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MANAGEMENT

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Root (wilt) disease of coconut caused by Phytoplasma has no definite control measures. However, the bearing palms which are in initial to middle stage of disease intensity respond well to the management practices. Experiments carried out in the past have clearly brought out results in favour of formulating strategies for containing the disease in its present geographical limits (Anon., 1986) and managing the disease for sustained productivity of the palms (Sahasranaman *et al.*, 1964; Menon and Nayar, 1978; Muralidharan *et al.*, 1986; Rajagopal *et al.*, 1987).

The importance of plant nutrition in reducing the incidence and severity of pathogenic diseases has been recognised for many years (Huber, 1981). Considerable work was done to study the role of macro and micronutrients on the incidence of root (wilt) disease and on the yield of the disease affected palms as reviewed under Chapter 5. Based on these studies the CPCRI (Anon., 1986) recommended a balanced dose of 500 g MgO per palm per year for the root (Wilt) affected areas to maintain the productivity of the palms.

Eradication of disease affected palms to contain the disease within the contiguously infected geographic limits has been very successful. Uprooting and burning of these diseased palms which occurred in an isolated garden in Vellum village, Shencottai in Tamil Nadu during 1971 prevented recurrence of the disease in the area (Anon., 1986). Based on this encouraging result an attempt was made to create a buffer zone in the sparsely affected areas north of Karuvannoor river in Thrissur District by eradicating nearly 28,000 diseased palms. A garden to garden survey to locate diseased palms was conducted (Rethinam *et al.*, 1982) in 10 villages adjoining north of the buffer Zone during 1979-82. A total of 730 palms in 341 gardens were confirmed to be diseased. These diseased palms were sprayed with 0.05 percent carbaryl to suppress the vector *Stephanitis typica*, before eradication. The bole and roots of the eradicated palms were burnt *in situ*. Replanting was done with elite seedlings. Eradication of diseased palms was continued as and when noticed in succeeding years. These operations have brought down the recurrence of the disease to just 21 palms spread over in 15 gardens of 3 villages in 1989-90 (Table 38).

In an integrated approach to eradicate root (wilt) disease on a large area basis and to increase productivity of the coconut, the Central Plantation Crops Research Institute in collaboration with the Kerala Agricultural University, Department of Agriculture, Kerala State, the Fertilizers and Chemicals Travancore Ltd., (FACT) Alwaye and Indian Overseas Bank,

Table 38. Effect of eradication on disease recurrence in Thrissur District

Year	No. of Villages	No. of gardens	No. of diseased palms
1979-82	10	341	730 *
1983	8	18	21
1984	1	5	8
1985	6	17	21
1986	4	19	22
1987	3	12	25
1988	7	21	39
1989-90	3	15	21

* Total number of diseased palms eradicated in the beginning.

Varandarapally Branch, (a local financing agency) implemented a scheme in 1980-81 in Varandarapally village in Thrissur District, (Anon., 1983; Anon., 1990). The area of operation comprised 50 ha with a total of 5739 palms having an average yield of 28 nuts per palm per year. The schemes involved identification of all diseased palms, spraying them with 0.05% carbaryl, cutting and removing the diseased palms with the bole and roots, and burning them *in situ*. Quality coconut seedlings were used for replanting and a compensation of Rs. 75/- was given for one diseased tree eradicated. All the coconuts in the area were fertilized as per recommended practices. Loans were given for providing irrigation facility wherever necessary. Surveillance of the disease affected gardens for disease recurrence was carried out periodically. An evaluation of the scheme conducted after three years showed that the disease incidence was 79 in 1980-81 prior to implementation of the scheme, with a recurrence of the disease in 20 palms in 1982 and 2 palms in 1985. The productivity increased to 51 nuts per palm in diseased gardens (83% increase) compared to 28 nuts per palm prior to implementation of the scheme. Thus, coordinated and cooperative efforts of all agencies concerned helped to check the root (wilt) disease and increase productivity through scientific management over a large area.

Experiments conducted in farmers fields (Muralidharan *et al.*, 1986) have shown that disease advanced palms never respond to any kind of management practices. Juvenile palms that contract the disease before the onset of flowering seldom yield (Ramadasan *et al.*,1971). These observations necessitate removal of all infected juvenile palms and bearing palms in advanced stages of the disease.

Multiple cropping and mixed farming systems in root (wilt) affected coconut gardens have indicated to exert ameliorating effect on the disease affected palms. Menon and Nayar (1978) reported that intercropping with cassava, elephant foot yam and greater yam for five years in a 16 year old coconut garden planted at 7.5 m x 7.5 m, gave an over all increase in nut yield of root (wilt) affected palms to the extent of 5, 15 and 8 percent respectively. They also reported that in plots intercropped with cassava the intensity of root (wilt) disease was on the increase (indices 32.1 to 37.3) whereas in other plots intercropped with elephant foot yam and greater yam there was a decline (37.0 to 33.3). Antony (1983) studied the effect of intercropping with

cassava, elephant foot yam, colocasia, greater yam, ginger and turmeric and found that there was no significant change in disease indices and yield in affected palms under rainfed condition.

Amma *et al.* (1983) reported that yield of coconut in a root (wilt) affected garden has increased by 27 to 35 per cent as a result of mixed cropping with cocoa. The increase was maximum under double hedge systems of cocoa planting. The superiority of double hedge system in increasing the yield of coconut was also reported earlier by Nair *et al.* (1975). However, data collected from the same experiment after 10 years have shown that the yield of coconut was more under single hedge system of cocoa (Anon.,1988).

The effect of mixed farming on disease amelioration, yield of root (wilt) affected palms and soil fertility was investigated in detail (Sahasranaman *et al.*, 1983). Considerable reduction in foliar yellowing was observed due to mixed farming but flaccidity and necrosis increased indicating that the practice had no curative effect on the disease. Beneficial effects like rejuvenation of roots of disease affected palms, increase in soil organic carbon, available P and exchangeable Ca, Mg and K in the sub-soil were also reported. A net increase of 28.1 per cent in the yield of root (wilt) affected palms was also reported (Table 39). The response was high in disease early palms and low in disease advanced palms (Figs. 27 and 28).

A field experiment was conducted in a farmers garden in laterite soil type with the palms in the early and middle stages of disease to study the influence of basin management with green manure legumes along with recommended dose of fertilizers and 500g MgO on root(wilt) disease. The biomass generated by *Pueraria phaseoloides*, *Mimosa invisa* and *Calopogonium mucunoides* in a growth period of 130 days during the monsoon period in coconut basin was 24.6, 27.9 and 24.9 kg/basin and the legume biomass was incorporated in respective basins.

There was no significant change in the disease condition of the palms due to legume treatment. But the yield of palms increased as a result of legume treatment, (Table 40) fertilizer application and adoption of plant protection measures (Thomas *et al.*, 1993).

Studies on the regeneration of the root system of disease affected palms using growth hormones (IBA and NAA), thiamine (amino acids, vitamins, glutamic acid) and phenols (chlorogenic acid, caffeic acid, gallic acid and coumarin) showed that the application of 500 ppm IBA+ 400 ppm phenols produced 51 fresh roots compared to two roots in the control and reduction in disease index from 35 to 26 within a period of one year (Amma and Patil, 1982). Dwivedi *et al.* (1980) reported that ascorbic acid (400 ppm fed through cut root) not only reduced disease symptoms but also improved the yield of palms. However, studies made by Rajagopal *et al.*, (1986b) ruled out the role of ascorbic acid in reducing the disease indices or increasing the yield.

Rajagopal *et. al.* (1986a) found that

Fig. 27. Root (wilt) disease managed garden in farmer's field

Fig. 28. Farmers having discussion with the scientists in the root (wilt) disease management demonstration plot

Table 39. Effect of mixed farming on nut yield of root (wilt) palms

Disease index	Pre-treatment yield		Post-treatment yield		Increase over pre-treatment (%)		Estimated net response due to mixed farming (%)
	Control	Treat.	Control	Treat.	Control	Treat.	
0-10	58.3	50.3	62.4	68.4	7.0	36.0	29.0
11-25	31.1	33.7	29.2	42.3	-6.1	25.5	31.6
26-50	20.9	22.5	18.1	24.5	-13.4	8.9	22.3
> 51	19.5	19.0	21.4	23.7	9.8	24.7	14.9
Overall	32.5	31.4	29.8	39.6	-2.0	26.1	28.1

Table 40 : Effect of basin management with green manure legumes on root (wilt) disease and yield of coconut palms

Treatment	Root (wilt disease index		Nut yield/palm/year	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
M. invisa	18.00	17.91	32.32	54.46
P. phaseoloides	12.38	16.58	39.51	63.84
C. mucunoides	21.12	20.91	42.96	52.21
Control	19.38	24.18	26.50	38.93
LSD (P=0.05)		NS		17.12

the flaccidity on leaflets of root (wilt) affected coconut palms was associated with impaired stomatal mechanism leading to increased rate of transpiration. Summer irrigation increased water up-take and reduced transpiration rate of root (wilt) affected palms, thus bringing about balanced water economy to the disease affected palms (Rajagopal *et al.*, 1986 b). From a field experiment, Rajagopal *et al.*, (1987) reported significant decline in disease index, due to summer irrigation at the rate of 250 l water per palm per week. The irrigation and fertilizer managed palms showed 69.7% improvement while there was 78.5% deterioration when both these inputs were absent (Table 39). There was significant reduction to the extent of 51, 60, 40, 60 and 45 per cent respectively in flaccidity, yellowing, leaf rot, senescence and necrosis due to irrigation over the pre-treatment. There was an overall increase of 53.3 per cent of the photosynthetic area with an increase in yield of 10 nuts per palm over the pretreatment (Fig. 29).

Fig. 29. A bearing palm under well managed farmer's garden

Average yield of palms in a root (wilt) disease affected garden increased from 17.6 to 46.0 nuts/palm/year due to combined adoption of irrigation, plant protection measures, mixed cropping and fertilizer application (Anon., 1982). Nambiar (1984) reported that inspite of an increase in the disease index from 23.7 to 34.2, the yield level of palms was maintained over a period of six years under good management practices in a heavily infected area. A large scale demonstration on the eradication of root (wilt) disease affected palms in a mildly infected area of Thrissur district (Anon., 1986) revealed an increase of yield from 20.2 to 49.2 nuts/palm due to the adoption of improved management practices over a period of four years from 1981 to 1985.

Muralidharan *et al.* (1986) reported beneficial effect of integrated management practices on yield and disease condition of palms. An average increase of 24.3 nuts/palm/year (Table 42) was observed under rainfed conditions. This response was mainly derived from the apparently healthy and disease early palms. Increase in yield by adopting management practices was also observed under irrigation (Table 43).

Strategies have been evolved for managing the disease in the mildly affected border districts and severely affected contiguous areas (Anon., 1982, 1986). Based on the available experimental findings, the following management practices are recommended.

1. Application of balanced doses of fertilizers (500g N, 300 g P_2O_5, 100 g

Table 41. Effect of summer irrigation on the condition of root (wilt) diseased coconut palms.

Treatments	No. of palms observed	No. of palms showing		
		Improvement	Deterioration	No change
Irrigation + Fertilizers	33	23 (69.7)*	5(15.1)	5(15.1)
Fertilizer alone	46	14(30.4)	20(43.4)	12(26.2)
No fertilizer, no irrigation	14	2(14.3)	11(78.5)	1(17.2)

* Values in paranthesis indicate percentage on number of palms observed.

Table 42. Effect of integrated management practices on yield of root (wilt) affected palms (rainfed)

Disease index	Yield (nuts/palm/year)				Increase in nut yield over control	
	Pre-expt.		Post-expt.			
	Control	Treat.	Control	Treat.	Number	%
0 - 10	40.8	43.5	51.3	80.9	29.6	57.7
11 - 25	29.9	26.4	35.5	64.3	28.8	81.1
26 - 50	18.7	17.7	21.2	29.6	8.4	39.6
>51	9.7	8.0	9.4	11.4	2.0	17.5
Mean	33.4	32.6	41.0	65.3	24.3	59.3

Table 43. Effect of integrated management practices on yield of root (wilt) affected palms (irrigated)

Disease index	Yield (nuts/palm/year)				Increase in nut yield over control	
	Pre-expt.		Post-expt.			
	Control	Treat.	Control	Treat.	Number	%
0 - 10	52.4	54.4	58.2	72.1	14.0	24.1
11 - 25	27.5	32.6	35.5	61.5	26.0	73.0
26 - 50	13.3	18.6	21.5	25.1	3.0	17.0
>51	9.8	10.2	10.4	7.8	-2.6	-25.0
Mean	35.8	43.6	45.1	62.3	17.2	36.0

K_2O and 500g MgO/palm/year in two splits. One-third dose to be applied during April-May and two-thirds during September-October for rainfed palms and in four splits during January, April, July and October for irrigated palms.

2. Control of leaf rot disease and rhinoceros beetle are given below:

a. Cut and remove rotten portions of only spindle and two top most fully opened leaves.

b. Mix Hexaconazole (Contaf 5 EC) @ 2ml per palm and Dithane M-45/ Indofil M-45 @ 3 gm per palm in 300 ml water. Pour around the base of spindle leaf.

c. Apply Furadan around the base of the spindle.

d. Apply Sevidol (8g @ 50 gm/palm) mixed with 200 CCC river sand around the base of the spindle.

(The above treatment, including labour charges, costs around Rs. 20/palm.)

3. Application of 50 kg farm yard manure per palm per year.

4. Irrigating palms during summer months atleast @ 250 l/palm/week.

5. Application of 50 kg farm yard manure per palm per year.
6. Provision of proper drainage wherever found necessary.
7. Growing green manure crops, preferably *Peuraria phaseoloides* in basins during the period April-May to September-October and incorporation.
8. Raising intercrops in rotation/ adopting mixed cropping/mixed farming with recycling of organic matter.
9. Removal of all disease advanced and uneconomic palms and replanting with healthy elite seedlings if the planting density is less than 175/ha.
10. Removal of juvenile palms showing symptoms of root (wilt) disease irrespective of its intensity.
11. In mildly infected areas all disease affected palms, irrespective of the intensity of disease and yield of palms, should be removed to eliminate the foci of infection.
12. Restructuring the canopy of other perennial tree crops to provide maximum light for the coconut palms.

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