families 39.2-1/205 and 41/588 have already been identified as prepotent palms based on yield transmission to their progenies, and SB/22 is the progeny of 41/588. The family mean of these three families was more than the general mean for all the characters studied.

Identification and critical study of elite palms

Of the 20 elite palms identified, two in north Kerala and three in south Kerala are maintaining their high yield of over 200 nuts/year and have not taken disease so far. The 120 seedling progenies of eight elite palms planted at Kayangulam and neighbourhood have so far remained healthy.

Tissue culture

In the tissue culture experiments on coconut, it has been possible to induce nodular callus from the tender leaf segments excised from one year old West Coast Tall seedlings. These calli have rooted profusely, following their transfer to media containing lower auxin levels. Higher levels of myoinositol (300 mg/l) were helpful in increasing the frequency of callus induction to 70%.

Production physiology

Regression equation for estimation of leaf area and annual dry matter production non-destructively in adult

WCT palms has been worked out. Based on this, a method for determination of Annual Productivity Index (A. P. I.) in adult palms has been developed.

Establishment of crop in coastal sand

Beneficial effect of different organic manures along with NPK in establishing coconut gardens in coastal sand has been demonstrated; wherein organic manures improved the soil physical and chemical environments including various growth parameters. The available nitrogen, nitrate nitrogen, exchangeable and calcium chloride extractable potassium increased in soils treated with different organic manures. The coir dust treated soil improved the water retension properties in the coastal sand. Further studies have shown the nitrification inhibition or nitrogen immobilization properties which could be successfully exploited for nitrogen management in the light textured soils.

Phosphorus nutrition

The studies on P nutrition of coconut clearly revealed that skipping of phosphorus application to adult coconut palms for a period of seven years in red sandy loam soil did not influence significantly either the foliar nutrient concentration or the yield. Thus the skipping of P has been recommended in coconut nutrition, where the available P status of the soil is more than 30–40 ppm. The studies with 16 different coconut growing soils for adsorption and desorption of P showed a gradual release of adsorbed P in soils rich in iron and alumininm oxides suggesting a long term recycling of applied P. It is further indicated that the dominant P fraction in these soils was the reductant soluble – P followed by iron and aluminium phosphates.

Green manuring

Pueraria and *Calapogonium* established well in coconut basins in sandy soil types while *Mimosa invisa* established well in lateritic soil type.

Pepper

Light saturation for this crop was reached at 50,000 lux. Partitioning of photosynthates was more efficient in high yielding cultivars as compared to low yielders.

Cocoa

Cocoa plants exhibit two peaks as regards to growth and yield during January, June and September–November. Specific leaf weight was correlated with high yield rather than nitrate reductase activity and carbohydrates. Leaf elongation rates were very sensitive to water stress as compared to epicuticular wax, NR activity and proline content.

Cashew

A new medium consisting of polyethylene glycol, sugar, Ca and B gave 90% of cashew pollen germination and tube growth. Less than 30% of sunlight was found to affect fruit set and yield. Fifteen percent (w/v) solution of course salt can be used for selecting cashew seeds of higher specific gravity. Pre–soaking of seeds in acetone and chloroform for one hour was found to hasten the seed germination and increase seedling vigour.

CROP HUSBANDRY

Coconut

Nutrition

Under rainfed condition at Kasaragod, Chowghat Dwarf Orange × West Coast Tall palms receiving 500 g N + 500 g P + 1000 g K/palm/year gave the highest yield of 71 nuts/palm/year. Although the high yielding Tall palms responded upto double the above dose, the highest yield was only 61 nuts. The WCT × CDO palms showed a small increase in yield (three nuts) at double dose. Even under 'no fertiliser' application CDO × T palms (24 nuts) performed better than high yielding Tall (16 nuts) and WCT × CDO (10 nuts). In WCT palms, summer irrigation at IW/CPE ratio of 1.0 with a fertiliser dose of 750 : 670 : 1500 : 170g of N, P, K and Mg/palm/year gave the highest yield of nuts (91), followed by irrigation at IW/CPE ratio of 0.75 with a fertiliser dose of 1000 : 1000 : 2250 : 170 g of N, P, K and Mg (83 nuts/palm/year). In the micro irrigation techniques experiment in laterite hill slopes, 75% of CDO × T palms had flowered at the end of sixth year compared to only 41% in WCT.

Disease tolerance of D × T palms

Long term field experiments conducted on WCT and D × T with high fertility managements in sandy loam soil showed that the incidence of root (wilt) disease reached to the extent of 35.5% in WCT and 22.1% in D×T, respectively nine years after planting. (Table 1). A concomitant marked reduction in the yield was also recorded in WCT, thereby suggesting the superiority of D × T hybrid with respect to yield and disease intensity. Further, a dose of 500 g N, 300 g P and 1000 g K along with 500 g Mg has been found to be optimum for this variety in sandy loam soils under rainfed culture.

Heavy metal toxicity study

A detailed study on heavy metal toxicity in relation to root (wilt) had shown that high concentrations of Cd, Bi, Cr, Pb, Ba, Ti, Ga, Sr and Li were present in all the leaf positions tested in the diseased samples compared to healthy ones. This was also reflected in the HNO_3 and DTPA extractable fractions of heavy metals in different soils of diseased area. Further, the scanning electron X-ray microprobe analysis of root tips

Table 1. *Incidence of root (wilt) disease in WCT and D×T*

Year after planting	Disease incidence %		Average yield of nuts/palm/year	
	WCT	D×T	WCT	D×T
4	2.2	1.8	Nil	Nil
5	4.3	3.6	Nil	75
6	8.8	5.0	Nil	129
7	22.5	5.0	17	90
8	29.3	8.9	40	118
9	35.5	22.1	50	112

and cabbage leaves of diseased palms showed very high deposition of Al, Mn, Cu, Co, Bi, Ga, Ti, Cd and Pb.

Irrigation

Summer irrigation with balanced fertiliser application and plant protection measures resulted in the yield improvement of the root (wilt) affected palms to the extent of 15–17% compared to farmers' management conditions. The cost of cultivation/palm/year was found to be Rs. 20.20 and Rs. 33.09 under unirrigated and irrigated conditions, respectively.

Root regeneration in diseased palms

Preliminary trials on root regeneration in disease affected palms in the Institute campus revealed that treatments like IBA (500 ppm) + phenols (400 ppm) and NAA (500 ppm) + glutamic acid (500 ppm) were effective in the production of roots with consequent remission of foliar symptoms. These results were subsequently confirmed with more number of palms in the farmers' fields.

Arecanut

For arecanut palms, irrigation with 30 mm water when the pan evaporation totals 30 mm (IW/CPE ratio of 1.0) was found to be optimum. Mulching with arecanut husk @ 6 kg/palm helped to widen the intervals between irrigations by 3–4 days. Mulching reduced the bulk density of soil, lowered soil temperature and narrowed the diurnal variation of soil temperature. Drip irrigation helped to economise the irrigation water by 50%. The yield per unit area was maximum under arecanut and cocoa mixed cropping system when both the crops were spaced 3.3×3.3 m. The roots of cocoa appeared to penetrate deeper when grown as a mixed crop with arecanut. Yellowing and mortality of pepper vines trailed on areca palms were found to be more in closer spacing of 1.8×1.8 m compared to wider spacings of 2.7×2.7 m and 3.6×3.6 m. Pepper can be grown successfully on raised mounds and trained on areca palms as standard in the maidan parts of Karnataka.

Cardamom

Better growth of the seedlings in the secondary nursery (as recorded by the number of tillers) was obtaind when the seedlings were transplanted at the 5th leaf stage with a spacing of 30×30 cm.

Ginger

Application of organic amendments like neem cake or pongamia cake at two tonnes/ha as a basal dose reduced the rhizome rot of ginger and improved the yield by about 20%.

CROP PROTECTION

Coconut

Root (wilt) disease

Electron microscopic examination of tissue samples of root (wilt) disease affected palms has revealed the presence of mycoplasma like organisms (MLOs) in sieve tubes of apical meristem, petiole of spear leaf and root tips. Such organisms were not present in tissue of healthy palms. MLOs are known plant pathogens in other coconut diseases like Lethal Yellowing in Florida, Kaincope and Cape St. Paul Wilt Disease in West Africa and Coconut Stem Necrosis in Malayasia and Sumatra. In this

context the present finding is of great importance. The studies on the role of this organism in the causation of the disease are being intensified.

The observations carried out in 156 root (wilt) disease affected gardens from 1979 onwards gave an indication that eradication of diseased palms considerably reduces the chances of further spread of the disease. The application of Bavistin and Temik was found to have no effect in checking the spread.

Oxytetracycline treatment to root (wilt) affected palms over a period of six years resulted in an increase in nut yield.

Nematodes

Five species of nematodes *Epicherinema keralense, Ecphyadophoraters, Ecphyadophoroides macrocephalus, E. leptocephalus* and *Chromogaster spinicorpus* were identified from soil around roots of coconut. Pathogenicity of the burrowing nematode, *Radopholus similis*, on coconut seedling was established. An inoculum level of 10,000 nematodes/plant was found to cause as high as 40 to 45 per cent reduction of plant growth over a period of three years. Application of phenamiphos or phorate @ 10 kg ai/ha was found to control *R. similis* in coconut nursery. Ninteen cultivars and fifteen hybrids of coconut were screened against the burrowing nematode and all of them were found susceptible. *R. similis* was cultured successfully within mesocarp of tender coconut. Population of *R. similis* that comes out of infested roots to soil remained active under moist condition in field for six months compared to one month in dry soil, whereas the population under moist condition stored in green house was active upto 14 months compared to three months in dry soil.

Pests

The population of *Oryctes rhinoceros* reduced progressively after treating of breeding grounds of the beetle with lindane granules at 0.005% and 0.01% on w/w basis. By adopting an integrated pest management system, the incidence of red palm weevil *Rhynchophorus ferrugineus* could be brought down to zero level from an initial incidence of 6.7%. Coconut logs smeared with macerated pineapple and molasses/yeast, proved to be an efficient attractant material for adults of red palm weevil. The bioassay experiments on the effect of contact insecticides applied to soil for the control of root grubs revealed that the third instar grubs could not be economically controlled by insecticidal application to soil. From the field trials and studies on the persistence of insecticides in soil it was concluded that the insecticidal application during April was of no use whereas it was advantageous to apply during June and September using BHC @ 5 kg ai/ha and heptachlor @ 1.4 kg ai/ha as against the present schedule of application in April and August. In a field trial to study the comparative efficacy of various insecticides for the control of the nut crinkler (coreid bug) *Paradasynus rostratus*, it was found that BHC, carbaryl and endosulfan at 0.1%, 0.05% and 0.01% respectively effected significant control of the pest in the field. Cost of application per palm

per treatment works to 11 paise, 8 paise and 35 paise for BHC, carbaryl and endosulfan, respectively.

Monitoring of *O. rhinoceros* populations for the natural incidence of baculovirus disease revealed disease incidence in 54.2% beetles collected from Kerala and Karnataka. The absence of the virus in beetles collected from Minicoy Island of Lakshadweep opens up the possibility of introducing it in these islands for the biological suppression of the pest. The exotic tachinid parasite *Bessa remota* could be successfully reared on *Opisina arenosella (= Nephantis serinopa)*. The sampling technique adopted for monitoring *Opisina* population in the field was found appropriate in estimating the total population of the pest.

Arecanut

Brachydorus swarupi, a new species, of nematode was described from the soil around the roots of arecanut.

The fungus *Cylindrocarpon obtusisporum* was isolated from lesions produced by *R. similis* on arecanut roots.

Phorate 10 G or lindane 10 G application to the leaf axils @ 10 g/palm at quarterly intervals is recommended for the control of the arecanut spindle bug *Carvalhoia arecae* in the field. Cost of the insecticidal application for 100 palms works out to Rs. 38/- and Rs. 30/- for phorate and lindane respectively for each treatment.

Pepper

A survey was conducted to assess the quick wilt incidence in pepper in Calicut district and the overall disease incidence was observed to be 6.2%. Arakulamunda type had 7.5% wilt incidence while Karimunda and Panniyur-1 had 6.8% and 6.4% wilt disease, respectively.

A systemic fungicide metalaxyl at 500 ppm was found to check the *Phytophthora* infection of black pepper and the fungicide remains persistent in the plant upto 50 days after its application. This finding is important in that the fungicide once applied in the rainy season will prevent the disease for about one and half months.

An endoparasitic nematode, *Trophotylenchulus* sp. was recorded from roots of black pepper.

Results of a field trail carried out for three years to work out a spray schedule for the control of pollu beetle *Longitarsus nigripennis* with 0.05% endosulfan revealed that two sprays of insecticides, first during June–July and second during October, gave significant and effective control of the pest.

Cardamom

Six strains of 'Katte' disease agent were identified. Mild strain K-IV gave protection against four severe strains when tested under green house conditions. Katte infection causes a yield loss of 39%, 59% and 68% in one year, two years and three years respectively, after infection under field conditions. Vector population was observed throughout the year, though the peak was during the dry months. Regular roguing of affected clumps helped in reducing the disease incidence from 15.6% to 0.9% on an average. Katte eradication programme

was successfully implemented under 'Katte clinic' on payment system by the growers for the technical assistance in tracing and roguing. This was taken up in 61 plantations distributed in 30 villages in an area of 462 ha.

All soil and root samples collected from various Cardamom Board nurseries in Kerala, Karnataka and Tamil Nadu had root-knot nematodes.

Cocoa

Black pod disease *(Phytophthora palmivora)*, *Colletotrichum* leaf spot and pod rot *(C. gloeosporioides)*, charcoal pod rot *(Botryodiplodia theobromae)* and stem canker *(P. palmivora)* were recorded as the major cocoa diseases in India. Cherelles are more susceptible to *C. gloeosporioides* infection. However, foliar infection was found to be more important than pod rot. *Phytophthora* isolates from cocoa and arecanut are cross-inoculable.

The most susceptible stage of areca inflorescence to *C. gloeosporioides* infection was found to be after the shedding of male flowers, and the scars left by the shedding of male flowers were found to be the main foci for the initial infection. The incidence of *Colletotrichum* disease of cocoa and inflorescence die-back of arecanut was maximum during February-May in cocoa-areca mixed garden, whereas incidence of leaf spot in pure cocoa plantation was maximum in June-September.

Studies on cocoa mealy bug *Planococcus lilacinus* in various locations revealed that the incidence ranged from 42.4 % to 70.3 % during summer season and 15.2 % to 43.3 % during post monsoon season. Four species of ants were identified as symbionts with *P. lilacinus*. The lycaenid caterpillar *Spalgis epius* predacious on the mealy bug occured in high proportion during summer months in all locations surveyed.

Cashew

The peak population build up of tea mosquito bug *Helopeltis antonii* occurred during January and February, respectively at Goa and Vittal. Mass rearing technique could be standardised for *Sycanus collaris*, the reduvid predator on tea mosquito bug. At Goa, peak population build up of *Scirtothrips dorsalis* occurred during December.

Ginger

Spraying of malathion 0.1 % at monthly intervals from July to October significantly lowered the incidence of the shoot borer *Dichocrocis punctiferalis*.

Rodents on plantation crops

Regular trapping of rodents mainly *Rattus rattus* and *Funanbulas tristriatus* from CPCRI Farm, Kasaragod and the adjoining farmer's fields resulted in a reduction of rodent damage by 76.2 % and 92.2 %, respectively from coconut and cocoa.

AGRICULTURAL ECONOMICS

Multi-storeyed cropping

Economic evaluation of multi-storeyed cropping experiment at Kasargod involving coconut, pepper, cocoa and pineapple grown under irrigated condition showed that the system resulted in a net added return of Rs. 9700/ha over coconut as monocrop. The generation of employment also

increased from 113 man-days/ha in coconut alone to 425 man-days/ha in multistoreyed cropping.

Mixed cropping

Economics of mixed cropping of coconut and cocoa at Kasaragod revealed that single hedge cocoa (600 plants/ha) gave higher profit than double hedge cocoa (1200 plants/ha). The relationship between coconut and single hedge cocoa was found out to be complementary, whereas with double hedge cocoa it was competitive. Eventhough double hedge cocoa generated nearly 40% additional employment over single hedge system, the realised economic returns suggest for single hedge planting system of cocoa in coconut gardens.

Evaluation of hybrids in coconut

The cumulative yield for D×T hybrid grown under rainfed condition at Kayangulam at the end of 10th year from planting was 72,625 nuts/ha while it was 29,225 nuts/ha in case of WCT. Similarly while D×T hybrids yielded a cumulative net profit of Rs. 28,000/ha at the end of 10th year from their planting, WCT still remained at a cumulative net loss stage. This suggests that D×T hybrids are not only highly remunerative but also faster in getting back the investment than WCT. The fertiliser response in D×T hybrids grown under rainfed condition in sandy loam soil indicated that $N_1P_1K_1$ (500 g N + 300 g P + 1000 g K/palm/year) gave higher net benefit than the other two higher levels of fertilisers.

Evaluation of Mangala cultivar

The study on the varietal evaluation of arecanut showed that at the end of 10th year from planting the cumulative yield per hectare from 'Mangala' an 'Vittal Local' were 25 tonnes and 1 tonnes, respectively. The net returns o 10th year for 'Mangala' was estimate at Rs. 57,500/ha, while it came to R 27,000/ha in case of 'Vittal Local'.

Commodity survey

The compound growth rates of are production and yield of arecanut i India were estimated at 0.32%, 3.05 and 2.69% respectively per annum fo the period 1970-'71 to 1979-'8 Similarly, the annual compound growt rates for the quantity exported, expo earnings and unit values for arecan worked out to be 12.07%, 17.86% an 5.17% respectively. The wholesale pri for different types of arecanut in 198 was found to be three to four times ov 1960 price.

AGRICULTURAL STATISTICS

Though coconut yields obtaine in different years were found to be high correlated, the relationships were comp ratively weak, when the annual data fo immediately preceding and succeedi years were considered. Pooling the da for consecutive years was found increase the efficiency of analysis b about 50 to 60 per cent. Four fo increase in efficiency was noticed wh post-treatment data for a minimu period of two years were considere along with pre-treatment data for tw years, in covariance analysis.

A sampling technique to estima the field population of *Opisina arenose* Wlk., a pest of coconut palm was evolve using regression method, by countin the larval population in the middle 4

to 60% of the leaflets in the first 20% of the leaves, from the bottom. Separate formulae were suggested for different seasons, according to the intensity of pest population. During April-May, when the pest population is maximum, the total larval population in a tree can be estimated using the regression equation $y = 38.40 + 9.70\ x$ (R^2-0.59) where x is the count of larval population in the sampled leaflets.

Square root transformation of the form $\sqrt{x} + 10$ was found to normalise the distribution of annual yield data of coconut which is a pre-requisite in analysis of variance. Even when the data for consecutive years were pooled, or when data for different plot sizes were considered, the above transformation was found necessary. In the case of arecanuts, $\sqrt{x+3/8}$ transformation for number of nuts and $\sqrt{x}$ transformation for weight of nuts gave a closer approximation to normal distribution.

With rise in prices, the amplitude of the fluctuations in the seasonal indices for wholesale prices of coconuts, copra and coconut oil were found to increase. In the case of coconuts, increase in price (wholesale as well as farm prices) was accompanied by a shift in the pattern of variations, which was against the interests of the small cultivators.

TECHNOLOGY

A small-holder copra dryer using agricultural waste as source of energy has been developed. The salient features of the dryer are: 1) it occupies less space, 2) the temperature can be controlled, 3) it is portable and 4) it can be used for other crops also. Four hundred coconuts can be dried in 37.5 hr utilising about 30 kg of fuel. Other plantation crops like cocoa (35 kg beans) and arecanut (150 kg) can be dried in 18 hr and 80 hr, respectively.

A simple device for climbing arecanut palms has also been developed. The device can be easily attached to the trunk of the palm and can be adjusted at any desired height by means of a locking arrangement. A safety chain also is provided. The device costs about Rs. 350.

ICAR RESEARCH COMPLEX FOR GOA (CPCRI)

Crop husbandry

In upland rice DR-92, IET 5878, 6223 and 6983 were found to be the best among short duration varieties. Other selected varieties are, CR-94-721-3 for gall midge endemic areas, FPAR-7809 and OR-143-32 for water-logged condition, 'Bhavani' as fine grain table rice and IET 4592, 5688, 6238 and 7302 as medium duration varieties.

Crop protection

Application of carbofuran 3% granules @ 20 kg/ha on 15th day after transplanting of rice was found effective in controlling whorl maggot and leaf roller.

Weed control in wet land rice with application of granular herbicide 'Machete' @ 20 kg/ha six days after transplanting was found very effective and application of 'Saturn' @ 2 kg ai/ha on dry land after seed sowing showed excellent weed control.

In biological control of tea mosquito bug on cashew, a few species of

reduvid bugs and one species of spider have been identified as most active predators under field conditions.

Animal husbandry

The average involution time of uterus after calving in cross-bred cows was found to be about 34 days.

Under pathology of reproduction, it was found that calcium-phosphorus imbalance was a contributing factor for true anoestrum in cows. For restoring fertility in true anoestrous cases non-hormonal Ayurvedic preparation showed response.

Trials on reproductive management indicated that (i) Tonophosphan and prepalin combination and (ii) Clomiphene citrate administration in fresh calvers could make possible breeding at desired post partum period.

Animal nutrition

Studies on fodder preservation techniques indicated that addition of 1% molasses and 1% salt to the green fodder while ensiling could reduce the nutrient loss (NFE) by 15%.

Digestibility study *in vitro* indicated that the commonly fed 'karad' hay is less digestible than paddy straw.

Clinical trials on avian coccidiosis revealed that the cheap homeopathic drug, 'Arsenicum Album' is very safe and effective in prevention and control of the disease.

ALL INDIA COORDINATED SPICES AND CASHEWNUT IMPROVEMENT PROJECT

Cashew

Four high yielding selections and two hybrids of cashew developed at the Cashew Research Station, Bapatla under Andhra Pradesh Agricultural University were released as varieties. The average annual yield of these varieties in kg/tree are 17.1 for BPP. 1, 19.4 for BPP. 2, 13 for BPP. 3, 12.5 for BPP. 4, 42.1 for BPP. 5, and 20.5 for BPP. 6.

Coriander

GAU-1, a coriander selection developed at Jagudan under the Gujarat Agricultural University was recommended for release for cultivation in Gujarat. This variety has medium sized seeds with a yield potential of 10.5 q/ha as against 8.5 q/ha for local.

Fennel

UF. 32, a fennel selection from Jobner (Rajasthan) centre has been recommended for release in Rajasthan. It has a yield potential of 14 q/ha as against 12 q/ha in the local.

P.F. 35, another selection from Jagudan centre has been recommended for release. This has an yield potential of 11 q/ha as against 8.5 q/ha in the control.

Based on the results of fertilizer trial conducted on fennel at Jagudan 45 kg N, 30 kg P and three sprays of 0.6% zinc and 0.2% boron are recommended for fennel.

ALL INDIA COORDINATED COCONUT AND ARECANUT IMPROVEMENT PROJECT

Coconut

Crop Improvement

At Pilicode, out of 15 cross combinations, the crosses of WCT × CDG and

WCT × CDO performed well in respect of number of total and functional leaves as well as nut yield. At Ambajipeta, Tall × Dwarf continued to be superior followed by Laccadive Ordinary. At Veppankulam, ECT × DG was superior to other crosses. At Coimbatore, T × D hybrid gave the highest nut yield of 161 nuts/palm/year. At Ratnagiri, Banawali Green Round recorded the highest yield of 131 nuts/palm/year followed by T × D hybrid (119 nuts), and Laccadive Ordinary (107 nuts). At Arsikere T × D hybrid produced the highest yield (148 nuts/palm/year) followed by Laccadive Ordinary.

Crop husbandry

In both black and red soils of 'maidan' tract of Karnataka (Arsikere) planting coconut at 7.3 m × 7.3 m spacing and fertillser dose of 680 : 454 : 906 g N, P and K/palm/year gave maximum nut yield. Planting of coconut with a spacing of 6.1 m × 6.1 m with same level of fertiliser dose gave highest gross and net income of Rs. 17,126 and Rs. 12,454/ha, respectively. Regular manuring, irrigation once in 10 days, and cultural operations of ploughing twice gave the highest yield in Veppankulam. At Ratnagiri 750 g N and 450 g K/palm/year gave the highest cumulative yield of 400 nuts/palm/year.

Coconut based inter and mixed cropping

At Arsikere (Karnataka), the silkworm rearing and cocoon production using mulberry leaves grown as mixed crop in an area of 1000 m^2 gave Rs. 10,499 as net income when compared to Rs. 3,120 from the pure coconut crop. The employment opportunities were also doubled. Double cropping practice of potato–wheat, french bean–wheat, and ragi–wheat in coconut gardens as intercrops gave net income of Rs. 12,800, Rs. 12,760 and Rs. 9,208/ha/year respectively. At Veppankulam, highest net income was obtained by raising banana as an intercrop. At Ambajipetta, elephant foot yam as intercrop was most profitable followed by TC Keli Banana.

Arecanut

At Coimbatore, arecanut variety 'Mangala' (VTL 3) gave increased yields for the last three years over the local Mettupalayam.