3.3

ETIOLOGY - NEMATODES

V.K. SOSAMMA and P.K. KOSHY

Root degeneration to the extent of 90 per cent has been reported in root (wilt) affected palms (Butler, 1908; Menon and Nair, 1949; Radha and Menon 1954; Menon and Pandalai, 1958). Increasing evidence on soil transmissible nature of the disease and the suspected involvement of virus in the sixties indicated the possible involvement of plant parasitic nemotodes as probable vectors of the disease (Shanta *et al.*, 1972; Mathen *et al.*, 1976). Weischer (1967) examined a total of 60 soil samples covering six soil types in the diseased tract and four samples from three soil types from healthy tract and reported the occurrence of plant parasitic nematodes belonging to the genera *Criconema, Criconemoides, Dolichodorus, Helicotylenchus, Hemicriconemoides, Hemicycliophora, Hoplolaimus, Longidorus, Meloidogyne, Paratylenchus, Radopholus, Rotylenchulus, Tylenchorhynchus* and *Xiphinema* from the rhizoshphere of coconut. He concluded that the presence of species of *Xiphinema* or *Longidorus* in all soil types could be of importance if viruses were involved in the disease. While *Xiphinema* was present in both the diseased and healthy areas, *Longidorus* was found only in the diseased zone or very near the border between these two areas (Weischer, 1967). Later Khan *et al.* (1971) reported *Dolichodorus pulvinus, Macroposthonia oachirai, Discocriconemella recensi, Longidorus saginus* and *Paralongidorus flexus* from sandy loam soil around the rhizosphere of coconut at Kayangulam. The vector role of *L. saginus* and *P. flexus* in the disease need to be studied in the light of reported soil transmissible nature of the disease (Radha and Menon, 1954; Weischer, 1967; Shanta *et al.*, 1972).

Initial investigations on root (wilt) affected coconut palms showed very high populations of *R. similis* from roots of root (wilt) affected as well as healthy palms in disease tracts (Koshy *et al.*, 1975; Koshy *et al.*, 1978).

R. similis infestation produces small elongated orange coloured lesions on tender creamy white roots which leads to extensive rotting of roots. On merging of lesions, cracks develop on the epidermis of the semi-hard orange coloured main roots (Fig. 5). Lesions and rotting are confined to the tender portion of roots. Lesions are not conspicuous on the secondary and tertiary roots as they are narrow and rot quickly on infestation (Fig. 6). Tender roots of coconut seedlings on heavy infestation become spongy in texture.

Maximum number of nematodes and cavities are seen in the outer cortex. Nematodes have not been observed in the stelar region or in closely packed 4-6 layers of cells outside the strongly suberised endodermis even in heavily infested roots. The endodermis and the 4-6 layers of cells around it appear to serve as an effective

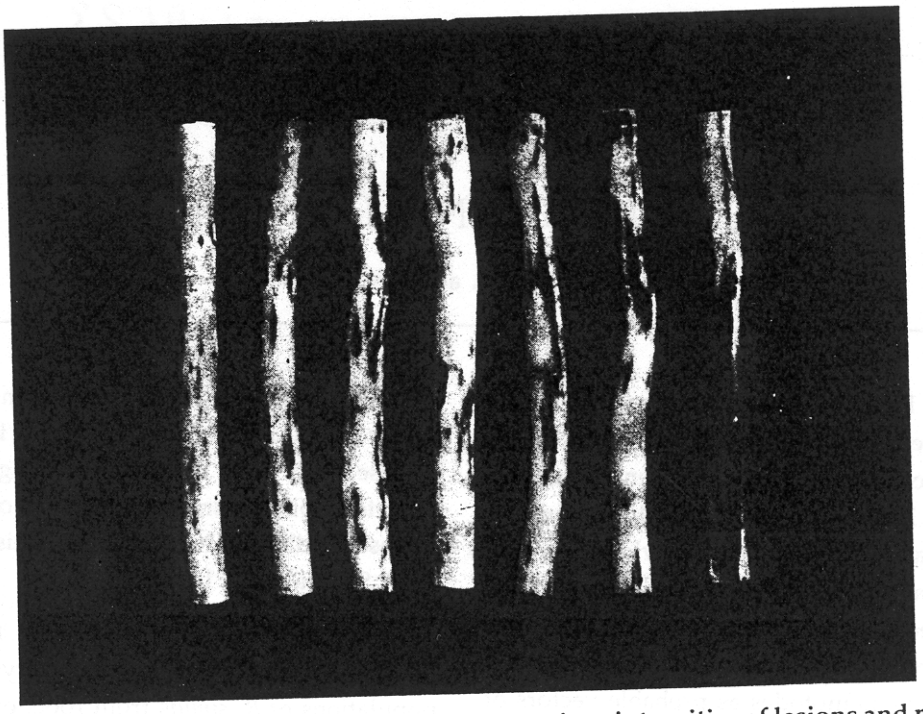

Fig. 5 Tender, white main roots of coconut with various intensities of lesions and rotting on infestation by *R. similis*

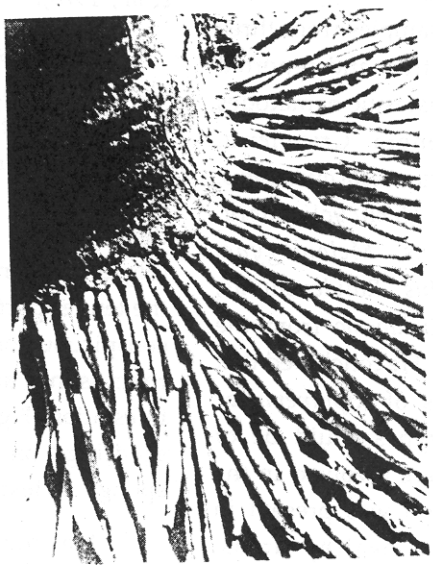

Fig. 6 Tender roots at the base of the palm showing lesions and rotting on infestation by the burrowing nematode

barrier against the invasion of the stele. In the early stage of infection, roots have cavities of independent origin separated by several cells. Consequent to nematode multiplication and lysis of cytoplasm and cell walls, adjacent cavities merged with each other. Multiple cavities and their coalescence destroy the cortex to a great extent. The stelar tube remains intact even in heavily infested roots in transverse and longitudinal sections.

In an extensive survey carried out comprising 965 samples each of soil and root from Kerala (836), Karnataka (13) and Tamil Nadu (116) during 1973-1982 the widespread occurrence of the burrowing nematode, *R. similis* on coconut was reported.

Studies on population of the burrowing nematode in coconut plantations in Kerala, show that infested coconut roots yield maximum number of *R. similis* during October to November and minimum or nil during March to July. Factors favourable for nematode multiplication are soil temperature between 23 to 25°C and moist soils coupled with availability of tender fleshy roots. Nematode population in roots of individual palms varies considerably during low and high peaks depending upon the age, variety and disease index of the palms involved (Koshy and Sosamma, 1978 a).

The pathogenicity experiments conducted at CPCRI R.S, Kayangulam have clearly established the pathogenic potential of the nematode on coconut, but the role of the nematode in the etiology of the root (wilt) disease could not be established. A detailed pathogenicity trial was initiated in October 1982. 1.8m x 1.8m x 1.2m field tanks (microplots) filled with sandy loam soil fumigated with methyl bromide were used to facilitate normal growth of the plant to flower, yield and exhibit the disease under natural conditions. The seedlings were inoculated with fungus and different levels of nematode inoculum viz. 100 to one million per seedling.

The growth parameters recorded at six monthly intervals showed reduced growth of palms corresponding to the initial inoculum levels one year after inoculation. The progressive production of number of leaves in various treatments is shown in Table 5. The seedlings that received the highest initial inoculum (T_6) had put out three leaves compared to four leaves in all the other treatments after one year. The seedlings that received 10,000 nematodes (T_4) and above had put out on an average six leaves from third year onwards compared to eight to nine leaves by seedlings that received 100 and 1000 nematodes and nine to ten leaves in uninoculated seedlings. Similar decreasing trend was seen with regard to height as well as girth at the base with increase in inoculum levels.

After eleven years initial inoculum of nematodes caused reductions in height, girth at base, root weight, number of main roots, total number of leaves, lamina length and lamina breadth.

One of the control palms put out the first inflorescence in the 31st leaf axil after 65 months of planting. All the uninoculated palms came to flowering during 65 to 83 months after planting between 31st to 49th

Table 5. Effect of different initial inoculum levels of *R. similis* on growth parameters of coconut

Treatment	Initial inoculum level (cm)	Height (cm)	Girth at base (cm)	Shoot weight (kg)	Total no. of leaves produced	No. of leaves retained	Av. lamina length	Av. no. of leaflets	Middle leaflet length	Middle leaflet breadth	No. of Root main roots	Root weight (kg)
T_1	0	958	146	514	100	20	364	233	108	6.5	4577	84.8
T_2	100	784 (14)	131 (10)	329 (36)	84 (16)	14 (28)	362 (1)	229 (2)	106 (2)	6.2 (5)	4091 (11)	76.4 (0)
T_3	1,000	761 (21)	124 (15)	273 (47)	85 15)	16 (20)	331 (9)	211 (10)	94 (13)	5.8 (11)	4611 (+12)	75.8 (11)
T_4	10,000	649 (32)	112 (23)	165 (68)	75 (25)	11 (45)	336 (8)	207 (11)	91 (15)	5.5 (14)	2834 (38)	28.4 (67)
T_5	1,00,000	658 (31)	94 (36)	145 (72)	70 (30)	10 (50)	291 (20)	194 (17)	83 (22)	4.8 (26)	1529 (61)	15.4 (62)
T_6	10,00,000	564 (41)	87 (41)	109 (79)	63 (37)	9 (54)	289 (21)	208 (11)	89 (17)	4.6 (29)	1529 (67)	15.4 (82)
	G. Mean	729	116	256	79	13	329	213	95	5.5	3239	52.0
	CV%	16.11	18.1	45.6	13.6	36.0	15.3	12.3	14.5	13.5	43.21	47.8
	F. ratio	6.89**	5.76**	8.43**	7.12**	3.70*	2.11	1.55	2.4	4.98**	4.89**	7.33**
	CD (P=0.05)	153.0	27.4	151.9	14.1	6.34	NS	NS	NS	0.99	1823	32.47

Figures in parentheses are per cent reduction over control.

leaf axils whereas four out of the five palms that received an initial inoculum level of 100 nematodes flowered during 67 to 130 months in the leaf axils from 39 to 56. Two palms each that received an initial inoculum level of 1000 and 10,000 nematodes came to flowering after 108 months and one out of five palms that received an initial inoculum level of 1 lakh nematodes also came to flowering after 132 months. None of the palms that received 10 lakhs came to flowering (Table 6). The control palms produced a total of 155 inflorescences compared to 67 inflorescences in palms inoculated with 100 nematodes as initial inoculum level. However, the palms that received an initial inoculum of 1000 nematodes and above did not yield any nut even after eleven years of planting. The control palms produced an average of 125 nuts compared to 37 nuts by palms that were inoculated initially with 100 nemotodes (Table 7). This clearly showed that nematodes in soil reduced the yield under the present experimental conditions. The need for application of nematicides to infested seedlings at planting and later in July and October for proper

growth has been clearly brought out in this experiment.

This pathogenicity experiment, first of its kind on a perennial crop, has clearly brought out the damage potential of the burrowing nematode on growth, flowering and yield of coconut under field conditions over a period of eleven years from planting. The absence of production of typical root (wilt) disease symptoms even after eleven years on palms inoculated with one million nematodes clearly shows that *R. similis* is not involved as an incitant in the etiology of root (wilt) disease. The root (wilt) affected palms may decline at a faster rate on infestation by *R. similis*, which is wide spread on coconut as well as on intercrops like banana, black pepper etc. (Koshy and Sosamma, 1996).

The effect of the biocontrol agents *Paecilomyces lilacinus, Trichoderma viride, T. harzianum, Verticillium chlamydosporium, Pasteuria penetrans* and AMF on the burrowing nematode of coconut was studied in the green house. *P. lilacinus* and *V. chlamydosporium* are found to infect the eggs of the burrowing nematode.

Thirty per cent increase in yield and 5 to 10 per cent decrease in disease indices of palms affected with root (wilt) disease has been recorded by the application of *Hydnocarpus* oil cake @ 4 kg per palm as well as with phorate @ 10 g a.i/palm in June-July and October-November (Koshy, 1986). Maximum increase in yield is obtained with application of phenamiphos 2 10 g a.i./palm. The control palms, on the contrary recorded 10 per cent increase in disease indices and 2-5 per cent reduction in yield.

Table 6. Effect of different levels of *R. similis* on flowering

Treatment	Initial inoculum level	No. of palms flowered	Production of inflorescences in leaf axil	Time taken for flowering in months	Delay in initiation of flowering in months	No. of yielding palms
T1	0	5/5	41.8 (31-49)	73.8	-	4/5
T2	100	4/5	47 (39-36)	84.8	11	2/5
T3	1,000	2/5	55 (42-68)	116	42	0/5
T4	10,000	2/5	58.5 (54-63)	125	51	0/5
T5	1,00,000	1/5	68	132	58	0/5
T6	10,00,000	0/5	0	0	0	0/5

(Range in parenthesis)

Table 7. Effect of different levels of *R. similis* on yield

Treatment	Control							*R. similis* - (100)						
Replication	1	2	3	4	5	Total	Average	1	2	3	4	5	Total	Average
No. of inflo-rescences produced	61	39	26	25	4	155	31	7	32	26	2	0	67	13.4
No. of nuts produced	396	137	38	53	0	624	125	0	99	87	0	0	186	37.0

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