

MANAGEMENT

A. MURALIDHARAN, N.P. JAYASANKAR, K.J. ANTONY and P. RETHINAM

The etiology of the root (wilt) disease dealt with in Chapter-3 has brought out the implication of mycoplasma-like organisms (Solomon, Govindankutty and Nienhaus, 1983), but no curative measures are available. However, 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, Radha and Pandalai, 1964; Menon and Nayar, 1978; Sahasranaman *et al.*, 1983; Muralidharan, Nair and Jayasankar, 1986; Rajagopal, Patil and Amma, 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 on Soils and Nutrition. Based on these studies the CPCRI (Anon., 1986) recommended a balanced dose of 500 g N, 300 g P₂O₅, 1000 g K₂O and 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 much successful (Anon., 1986). Uprooting and burning of three diseased palms which occurred in an isolated garden in Vallom village, Shencottah 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 Trichur District by eradicating nearly 28,000 diseased palms. A garden to garden survey to locate diseased palms was conducted (Radha, Rethinam and Kochubabu, 1981; Rethinam, Kochubabu and Radha, 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 per cent 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 1).

In an integrated approach to eradicate root (wilt) disease on a large area basis and to increase productivity of the

Table 1. Effect of eradication on disease recurrence in Trichur 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.

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, Varandarapally Branch, (a local financing agency) implemented a scheme in 1980-81 in Varandarapally village in Trichur 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 removal of diseased palms with the bole and roots, and burning the bole and roots *in situ*. Quality coconut seedlings were used for replanting and a compensation of Rs. 75/- was given for each 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, Nair and Jayasankar, 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, Shanta and Lal, 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 overall increase in nut yield of root (wilt) affected palms to the extent of 5, 15 and 8 per cent 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 system 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 2). The response was the highest in disease early palms and the lowest in disease advanced palms (Fig. 1).

Studies on the regeneration of the



Fig. 1 Mixed farming in root (wilt) affected garden.

Table 2. Effect of mixed farming on nut yield of root (wilt) affected 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
Mean	30.5	31.4	29.9	39.6	- 2.0	26.1	28.1

root system of disease affected palms using growth hormones (IBA and NAA), aminoacids (thiamine and 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, Patil and Amma (1986b) ruled out the role of ascorbic acid in reducing the disease indices or increasing the yield.

Rajagopal *et al.* (1986a) found that 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 uptake and reduced transpiration rate of root (wilt) affected palms, thus bringing about balanced water economy to the disease affected palms (Rajagopal *et al.*, 1986b). From a field experiment,

Rajagopal, Patil and Amma (1987) reported significant decline in disease index due to summer irrigation at the rate of 250 l water per palm per week. 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 pre-treatment.

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 in spite 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 Trichur district (Anon., 1986) revealed an increase of yield from 20.2 to 49.2 nuts/palm due to the adop-

tion of improved management practices over a period of four years (Table 3).

Muralidharan *et al.* (1986) reported beneficial effect of integrated management practices on yield and disease condition of palms. An average increase of 23.4 nuts/palm/year (Table 4) 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 5).

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 (Anon., 1989).

1. Removal of all disease advanced

Table 3. Effect of management practices on yield of palms in sparsely affected area.

Replications	Mean yield of nuts/palm/year over years				Remarks
	1981-82	1982-83	1983-84	1984-85	
1	14	22	18	38	
2	21	37	39	56	
3	18	30	36	58	
4	26	34	36	51	
5	21	36	34	48	
6	29	43	48	64	
7	13	18	16	34	Rainfed
8	20	36	34	54	
9	21	33	31	54	
10	32	42	34	64	
11	9	15	12	21	Rainfed
Total	224	344	338	542	
Mean	20.2	31.2	30.7	49.2	

Table 4. 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.		Number	%
	Control	Treat.	Control	Treat.		
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 5. 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.		Number	%
	Control	Treat.	Control	Treat.		
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

and uneconomic palms and re-planting with healthy elite seedlings.

2. Removal of juvenile palms showing symptoms of root (wilt) disease irrespective of its intensity.
3. Spraying the leaves with 0.01% monocrotophos/endosulfan before felling the palms.
4. Application of balanced doses of fertilizers (500 g N, 300 g P₂O₅, 1000 g K₂O and 500 g MgO/palm/year in two splits, one-third 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.)
5. Growing green manure crops, preferably *Peuraria phaseoloides* in basins during the period April-May to September-October and incorporation.
6. Application of 50 Kg farm yard manure per palm per year.
7. Sequential spraying with Bordeaux

mixture (1%), Dithane M-45 (0.3 per cent) and Fytolan (0.3 per cent) to control leaf rot.

8. Filling the innermost leaf axils of palms below 20 years with BHC 5% - sand mixture (1:1 by volume) to control red palm weevil and rhinoceros beetle.
9. Irrigating palms during summer months at the rate of 600 to 900 l water per palm once in four to six days.
10. Provision for proper drainage.
11. Restructuring the canopy of other perennial tree crops to provide maximum light for the coconut palms.
12. Raising intercrops in rotation/adopting mixed cropping/mixed farming with recycling of organic matter.

In mildly infected areas all disease affected palms, irrespective of the intensity of disease and yield of palms, should be removed to elimi-

nate the foci of infection.

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A. Muralidharan
Scientist (SQ)
CPCRI Regional Station
Kayangulam
Krishnapuram 690 533
Kerala

K.J. Antony
Scientist
CPCRI Research Centre
Kannara 680 652
Trichur District
Kerala

N.P. Jayasankar
Jt. Director
CPCRI Regional Station
Kayangulam
Krishnapuram 690 533
Kerala

P. Rethinam
Asst. Director General
Indian Council of Agricultural
Research
Krishi Bhavan
New Delhi 110 001