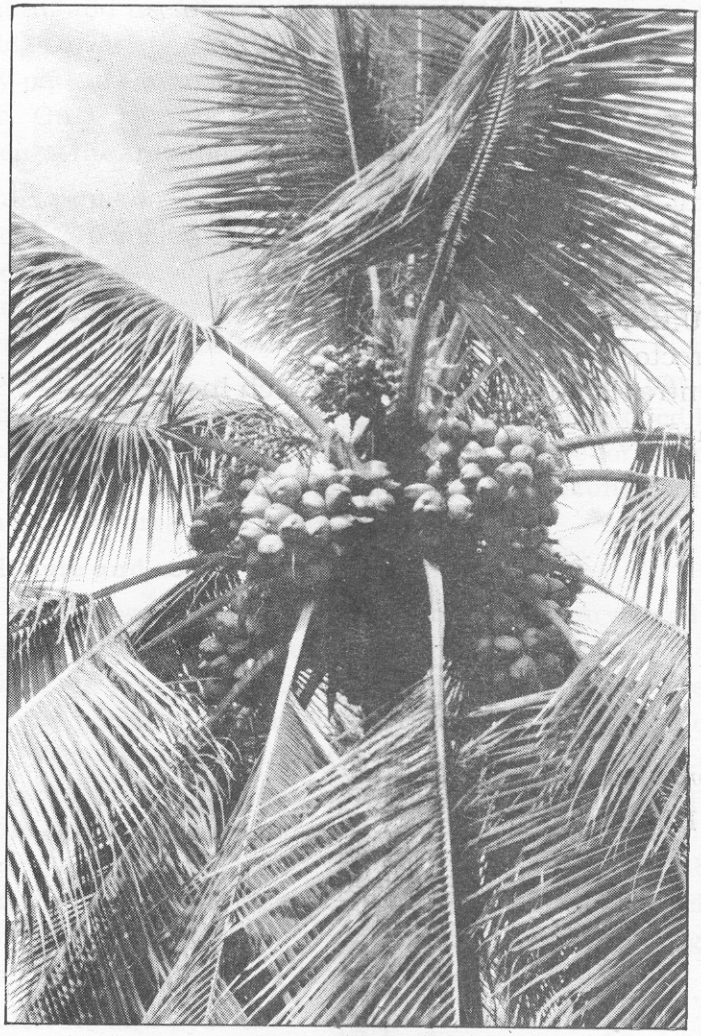
COCONUT
CULTIVATION PRACTICES



CPCRI

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COCONUT: CULTIVATION PRACTICES

1. Introduction

The coconut palm, *Cocos nucifera L.,* is one of the most beautiful and useful palms in the world. It is important that it provides a variety of useful products like food, fuel and timber. Every part of the tree is being utilized for some purpose or the other. On account of this, it is called Kalpavriksha- the "tree of heaven" - the tree that provides all the necessities of life.

India ranks first in production (13968 million nuts) from an area of 1.796 million ha ranking third and contributing to 26.06% share of total coconut production from different coconut producing countries of the world. Still the productivity of coconut palm in India is low compared to its potential. The main reason for such low yield is that the cultivators do not pay much attention to its cultivation. In the current situation of edible oil shortage in the country, there is enormous scope for improving the yields in the existing plantations of coconut and for extending the area under this crop.

2. Climate and soil

The coconut palm is found to grow under varying climatic and soil conditions. It is essentially a tropical plant, growing mostly between 20^0 N and 20^0 S latitudes. The farther, one goes from the equator, the more is the palm confined to low lands. Near the equator, productive coconut plantations can be established upto an elevation of about 1000 m. The palms tolerate wide range in intensity and distribution of rainfall. However, a rainfall of about 200 cm per year and well distributed throughout, is the best for proper growth and maximum yield. In areas of inadequate rainfall with uneven distribution, irrigation is required.

3. Cultivars and hybrids

Coconut palms are broadly classified into two groups, the Talls and the Dwarfs. The Tall cultivars are the common type that occur throughout the world. The different cultivars of the Talls are known by the place where they are largely cultivated. The Tall cultivars largely grown in India are the West Coast Tall

and East Coast Tall. The Dwarf varieties are shorter in stature and life span as compared to Talls. The size of the nut and the quality of copra are inferior to Talls. The Dwarf cultivars occur with three nut colours, green, yellow and orange. The Dwarf cultivars are generally grown for tender nuts and also for hybrid production. The common Dwarfs available in India are Chowghat Orange Dwarf, Chowghat Green Dwarf, Malayan Green Dwarf, Malayan Yellow Dwarf, Malayan Orange Dwarf, Gangabondom etc. Among the Tall cultivars, Lakshadweep Ordinary gave 33% more nuts and 30% more copra yield annually over local Talls under rainfed conditions. Benaulim Green Round has given 62.3% increased nut yield over West Coast Tall in the Konkan Coast of Maharashtra. Kera Chandra (Philippine Ordinary Tall) which has been released for cultivation gave 38% more nuts and 55% more copra yield annually over local Tall under rainfed conditions. Chowghat Orange Dwarf (COD) which is being used as a female parent for hybrid seed production has been released as a good tendernut variety.

Anandaganga (AOxGB), Kera Ganga (WCTxGB) and Kerashree (WCTxMYD) are the promising hybrids released by KAU, which gave 19-76% higher yield than WCT under rainfed conditions.

The hybrids between Tall and Dwarf cultivars show hybrid vigour for growth and yield. As a consequence, hybrid seed gardens have been established in most of the coconut growing states. The hybrids are produced using Talls and Dwarfs. When the Tall is used as female and Dwarf as male, they are called TxD while the reciprocal is known as DxT. Laksha Ganga (LO x GB) is a TxD hybrid, while Chandra sankara (COD x WCT) is a DxT hybrid. Laksha Ganga, Chandra sankara, Chandra Laksha (LO x COD) are superior hybrids and yield 19-42% over other combinations and their parents. Laksha Ganga and Chandra Laksha showed tolerance to drought. VHC - 1 (East Coast Tall x Chowghat Green Dwarf) and VHC-2 (East Coast Tall x Malayan Yellow Dwarf) are TxD hybrids released by the Tamil Nadu Agricultural University which have given 9 to 26% more yield in Tamil Nadu.

Based on the available information on the performance, the following cultivars are found suitable in the states noted against each:

West Coast Tall	:	Kerala, Karnataka, Gujarat, Bihar, Madhya Pradesh, Lakshadweep, Orissa, Tamil Nadu and Tripura
Chandrakalpa (LO)	:	For all the states
Chowghat Orange Dwarf	:	For all the states as tendernut variety
Andaman Ordinary	:	Andamans, Andhra Pradesh, Bihar, Assam, Madhya Pradesh, Kerala, Orissa, Pondicherry, Tamil Nadu, Tripura and West Bengal
East Coast Tall	:	Tamil Nadu, Andhra Pradesh, Bihar, Madhya Pradesh, Orissa, Pondicherry, Andamans and West Bengal
Tiptur Tall	:	Karnataka
Benaulim	:	Maharashtra and Goa
Philippine Ordinary	:	Kerala, Andhra Pradesh and Tamil Nadu

In addition to the above cultivars, for seed garden establishment, Chowghat Orange Dwarf and Malayan Yellow Dwarf are suggested for all states.

4. Planting materials

Selection of seednuts and seedlings is of utmost importance in coconut as the performance of the new progeny can be evaluated only several years after planting. If the seednuts and seedlings happen to be of poor quality, the new plantation will prove to be uneconomic, causing considerable loss of time and money to the grower. The fact that the coconut is a cross-fertilized palm and that it does not breed true, makes the selection of seednuts and then of seedlings in the nursery all the more difficult and important. By means of a series of selections made at different stages, it is possible to eliminate poor quality seednuts and seedlings. Seednuts should be collected from mother palms which should have attained an age of 20 years, yielding constantly more than 80 nuts per palm per

year and free of any disease. Further, it should have a minimum of 30 leaves with nut weight more than 600 g and copra weight 150g and above. Generally the seednuts are collected in the months of April-May and is planted in June in west coast region, whereas in the east coast region, nuts are sown in the months of October-November. Tall varieties are sown one or two months after collection whereas Dwarfs should be sown immediately after harvest. (within 10-15 days). Seednuts grown in the pot mixture (soil:sand:FYM) either in polybag or in cement tanks produced healthy and vigorous seedlings. Vigorous seeding is one which has germinated earlier (before 5 months), has atleast 6 leaves and the girth at collar should measure more than 10 cm. Generally one year old seedlings are preferred for normal planting. However for planting in water logged area, 1½ to 2 year old seedlings are preferred.

5. Establishment of a plantation

5.1. Selection of the site : Soil with a minimum depth of 1.2 metres and fairly good water holding capacity is preferred for coconut cultivation. Shallow soils with underlying hard rock, low lying areas subject to water stagnation and clayey soils are to be avoided as it will be difficult to raise successful coconut plantations under such conditions. However, in lands, reclaimed by heaping alternate layers of sand and clay, coconut thrives well. Proper supply of moisture either through well distributed rainfall or irrigation and sufficient drainage are essential for coconut.

5.2 Preparation of land and planting : Preparation of land for planting coconut depends to a large extent on soil type and environmental factors. If the land is uneven and full of shrubs, the shrubs have to be cleared and land levelled before taking pits. The depth of pits will depend upon the type of soil. In laterite soil with rocky substratum, deeper and wider pits, 1.2 x 1.2 x 1.2 m, may be dug and filled up with loose soil, powdered cowdung and ash upto a depth of 60cm before planting. In loamy soils with low water table, planting in 1.0 x 1.0 x 1.0 m pits filled upto 50 cm depth is generally recommended. However, when the water table is high, planting at the surface or even on mounds may be necessary. Even while planting at the surface or mounds,

digging pits and filling has to be done. While filling the pits with soil, use the top layer soil.

Arrange two layers of coconut husk at the bottom of the pit before filling up the soil with concave surface facing up. This will help in conserving the moisture. In laterite soil, addition of 2 kg of common salt will help in loosening the soil.

5.3 Replanting/Underplanting : Generally underplanting is done in plantations where the palms become unproductive and uneconomic to the farmer. Old palms are removed in stages over a period of 3 to 4 years. First peg mark the area to be underplanted. Remove the very poor yielders and those close to the planting pits and plant the seedlings in the usual way. The other trees are removed at the rate of one third each year during 2nd, 3rd and 4th year after planting. If the existing garden is irregularly spaced remove old palms within 1 m radial distance in first year, 2 m distance in second year, 3 m distance in third year and the rest in 4th year.

5.4 Spacing : Spacing of palms requires careful consideration. A spacing of 7.5 to 9.0 m may be adopted depending on the crown size. This will accommodate 177 and 124 palms per ha respectively under the square system of planting. If the triangular system is adopted, an additional 20 to 25 palms can be planted. Also a hedge system can be adopted giving a spacing of 5.0 to 5.5 m along the rows and 9 to 10 m between the rows. If wider spacing of 20m x 10m is adopted, it provides ample opportunity to put a number of perennial and annual crops in the interspaces.

5.5 Time of planting: In well drained soils where water stagnation is not a problem, seedlings can be transplanted with the beginning of southwest monsoon. If irrigation facilities are available, it is advisable to take up planting at least a month before the monsoon sets in so that the seedlings get well established before the onset of heavy rains. Planting can also be taken up before the north-east monsoon. In low lying areas subject to inundation during monsoon periods, seedlings are better transplanted after the cessation of the monsoon.

5.6 Care of young palms : Sufficient attention will have to be paid to the young palms in the early years of growth. The transplanted seedlings should be shaded and irrigated properly during the summer months. Irrigation with 45 litres of water once in 4 days has been found to be satisfactory in sandy soils. Provision of proper drainage is also equally important in areas subject to waterlogging. If planting is taken up in the littoral sandy soil, application of 0.15m^3 of red earth is recommended.

The pits should be cleared of weeds periodically. Soil washed down by the rains and covering the collar of the seedlings should also be removed. The pits should be widened every year before the application of manure. The pits should be gradually filled up as the seedlings grow. The palms should be frequently examined for any insect or fungus attack and necessary remedial measures should be taken up promptly.

5.7 Manuring : An application of 500g N, 320g P_2O_5 and 1200g K_2O per palm per year is generally recommended for adult plantations. Fertilizers like urea, rock phosphate, muriate of potash, Suphala, Factomphos, Rajphos and commonly available fertilizer mixtures may be used to supply the required quantity of nutrients. Rock phosphate (Mussorie phos) is recommended as an ideal and cheaper carrier of phosphorus in laterite and acidic soils. Fertilizers may be applied in two split doses for the rainfed palms. After the receipt of summer showers, one-third of the recommended dose of fertilizers may be spread around the palms within a radius of 1.8m and forked in. Circular basins of 1.8m radius and 25 cm depth may be dug in August-September and green leaf or compost at 50 kg per palm may be spread in the pits. The remaining two-third of the recommended dose of fertilizers may be spread over the green leaf or compost and the basins covered.

If the palms are irrigated, the fertilizers can be applied in 4 or more equal splits avoiding the heavy rain fall period of the area. If there is drip irrigation facility, then the water soluble fertilisers like Urea, DAP, phosphoric acid (commercial grade) and muriate of potash can be applied along with drip irrigation in 4 to 6 equal splits.

Regular manuring from the first year of planting is essential to ensure good vegetative growth, early flowering and bearing and high yields. The first application of fertilizers should be done three months after planting when the south-west monsoon ends on the West Coast, if seedlings are planted before the rains in May-June (see Table). During the second year, one third of the dosage recommended for adult palms may be applied in two split doses in May-June and September-October. This dosage may be doubled during the third year. From the fourth year onwards, fertilizers may be applied at the rates recommended for adult palms.

Fertilizer recommendation for coconut (g/tree)

	May-June			September-October		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
First year	Planting in May-June			50	40	135
Second year	50	40	135	110	80	270
Third year	110	80	270	220	160	540
Fourth year onwards	170	120	400	330	200	800

To supply the above quantity of nutrients for an adult palm, it is required to apply about 1 kg urea, 1.5 kg Mussorie phos/rock phosphate in acidic soil or 2 kg of super phosphate in other soils and 2 kg of muriate of potash in two split doses. If coconut mixture (10:5:20) is used, it is required to apply 5 kg of the same in two split doses.

Under average management, a minimum of 340 g N, 170 g P_2O_5 and 680 g K_2O may be applied per tree in two split doses (one-third in May-June and two third in September-October).

When the recommended level of nutrients are applied continuously, the available P_2O_5 in the soil tends to go up. When it is more than 20 ppm, application of P_2O_5 can be skipped off a few years till the level comes down to 20 ppm.

In addition to the recommended levels of fertilizers, 1.0 kg of dolomite (or 1.0 kg of lime) and 0.5 kg of magnesium sulphate per palm per year may be applied in acidic soils. Dolomite or lime may be broadcast in April-May in the basins and

incorporated into the soil by forking and should not be applied with other fertilizers. Magnesium sulphate can be applied along with other fertilizers in the basins in September.

In sandy soils of Onattukara part (Kollam and Alapuzha districts) of Kerala state, 500g N+300g P_2O_5 + 1000 g K_2O along with 500 g MgO (3 kg Magnesium sulphate) may be applied per palm per year.

5.8 Irrigation and soil moisture conservation : The coconut palm responds to summer irrigation. Under west coast conditions, 2 cm irrigation through perfo-sprays once in 5 days during December-February and once in 4 days during March-May has been found to be beneficial in sandy loam soil in increasing yields. Where basin irrigation is practised, 200 litres/palm once in 4 days will be beneficial. In areas where water is scarce, soil is sandy and labour is costly, drip system of irrigation can be adopted. The quantity of water recommended for drip irrigation is 66% of the open pan evaporation which comes to 30-32 litres/palm/day for Kasaragod conditions during summer months (for a basin area of 1.8 m radius). If the clogging problem is acute, then we can go for microtubes instead of emitters.

Addition of coconut pith/coir dust as a mulch at 25kg/palm basin or mulching with husk with the convex side upwards will help in conserving soil moisture. Tillage operations like digging the garden with 'mammatty' (spade), ploughing, forming small mounds in August-September and spreading them in December-January and making shallow basins with a radius of about 2 m at the beginning of monsoon and filling up at the close of monsoon are beneficial to the trees. In sandy soils, which are generally of low fertility and do not have a luxuriant growth of weeds, regular intercultivation may not be necessary; but in other soils which permit quick growth of weeds, intercultivation will be necessary to keep weeds under control. Method of intercultivation will depend upon local conditions, availability of labour, size of holding, soil type, topography and distribution of rainfall.

5.9. Cover cropping : Cover cropping is recommended where inter and mixed cropping is not followed to prevent soil erosion

in coconut gardens. This will also add organic matter to the soil. Leguminous crops such as *Mimosa invisa, Stylosanthes gracilis* and *Calopogonium mucunoides* are generally recommended. Green manure crops like sunnhemp (*Crotolaria juncea*) and kolinji (*Tephrosia purpurea*) can also be raised and ploughed in during August- September. These crops can be sown in April-May when pre-monsoon showers are received.

5.10 Inter and mixed cropping : A variety of inter-crops like pineapple, banana, elephant foot yam, groundnut, chillies, sweet potato and tapioca can be raised in coconut gardens upto 8-10 years. After the palms attain a height of 5 to 6 metres (20-22 years) i.e., in older plantations, cocoa, pepper, cinnamon, clove and nutmeg can be grown as mixed crops along with the inter crops which is called as High Density Multispecies Cropping System. In places where rainfall is not well distributed, irrigation may be necessary during summer months. However, these crops are to be adequately and separately manured in addition to the manures applied to the coconut palms.

5.11 Mixed farming : Milk is scarce in areas where coconut is extensively grown mainly because of non availability of fodder. Mixed farming by raising fodder grasses such as hybrid napier or guinea grass along with leguminous fodder crops such as *Stylosanthes gracilis* in coconut gardens has been found to be profitable. Raising the above crops in one hectare of coconut garden can support four to five dairy animals. In addition to the cattle, poultry, pisciculture and apiculture may be integrated depending upon the farmers' interest. The cattle and poultry manure generated from the system when applied to coconut garden improves the soil fertility considerably. Maintaining milch cows and other components in coconut garden helps the farmer to enhance his income and provide additional employment to the family.

5.12 Vermicompost : Good vermicompost can be prepared from fallen coconut leaves in the coconut garden. The fallen leaves can be put in trenches made in the garden or in cement tanks. Addition of 1kg of earth worms (*Eudrilus sp*) for one tonne of the material will provide good vermicompost within 3 to 5 months period. Care should be taken to keep the decomposing material

moist by spraying water frequently. To start with, we can add cowdung (1/10 of the total weight of the material) along with the coconut leaves to accelerate decomposing. Finally we will get 60 to 70% of the total weight of the material (dry weight) added as vermicompost.

6. Plant protection

6.1 Pests : The major insect pests of the coconut palm are the rhinoceros beetle, *Oryctes rhinoceros*, the leaf eating caterpillar, *Opisina arenosella* (=*Nephantis serinopa*), the red palm weevil, *Rhynchophorus ferrugineus* and the root eating white grub *Leucopholis coneophora.*

6.1.1 Rhinoceros beetle : This is the most serious pest, which has an ubiquitous distribution. The adult beetle bores through into the unopened fronds and spathes. The affected frond when fully opened shows the characteristic geometric cuts. Infestation on spathes often destroys the inflorescence and thus prevents production of nuts. The beetle breeds in a variety of materials such as decaying organic debris, farm yard manure, dead coconut stumps, logs and compost. The total duration of life cycle of this pest is about six months.

Maintenance of sanitation in coconut gardens by proper disposal of decaying organic debris is an important step in the management of rhinoceros beetle. Mechanical method of control is possible by extracting beetles with hooks, without causing any further injury to the growing point of the palm.

The innermost 2nd and 3rd leaf axlis may be filled with Sevidol 8G (25g) + fine sand (200g) per palm. Filling leaf axils with 10.5 g Napthalene balls covered with sand at 45 days interval is also effective. The breeding sites of beetle such as cattle dung, compost and other decaying organic debris may be treated with carbaryl 50% WP at 0.01%. Three applications in April, September and December are adequate to give sufficient protection to palms in heavily infested tracts.

Baculovirus inoculated beetles @ 10-15 per ha can be released to bring down the pest population. Release of the exotic predator *Platymeris laevicollis* was also found to be effective. Inoculations of breeding ground with entomopathogen *Metarhizum anisopliae*

(Metch) @ $5x10^{11}$ spores gave effective control. Adoption of all the proven methods of beetle control in an integrated manner would give quicker reduction in pest infestation.

6.1.2 Leaf eating caterpillar : Leaf eating caterpillar is another serious pest of coconut in the coastal and backwater tracts. In recent years, this pest got access into certain interior tracts as well and assumed severe proportions. The caterpillars live on the under surface of leaflets inside silken galleries and feed voraciously on the chlorophyll containing functional tissues. This affects the health of the palm adversely and results in reduction of yield. The severity of infestation by this pest will be marked during the summer months from February to June. With the onset of south west monsoon, the pest population begins to decline.

Spraying of infested palms on the lower surface of leaves with Dichlorvos (0.02%) would give satisfactory control of the pest. Chemical control treatment is generally adopted only in cases of severe outbreak of the pest. The treatment may be done at quarterly intervals in March, June, September and December depending on the abundance of the pest in the field.

As this pest is subject to parasitisation by a good number of indigenous larval and pupal parasites, its biological suppression is feasible. Mass multiplication, liberation and colonisation of indigenous and/or exotic parasites like *Parasierola nephantidis, Elasmus nephantidis, Brachymeria nosatoi* and *Xanthopimpla punctata* in the infested fields would control the pest population. The parasite breeding stations established in the major pest-infested regions are mass culturing and releasing different species of larval and pupal parasites of the pest. The bio-control laboratory at CPCRI maintains culture of important species of parasites for supply as nucleus culture material to the parasites breeding stations in the country for mass multiplication and release in infested gardens.

6.1.3 Red palm weevil : Red palm weevil is the most dreaded pest of young coconut palms. Generally palms of the age group 5-20 years are affected by this pest. At times, seedlings below 5 years are attacked by the pest. Since the pest is a tissue borer, its detection in early stage of infestation is rather difficult. The

major diagnostic symptoms of red palm weevil infestation are the presence of holes in stems, oozing viscous brown fluid and extrusion of chewed up fibres through the holes, longitudinal splitting of leaf bases and wilting of inner leaves. Sometimes the gnawing sound produced by the grubs feeding inside will also be audible. Quite often the infestation would become evident only when the growing point of the palm is damaged and the crown has topped.

Affected palms can be saved by injection of Carbaryl (Sevin) at 1% concentration. 20 g of 50% Sevin in 1 litre water per palm should be introduced into the trunk through a hole above the infested portion, using an auger and funnel. All the holes on the affected stem should be plugged after injecting the insecticide suspension to the palm. If the pest infestation is through the crown, the insecticide suspension should be slowly poured in after cleaning the crown of all affected materials. Endosulfan 0.1% is also found to be effective in controlling this pest.

Coconut logs of 50 cm long, split longitudinally and cut surfaces smeared with fresh toddy fermented with yeast and acetic acid are effective traps. Weevil thus trapped can be collected and killed. Pealed coconut petioles arranged in trays and treated with macerated sugarcane + yeast are suitable substitutes for coconut log traps.

Entry of this pest through the cut ends of leaf base can be prevented by leaving a length of 120 cm of petiole while cutting leaves, particularly from palms of the susceptible age. Cutting steps on the stem for easy climbing also has to be discouraged as a precautionary measure to avoid entry of the pest through injured tissues. Palms affected by leaf rot/bud rot diseases are more prone to weevil infestation. As such, they are to be treated with an insecticide as well, after the fungicidal treatment. Dead palms should be cut and burnt. An integrated approach involving all the proven methods of weevil control is feasible in maintaining gardens free of pest infestation.

6.1.4 Root eating cockchafer : The soil inhabiting white grubs cause damage to the roots of coconut. Besides coconut, it infests tuber crops like tapioca, colocasia, sweet potato etc., grown as intercrops in coconut gardens. The leaves of affected palms

become sickly pale yellow. In cases of heavy infestation, there will be immature nutfall as well.

Application of phorate 10 G @ 100g per palm in May-June and September-October so as to cover pre and post monsoon period is recommended in coastal and malanad areas. The pesticide applied should be mixed and raked in the top 15 cm soil, so as to give effective control of the pest.

6.1.5 Eriophyid mite *(Eriophyis guerreronis)* : Recently coconut gardens in Ernakulam, Thrissur, Kottayam and Alappuzha districts of Kerala and some parts of Tamilnadu were seriously affected by a non insect pest commonly called eriophyid mite. These mites infest by sucking sap from the soft tissues of buttons. In the initial stages, damage occurs as triangular patches close to perianth. Later because of the continuous desapping by various stages of mites present beneath the inner bracts of perianth, brown coloured patches are formed. As the nuts grow in size, the injured patches become warts and then develop into longitudinal splits on the surface of nuts. Apart from this, the liquid oozing out from these patches dries and as a result, dried decayed matter is noticed. The damage thus caused affects the quality of husk and dehusking becomes difficult.

Studies conducted at C.P.C.R.I. reveal that root feeding of monocrotophos (10 ml in 10 ml of water) keeps the mites in check. Care should be taken to harvest the nuts prior to root feeding.

Experiments conducted by K.A.U. showed the usefulness of spraying Dicofol @ 6 ml/litre of water two to three times a month. Spraying neem oil 200ml, soap 50 g and garlic 200 g mixed in 10 litres of water was also found to be effective.

At T.N.A.U., it was found that methyldemeton 4 ml or phosalone 3 ml or triazophos 5 ml diluted in one litre of water sprayed once in 10 days could control the mites. Root feeding of triazophos 20 ml in 20 ml water was also found to be effective.

6.1.6 Other pests : The coreid bug (nut crinkler) *Paradasynus rostratus* has become a serious problem in many parts of Kerala. It causes damage to the buttons and tender nuts. Nuts are shed in severe cases of infestation. Even those nuts which are retained in the bunches become deformed with the

characteristic crevices on the husk just below the perianth. There will also be gummy exudation from such crevices. Majority of such nuts will be totally barren or with only partial kernel development. Spraying carbaryl or endosulfan 0.1% on the unopened spathes and bunches (except the newly opened inflorescence) will control the pest.

During summer months, mealy bugs cause damage to spindle leaves, spathes and bunches and the scale insects make encrustations on the foliage. The infested leaves turn yellow and finally dry up. The mealy bugs can be controlled with two rounds of spray of 0.1% fenthion or monocrotophos. In the case of scale insects, spraying with dimethoate or monocrotophos 0.05% is efficacious.

It is estimated that nearly 20 per cent of coconut seedlings are damaged by termites, *Odontotermes obesus* Ramb. in coconut nurseries particularly in the laterite areas. Adoption of field sanitation by disposal of organic matter in nursery soil and covering the germinating nuts with a layer of river sand are some of the practices which would reduce termite infestation. Drenching the nursery with 0.05% chlorpyriphos twice at 20-25 days interval and swabbing the affected trunk with above mentioned chemical are effective in controlling termites.

Whenever, the slug caterpillars like *Contheyla rotunda*, *Parasa lepida* etc. which sporadically appear, assume the status of serious pests, the palms are to be sprayed with 0.1% carbaryl to get a satisfactory control of the pests.

The lace bug, *Stephanitis typicus* is not only a pest which sucks sap from coconut foliage but also acts as a vector in the transmission of Phytoplasma from root (wilt) diseased palms to healthy ones. This bug can be controlled by spraying endosulfan or monocrotophos 0.01%.

6.1.7 Mammalian pests : Rats damage tender nuts and cause severe crop loss in many places. Shed tender nuts with characteristic holes can be located at the base of the affected palms. Rats can be controlled by providing mechanical barriers (bands), poison baits and traps. G.I sheet bands, 40 cm wide, fixed around the trunk of palms at a height of 2m from the ground will serve as mechanical barriers for rats. The rats can be killed

by poison baiting using either single dose acute poisons like zinc phosphide or multiple dose anti blood coagulants like bromadiolone. Rat burrows in the field can be fumigated with aluminium phosphide tablets. Poison baiting with 0.005% bromadiolone in coconut crowns at 3-4 days intervals at the rate of 30 palms (bait points)/ha reduces the rat population and damage by 94% and 100% respectively. Poison baiting at the ground level does not have much effect in controlling the rats since they seldom come to the ground. If there are residential buildings within the plantations, rat control should be undertaken in both the places to check reinfestation. The best period to adopt the field operation to control the rat is late summer.

Coconut bunches can be protected from the ravages of frugivorous bats (*Pteropus edwardsii*) by covering the bunches with thorny twigs of the wild plants like *Ziziphus sp.*

6.2 Diseases : The coconut palm is affected by a number of diseases, some of which are lethal while others gradually reduce the vigour of the palm causing severe loss in yield. A brief account of the important diseases of coconut in our country is presented here:

6.2.1 Bud rot : This disease, caused by a parasitic fungus, *Phytophthora palmivora* has been reported from all coconut growing states. The first symptom of the disease is the yellowing of one or two young leaves surrounding the spindle. The spindle withers and droops down. The tender leaf bases and the soft tissues of the crown rot into a slimy mass of decayed material, emitting a foul odour. The disease proves fatal if it is not checked in the early stage. Even after the death of the central bud, the outer leaves and bunches may continue to remain intact for many months. Palms of all ages are susceptible to the disease, but it is more frequent in young palms. The disease is rampant during the monsoon when the atmospheric temperature is low and the humidity is high.

If the disease is detected in the early stage when the spindle is just withering, the infected tissue should be removed thoroughly by cutting the infected spindle along with two leaves surrounding it and the cut portion protected by application of

Bordeaux paste. The treated wound should be given a protective covering with polythene sheet till the next normal shoot emerges. Badly affected trees which are beyond recovery should be cut and burnt. As a prophylactic measure, all the healthy palms in the vicinity of the diseased one should be sprayed with 1% Bordeaux mixture. For varieties (dwarf) which are sensitive to copper injury, placing small perforated sachets containing 2-3 g of Dithane M 45/Indofil M 45 in the top two or three leaf axils is useful.

Preparation of 1% Bordeaux mixture : Dissolve 1 kg copper sulphate crystals in 50 litres of water. In another vessel containing 50 litres of water, prepare milk of lime with 1 kg quick lime. Pour the copper sulphate solution into the milk of lime slowly stirring the mixture all the while. Test the mixture before use for the presence of free copper (which is harmful to the palm) by dipping a polished knife in it. If the blade shows a reddish colour, add more lime till the blade is not stained when dipped afresh in the mixture. Always use wooden or earthen or copper vessels for the preparation of Bordeaux mixture. For preparation of Bordeaux paste, 100 g copper sulphate and 100g quick lime each are dissolved in 500 ml of water separately and mixed thoroughly.

6.2.2 Root (wilt) disease : The root (wilt) disease has been prevalent in the state of Kerala for nearly 100 years and is believed to have made its appearance after the great floods of 1882. It has now established itself almost contiguously in eight South districts of Kerala viz. Thiruvananthapuram, Alapuzha, Kollam, Kottayam, Pathanamthitta, Idukki, Eranakulam and Thrissur. It has also made its sporadic appearance in the districts of Malapuram, Palakkad, Kozhikode, Wayanad, Kannur and in some groves in the neighbouring state of Tamil Nadu.

The important visual diagnostic symptoms of the disease are abnormal bending or ribbing of the leaflets, termed as 'flaccidity', a general yellowing and marginal necrosis of the leaflets. The nuts are smaller and the kernel is thin. The oil content of copra is also reduced. Phytoplasma is the causative agent of the disease. The disease is transmitted by lace bug *Stephanitis typica* and the plant hopper *Proutista moesta.*

Since the disease is not lethal but debilitating and no curative control measure is known at present, the approach will be to manage the disease in the already infected gardens. To reduce the loss due to the disease, the strategy would be to control the disease in the eight southern districts of Kerala for which the following measures are recommended.

(i) Removal of diseased palms in Thiruvananthapuram and Thrissur district and other areas of sparse incidence. In areas of heavy incidence of disease, all the heavily infected and unproductive palms (those yielding less than 10 nuts per palm per year) should be eradicated. Within the contiguously disease affected tract, all palms in the prebearing age which have taken up the disease should also be eradicated.

(ii) Replanting with progenies of disease free palms located in the hot spot areas.

(iii) Application of NPK fertilizers, magnesium sulphate and organic manures at recommended dose.

(iv) Growing green manure crops in the basin and appropriate inter and mixed crops.

(v) Irrigation during the summer months.

(vi) Control of leaf rot disease which is usually noticed on root (wilt) affected palms.

6.2.3 Leaf rot : This disease is caused mainly by *Colletotrichum gloeosporioides* and *Exerohilum rostratum.* This is mostly prevalent in the southern districts of Kerala and generally occurs on palms already affected by root (wilt) disease. The first visible symptom of the disease is blackening and shrivelling up of the distal ends of the leaflets in the central spindle and in some of the younger leaves. Later, the affected portion breaks off in bits giving the infected leaves a fan-like appearance. If no protective measures are taken, each new leaf of the diseased tree gets infected with the result that a stage is soon reached when all the leaves of the tree show disease symptoms. The reduction in leaf surface adversely affects the yield.

Leaf rot can be effectively controlled

(i) By cutting and removing the rotten portion of the spindle and two successive leaves.

(ii) By pouring 300 ml of fungicidal solution containing 2 ml of Contaf 5% EC or 3 g of Indofil M 45 in the spindle well.

(iii) Apply 20 g Phorate 10 G mixed with 200 g of fine sand around the base of the spindle. The above treatment has to be done twice a year in April-May and in Oct-Nov.

6.2.4 Leaf blight or grey leaf spot : This fungal disease caused by *Pestalotia palmarum* is common in most of the coconut growing states. The disease symptoms develop in the mature leaves of the outer whorl. Minute yellow spots encircled by greyish bands appear on the leaf surface which later become greyish white. These spots coalesce into irregular necrotic patches. Complete drying and shrivelling of the leaf blade are common when the infection is severe. Removal of the older affected leaves and spraying the foliage with 1% Bordeaux mixture will check the spread of the disease.

6.2.5 Mahali or fruit rot and nutfall : Shedding of female flowers (buttons) and immature nuts are the symptoms of the disease. Water soaked lesions appear on the young fruits or buttons near the stalk which later develop and result in the decay of the underlying tissues.

The disease is caused by the fungus *Phytophthora palmivora* which appears as whitish webby growth on the surface of the affected part. The pathogen is more active during the rainy season when the atmospheric conditions are favourable for its growth.

A pre-monsoon spraying followed by one or two sprayings at intervals of 40 days is generally advisable. Spraying the crown with 1% Bordeaux mixture or any other effective copper fungicide such as Fytolan (0.5%) will control the disease. The shed nuts should be collected and burnt.

6.2.6 Stem bleeding : The typical symptom of the disease is the exudation of a reddish brown liquid through cracks developing on the trunk. The bleeding patches are generally spread throughout as the disease advances. On drying, the liquid

turns black. The tissues around the bleeding points start decaying first which later develop into a general decay of the tissues underneath the bark. As the desease advances, the leaf size is reduced resulting in reduction of crown size. Nut shedding also takes place. Stem tapers to a pencil point and dies slowly. Fatal instances of stem bleeding are not uncommon.

The fungus *Thielaviopsis paradoxa* has been found to be the primary causative agent of the disease. Soil and physiological factors like salinity, drought and flooding have some role in predisposing the palms to infection by this fungus. In advanced stages, infestation with Diocalandra weevil can be seen which quickens the deterioration of the palms.

The damage to stem can be checked to a certain extent by completely removing the affected tissues using a chisel and dressing the wound with Calixin 5% followed by hot coal tar. Apply 100 ml Calixin 5% through root feeding thrice a year during June, September - October and January. Apply 5 kg neem cake per palm per year during September-October. Also provide summer irrigation.

6.2.7 Thanjavur wilt/Ganoderma wilt : The disease was first noticed in the coastal areas of Thanjavur district following the cyclones of 1952 and 1955. It has now spread to all the coconut growing districts of Tamil Nadu.

Decay of root system, flaccidity of spindle leaves, browning of outer leaves, arrested fruit set and appearance of bleeding patches on the stem are the salient features of the malady. The affected palms die within 2-3 years. *Ganoderma lucidum* and *Ganoderma applanatum* are the causative agents of the disease. The bracket of fungus are seen on stumps of the diseased palms in very advanced stages.

Application of 5 kg neem cake per year, addition of organic matter and providing irrigation could check the spread of the disease. Drainage channels should be provided between the palm rows. Adoption of phytosanitary measures like removal of dead palm, burying the affected roots and bole in the pit and isolation of the diseased palm from the neighbouring healthy ones by digging trenches all around is beneficial in checking

further spread of the disease. Apply Calixin @ 2 ml/100 ml through root feeding at quarterly interval for one year. Soil drenching @ of 25 litre of Calixin 0.1% solution/palm/year is also useful.

6.2.8 Tatipaka disease of Andhra : The disease derives its name from the Tatipaka village of East Godavari District where it made its first appearance following the cyclone of 1949. Palms in the age group of 25-60 years are more susceptible.

Development of an abnormally large crown with dark green inner leaves and higher yield is the precursor of disease incidence. Subsequently the crown becomes smaller in size producing progressively shorter leaves. The stem begins to taper. The leaves give a fasciated appearance due to improper unfolding of leaflets. The affected tree produces smaller bunches with atrophied barren nuts. The cause of the disease is not known. Recent studies showed that diseased tissues contained Phytoplasma while the same was absent in healthy palms.

6.2.9 Crown choking disease : The disease is commonly observed in Assam and West Bengal. A recent survey shows that 10% of palms are affected by the disease in Assam. The disease is characterised by emergence of shorter leaves with fasciated and crinkled leaves. The leaflets show severe tip necrosis and fail to unfurl. In many cases, it gives a choked appearance to the frond. Ultimately the affected palm dies. Application of 50g borax at half yearly intervals, one in February-march and the other in September-October alongwith the recommended fertilizer in the basins of coconut palms in the early stage of disease helps in controlling it.

7. Post Harvest Technology

It is a common practice to store or season the harvested nuts before they are further processed. Traditionally husking is done manually by skilled workers. A manually operated coconut dehusker has been developed by CPCRI. The dehusker can husk 110 nuts per hour. The conventional system of copra drying is by spreading the cups on any open surface for sun drying. It takes about 5-8 days for getting copra and the quality deterioration due to deposition of dirt and dust on wet meat is

unavoidable. Improved methods generally used for drying of copra are solar drying, smoke drying or kiln drying and indirect hot air drying. A batch type solar cabinet dryer developed at CPCRI takes 3 days for drying. An indirect type copra dryer of 400 nuts per batch capacity using agricultural waste as fuel has also been developed. The dryer required $3m^2$ area for housing and could be carried by 2-3 persons. The drying time required per batch is 36 hours spread over 4 days. This dryer was further scaled up and suitably modified at CPCRI to raise its capacity to 3500 to 4000 nuts. An electrically operated dryer with forced hot air circulation was also developed at CPCRI to dry 1000 coconuts per batch. The drying time is about 28 hours. A smoke free copra dryer of capacity 1000-1500 coconuts per batch has been developed which can dry the copra in 24 hours. For safe storage of copra, the optimum level of moisture content recommended is 6%. To estimate the moisture content accurately, CPCRI has developed a moisture meter which works on the principle of electrical conductivity. It is calibrated to read the moisture content upto 40% so that the moisture level at the different stages of drying can be found out. As post-harvest processing and product diversification enhances the profitability of coconut farming, it should be our endeavour to use the latest technologies in these fields to improve returns.

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