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EFFECT OF SOME PLANT PARASITIC NEMATODES ON THE GROWTH OF SELECTED CROPS IN SRI LANKA

by
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Summary. Pot experiments in Sri Lanka indicated that *Hoplolaimus seinhorsti* suppressed the growth of rice, cowpea, pepper, eggplant, tomato, black gram, soybean, pineapple and cacao; *Xiphinema ifacolum* and *Meloidogyne arenaria* race 1, *M. incognita* race 1 and *M. javanica* were pathogenic to two cultivars of soybean. However, *M. javanica* appeared to be more pathogenic on cv. Pb1 and *M. arenaria* and *M. incognita* on cv. Caribe. All three species of *Meloidogyne* suppressed the growth of papaya seedlings but the effect of *M. incognita* and *M. javanica* was more severe compared to that of *M. arenaria. M. incognita* and *M. javanica* also negatively affected the growth of banana suckers, but *M. arenaria* did not. Although the three species of root-knot nematodes reproduced on pineapple, *M. javanica* at a higher rate compared to the others, none of them reduced the growth of suckers with respect to the control.

The root-knot nematodes, *Meloidogyne arenaria* (Neal) Chitw., *M. incognita* (Kofoid *et* White) Chitw. and *M. javanica* (Treub) Chitw. are widespread and attack several crop plants in Sri Lanka (Lamberti *et al.*, 1987), where *Hoplolaimus seinhorsti* Luc and *Xiphinema ifacolum* Luc are also numerous and often occur in the rhizosphere of declining crops (Lamberti and Ekanayake, 1983a; 1983b).

This paper reports the results of pot experiments undertaken in a screenhouse at Peradeniya to evaluate the effect of these nematodes on the development of selected crops in Sri Lanka.

Materials and methods

Large quantities of sandy loam soil collected from a natural habitat at Perandeniya were put into 50 cm deep metal drums and fumigated with 500 l/ha of 1,3 dichloropropene 1,2 dichloropropane at least three months before being used. Three months after fumigation 0.5 l samples from the drums showed that the soil was free from nematodes.

Groups of 10 cm diam. plastic pots were filled with about 0.5 l of the fumigated soil and planted on 18 August 1980 with a single seedling of the following plants: rice (*Oryza sativa* L.) cv. I.R.8, cowpea [*Vigna unguiculata (L.)* Walps.] cv. Bombay, pepper (*Capsicum annuum* L.) cv. C.A.8, eggplant (*Solanum melongena* L.) cv. Jaffna purple, black gram (*Phaseolus mungo* L.) selection type 9, tomato (*Lycopersicon esculentum* Mil.) cv. Katugastota and soybean [*Glycine max* (L.) Merr.] cv. Pb1. There were 40 pots for each plant species; 20 of them were inoculated on 23 August, each with 30 hand picked adult females of *H. seinhorsti* (collected from the rhizosphere of a coconut palm at Jaffna) poured in water suspension into three holes around the seedling; the other 20 pots were left as control. Plant heights were recorded at fortnightly intervals until 20 November when the experiment was terminated and top and root weights of each plant were determined; the nematodes in each pot were extracted by wet sieving and counted.

A similar experiment was carried out to determine the reaction of two cultivars of soybean (Pb1 and Caribe) to *X. ifacolum* (collected from the rhizosphere of a coconut palm at Giridara) and to *M. arenaria*, *M. incognita* and *M. javanica*. Seeds were sown directly in the pots on 13 August 1980 and inoculated with 10, 20, 40 or 80 adult female *X. ifacolum* per pot or with ca. 400 eggs and juveniles per pot of one of the three species of root-knot nematodes, on 20 August, when seedlings were 15 cm high. Inoculum of *Meloidogyne* species was obtained by means of the hypochlorite method (Hussey and Barker, 1973) from single-egg mass cultures of *M. arenaria* race 1 [from snakegourd (*Trichosanthes anguina* L.) at Peradeniya], *M. incognita* race 1 [from bitter gourd (*Momordica charantia* L.) at Peradeniya] and *M. javanica* (from tomato at Pallekele). There were 10 replicates for each nematode species/inoculum density including 10 uninoculated plants which served as control. The experiment was terminated on 12 November when plant height and weight and nematode population were recorded; *X. ifacolum* were extracted from each pot and counted and 5 g root per plant were stained in acid fucsin lactophenol to detect root-knot nematodes for counting.

Also, the effect of the three populations of root-knot nematodes was tested on papaya (*Carica papaya* L.) cv. Ambilipitiya, banana (*Musa acuminata* Colla) cv. Mysore and pineapple [*Ananas comosus* (L.) Merr.] cv. Kew.

Two month old (8-14 cm tall, produced in fumigated soil) papaya seedlings were planted singly on 26 October 1979, in 10 cm diam clay pots. After 20 days they were inoculated with 0 (plain tap water only), 100, 200 or 400 eggs/juveniles of one of the populations of *Meloidogyne*. There were 12 replicates for each inoculum density. Plant height was measured at monthly intervals, starting on 6 January 1980, until the experiment was terminated on 7 November 1980 recording plant weights, stem diameters at plant base and degree of galling on the root system according to a scale from 0 to 5, where 0 represented no galling and 5 heavy galling with severe deformation and alteration of the entire root system (Lamberti, 1971).

One month old (40 cm tall) banana suckers were planted in concrete pots, measuring 25x25x18 cm and containing about 4 l of fumigated soil, on 16 April 1980 and inoculated after one month with 0, 100, 200 or 400 eggs/juveniles per pot, with one of the three populations of *Meloidogyne*. There were five replicates of each inoculum density for each nematode species. Plant heights were recorded at monthly intervals starting in July and plant weights and rate of nematode reproduction and degree of galling were determined at the end of the experiment on 25 January 1981.

For the pineapple experiment, the three *Meloidogyne* populations were inoculated on 16 November 1979 to 3-4 month old suckers (12-16 cm tall) planted one month earlier in concrete pots, at the inoculum level of 500 eggs/juveniles per pot. There were 20 replicates for each nematode species and control plants. Plant heights were recorded monthly, starting two months after inoculation, and plant fresh weight and degree of root galling and rate of nematode reproduction were recorded, as already indicated, on 5 November 1980, at the end of the experiment.

The effect of *H. seinhorsti* and *X. ifacolum* was tested on the growth of pineapple in a second experiment using the same method as for *Meloidogyne*. Suckers were plant-

TABLE I - *Effect of* Hoplolaimus seinhorsti *on the growth of selected crop plants in Sri Lanka.*

Plant	Mean height (cm) of shoots						Mean weight (g) of plants		
	6 Sept.	20 Sept.	4 Oct.	18 Oct.	2 Nov.	16 Nov. 1980	Roots	Top	Total
Rice									
Inoculated	5.6**	7.0**	8.4**	10.2**	11.9**	18.0**	0.1	0.3**	0.4**
Control	7.1	10.0	13.1	15.8	19.8	25.8	0.1	0.7	0.8
Cowpea									
Inoculated	7.9	14.2	20.7**	25.5**	54.2*	79.1**	0.6	5.6**	6.2**
Control	7.9	15.8	23.5	31.2	75.7	118.9	0.6	7.8	8.4
Pepper									
Inoculated	6.4	10.6**	14.4**	18.2**	23.7**	28.5**	0.9**	8.2**	9.1**
Control	6.3	12.8	19.8	26.3	35.8	45.0	1.5	11.6	13.1
Eggplant									
Inoculated	6.4	8.0	9.3	10.7	12.2**	17.7	0.9**	9.4**	10.3**
Control	6.9	8.2	9.6	11.1	13.7	19.3	2.9	14.8	17.7
Black gram									
Inoculated	8.1	13.3*	19.8**	28.6**	37.3**	47.1**	0.1	1.2**	1.3**
Control	8.6	15.3	24.9	33.9	50.7	64.9	0.2	2.7	2.9
Tomato									
Inoculated	12.1	19.4**	29.6**	38.7**	49.4**	58.2**	1.6**	17.4**	19.0**
Control	11.6	21.1	33.2	44.4	58.4	74.0	5.1	32.7	37.8
Soybean									
Inoculated	6.9*	10.1**	18.9**	30.2**	55.0**	74.8	0.6**	6.4	7.0*
Control	7.9	14.1	24.9	35.6	58.7	78.9	0.9	7.6	8.5

Statistically different from control according to Student's *t* test. * for $P = 0.05$; ** for $P = 0.01$.

Fig. 1 - Growth of a rice plant in a pot infested by *Hoplolaimus seinhorsti* (control at right).

Fig. 2 - Growth of a pepper plant in a pot infested by *H. seinhorsti* (control at right).

ed on 2 May 1980, inoculated 20 days later, with 0, 10, 20, 30 or 50 adult females of either of the species and height measured at two monthly intervals, starting on 22 June, until the experiment was discontinued on 30 January 1981. Each inoculum density was replicated seven times. Final nematode populations were determined from 1 l subsamples of soil.

A preliminary test was undertaken to investigate the effect of *X. ifacolum* on the growth of cacao (*Theobroma cacao* L.). Seedlings of cv. I.C.S. 5 were planted on 17 January 1980 in concrete pots containing fumigated soil and inoculated one week later with 0, 10, 20, or 40 nematodes of different stages. There were 10 replicates for each inoculum density. Plant heights were recorded at monthly intervals, starting on 28 March 1980, until 7 November when the experiment was terminated.

The experiment was repeated planting one month old seedlings of the same cacao cultivar and inoculating groups of ten plants with 0, 10, 20, 40 or 80 adult females of either *X. ifacolum* or *H. seinhorsti.* Planting took place on 20 July 1980, inoculation on 22 August and plant heights were measured on 4 November and 4 December 1980 and 4 January and 4 February 1981, when the experiment was terminated. Plant weights were determined and nematodes extracted from 1 l soil as previously.

The data were analyzed statistically by least significant difference and averages compared to the control by Student's *t* test or between them by Duncan's multiple range test. Coefficient of correlations were calculated when appropriate.

Results and discussion

Rice, cowpea, pepper, eggplant, black gram, tomato and soybean were all severely affected by *H. seinhorsti* (Table I). In particular, rice was stunted throughout the experiment (Fig. 1); but at the end of it, significant differences in weight were observed only between the epigeal portion of the plants.

Cowpea started to show the effect of nematode attack only six weeks after inoculation and differences in height between inoculated and control plants increased with time; at the end of the experiment statistical differences occurred only between weights of the tops.

Growth of pepper was significantly suppressed, with repsect to the control, from the fourth week onward (Fig. 2) and, at the end of the experiment, both top and root weights were reduced. Plant and leaf sizes were much smaller (Fig. 2) and the root system was consistently reduced (Fig. 3) compared with the control.

Eggplants did not differ in plant development during the course of the experiment but at its termination, top and root weights of the inoculated plants were significantly suppressed.

Stunting of black gram plants was evident from the fourth week after inoculation and increased as the experiment progressed (Fig. 4), at the end of which signficant differences with the control were observed only between the weights of the epigeal portion of the plants.

Tomato was one of the most severely stunted crops. Growth suppression was already noticeable at four weeks

TABLE II - *Effect of* Xiphinema ifacolum *on the growth of two cultivars of soybean in Sri Lanka.*

Cv.	Inoculum density (Nem./pot)	Mean height of shoots (cm)	Mean weight (g) of plants		
			Roots	Top	Total
Pb1	0 (Control)	75.5a	2.6a	6.6a	9.2a
	10	53.7 b	1.5 b	3.3 b	4.8 b
	20	51.6 b	1.7 b	2.5 bc	4.2 bc
	40	51.6 b	1.7 b	2.7 bc	4.4 bc
	80	53.8 b	1.3 b	2.3 c	3.6 c
Caribe	0 (Control)	68.2a	3.4a	7.2a	10.6a
	10	49.4 bc	1.7 b	4.7 bc	6.4 b
	20	46.4 cd	1.8 b	3.5 c	5.3 b
	40	55.1 b	2.5 b	6.0ab	8.5 c
	80	40.2 d	1.2 c	2.4 d	3.6 d

For each cv., data flanked in the columns by the same letters are not statistically different for P = 0.05, according to Duncan's multiple range test.

Fig. 3 - Root system of a pepper plant grown in a pot infested by *H. seinhorsti* (control at left).

Fig. 4 - Growth of a black gram plant in a pot infested by *H. seinhorsti* (control at right).

after inoculation with *H. seinhorsti* and considerable at the end of the experiment (Fig. 5), when clear differences also occurred between the development of root systems of inoculated and control plants (Fig. 6).

Growth differences between inoculated and control soybean plants became evident and were significant at two weeks after nematode inoculation. Such differences persisted over the next six weeks but were not satistically significant at the end of the experiment, when however, significant reduction occurred in the weight and development of the root system between inoculated and control plants.

Initial populations of *H. seinhorsti* decreased in all of the inoculated pots and in most of them was nil at the end of the experiment, independently of the plant species grown.

X. ifacolum severely suppressed the growth and development of both of the soybean cultivars tested (Table II). Generally the response of cv. Pb1 was more consistent than that of cv. Caribe (Fig. 7), although the stunting effect of the nematode, at the highest inoculum level, was much more severe on cv. Caribe (Fig. 8).

Nematode populations at the end of the experiment had decreased to one per pot for the cv. Pb1 and less than that for the cv. Caribe, independent of the initial population levels. However, juveniles were found associated with both cultivars indicating that egg laying had occurred as initial populations consisted only of females.

Growth of the soybean cvs Pb1 and Caribe was significantly suppressed, compared to the control plants, by *M. incognita* and *M. javanica* while *M. arenaria* significantly suppressed only the height of cv. Pb1 (Table III). All of the three species of root-knot nematodes reduced top weights of both cvs, but root weights were significantly affected (increased with respect to control because of gall formation) only by *M. arenaria* and *M. incognita* on cv.

Fig. 5 - Growth of a tomato plant in a pot infested by *H. seinhorsti* (control at right).

TABLE III - *Effect of* Meloidogyne spp. *on the growth of two cultivars of soybean in Sri Lanka.*

Nematode species	cv.	Mean height of shoots (cm)	Mean weight (g) of plants		
			Roots	Top	Total
	Pb1				
M. arenaria		55.1 a	5.1a	3.7a	8.8ab
M. incognita		57.9 a	5.5a	4.8a	10.3 b
M. javanica		55.4 a	3.6 b	3.8a	7.4a
Control		75.5 b	2.6 b	6.6 b	9.2 b
	Caribe				
M. arenaria		59.6 ab	3.2a	4.7a	7.9ab
M. incognita		52.4 a	5.1 b	5.4a	10.5 c
M. javanica		50.6 a	2.8a	4.3a	7.1ab
Control		68.2 b	3.4a	7.2 b	10.6 c

For each cv., data flanked in the columns by the same letters are not statistically different for P = 0.05, according to Duncan's multiple range test.

Fig. 6 - Root system of a tomato plant grown in a pot infested by *H. seinhorsti* (control at left).

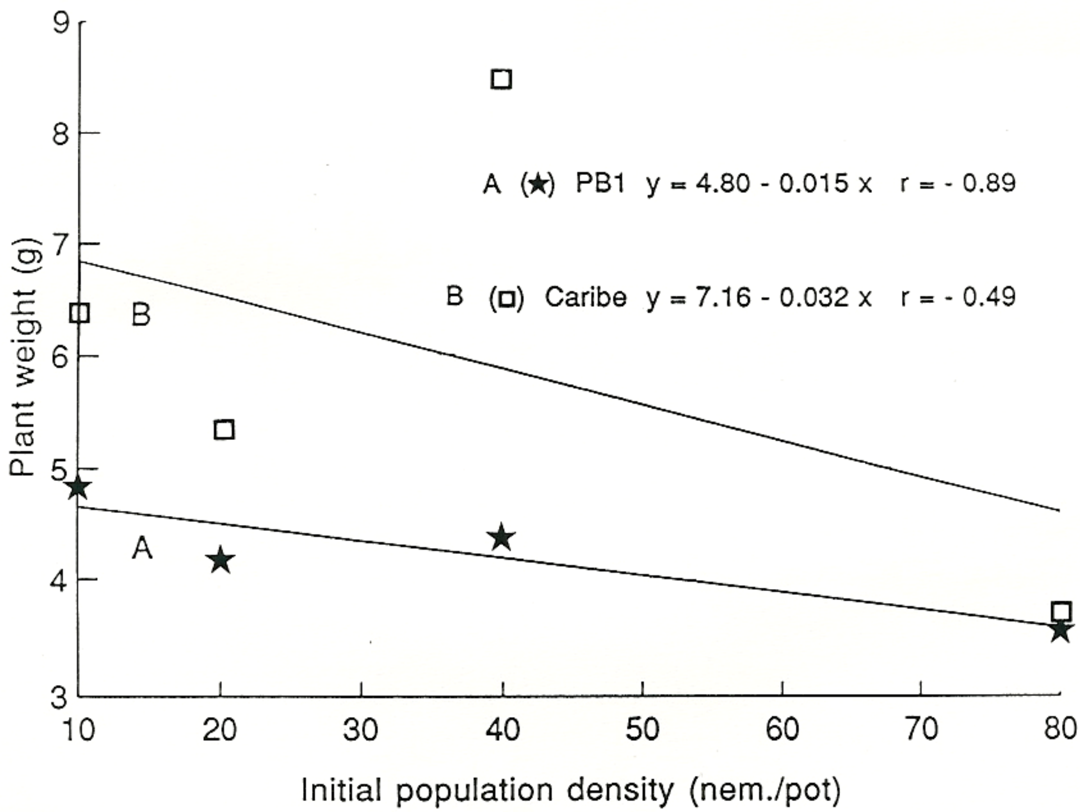

Fig. 7 - Correlation between initial population density of *Xiphinema ifacolum* and weight of soybean, cv. Pb1 (significant for P = 0.05) and cv. Caribe (not significant).

Fig. 8 - Root system of a soybean plant, cv. Caribe, grown in pot infested by an initial population of 80 *X. ifacolum* (control at right).

Pb1 and by *M. incognita* on cv. Caribe. Finally, total plant weight was significantly suppressed by *M. javanica* on cv. Pb1 and by *M. arenaria* and *M. javanica* on cv. Caribe.

Reproduction of the three species of *Meloidogyne* was similar on the two cvs with the exception of *M. incognita* whose population increased much less on Pb1 (Table IV).

Since January 1980 (six weeks after nematode inoculation) papaya plants grown in the pots infested with one of the three species of *Meloidogyne* showed significant growth suppression compared to the control (Fig. 9). No signfiicant differences occurred between root-knot nematode species nor between initial population densities (Table V). Root-knot nematode infestation generally increased root weight because of the heavy galling (Table VI). Weights of the epygeal portion of the plants were significantly decreased at the lowest inoculum level of *M. arenaria*, by the two highest inoculum levels of *M. incognita* and by all inoculum levels of *M. javanica* (Table VI). Trunk diameters of plants at ground level were significantly reduced by all species of *Meloidogyne* at all inoculum densities but the different initial population densities did not produce differences in plant development (Table VI). Galls were small and numerous on the root systems of plants grown in pots infested by *M. arenaria*, but larger and fewer on roots exposed to *M. incognita* and expecially to *M. javanica* (Fig. 10). From a comparison of mean top weights and diameters of plants, it appears that *M. javanica* is the most pathogenic species and *M. arenaria* the least (Table VI).

Fig. 9 - Growth of papaya plants in pots infested by root-knot nematodes (from right to left: control, *Meloidogyne arenaria*, *M. incognita* and *M. javanica*).

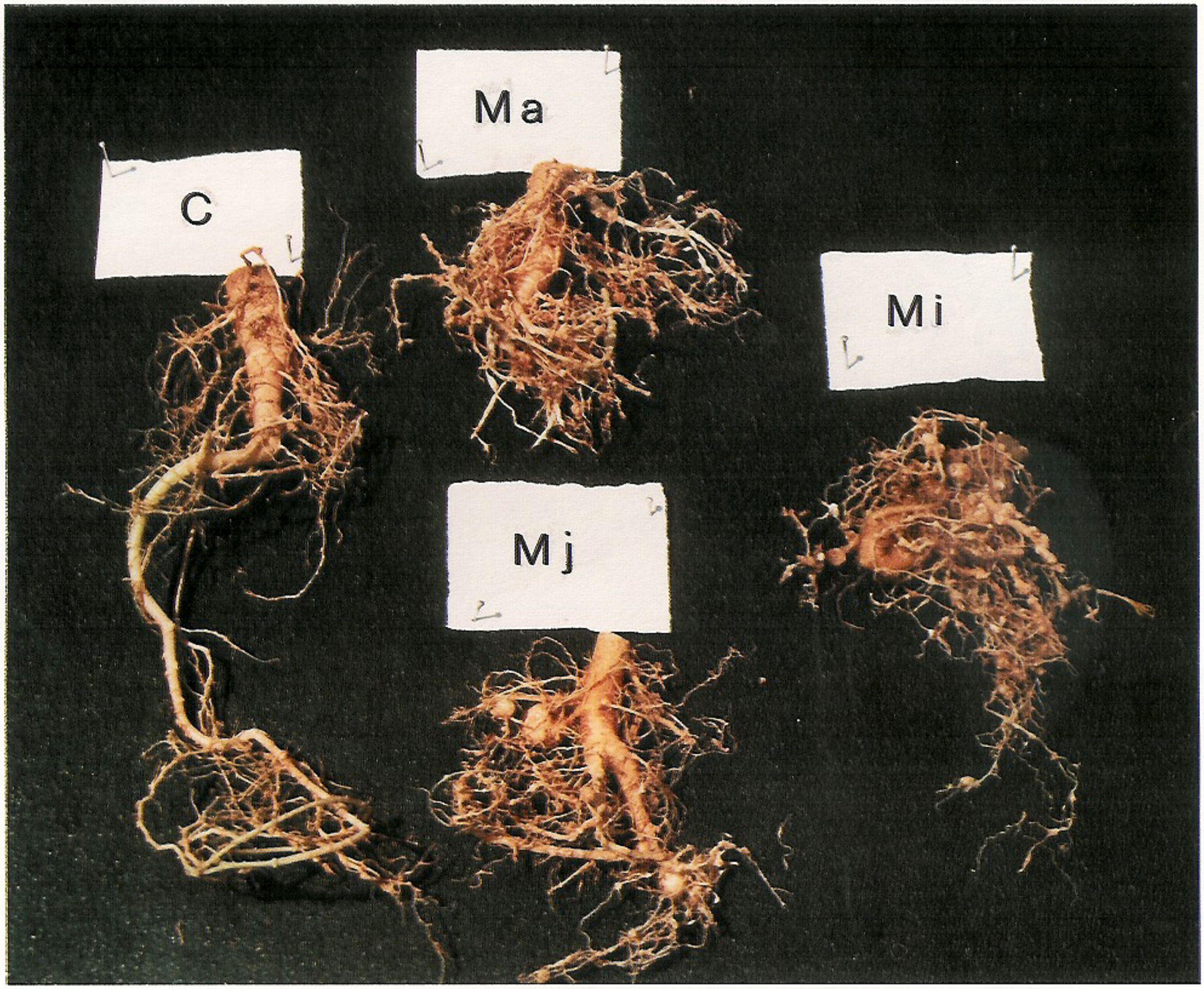

Fig. 10 - Root systems of papaya plants grown in pots infested by root-knot nematodes (C = control, Ma = *M. arenaria*, Mi = *M. incognita*, Mj = *M. javanica*).

TABLE IV - *Reproduction of* Meloidogyne spp. *in two cultivars of soybean in Sri Lanka.*

Nematode species	cv.	Mean numbers of stages in 5 g of roots		
		Adult females	Egg-masses	Eggs
M. arenaria	Pb1	186	148	36,830
	Caribe	178	142	32,240
M. incognita	Pb1	80	72	16,050
	Caribe	142	122	34,500
M. javanica	Pb1	224	184	43,050
	Caribe	180	138	30,624

The three species of root-knot nematodes did not affect the heights of banana plants but root weights were significantly decreased by all of the initial population densities of *M. incognita* and *M. javanica* but only by the intermediate (200 juveniles/pot) of *M. arenaria* (Table VII); top weights were significantly suppressed by all the inoculum densities of *M. javanica* and by the two highest inoculum densities of *M. incognita*.

Reproduction of the three species of *Meloidogyne* was greater at the largest initial population densities indicating that they had still unexploited reproductive potential (Table VIII); this is confirmed by the fact that independently of the inoculum levels, equal numbers of male juveniles occurred in the final populations, because none

Fig. 11 - Root system of a pineapple plant with galls induced by *M. javanica*.

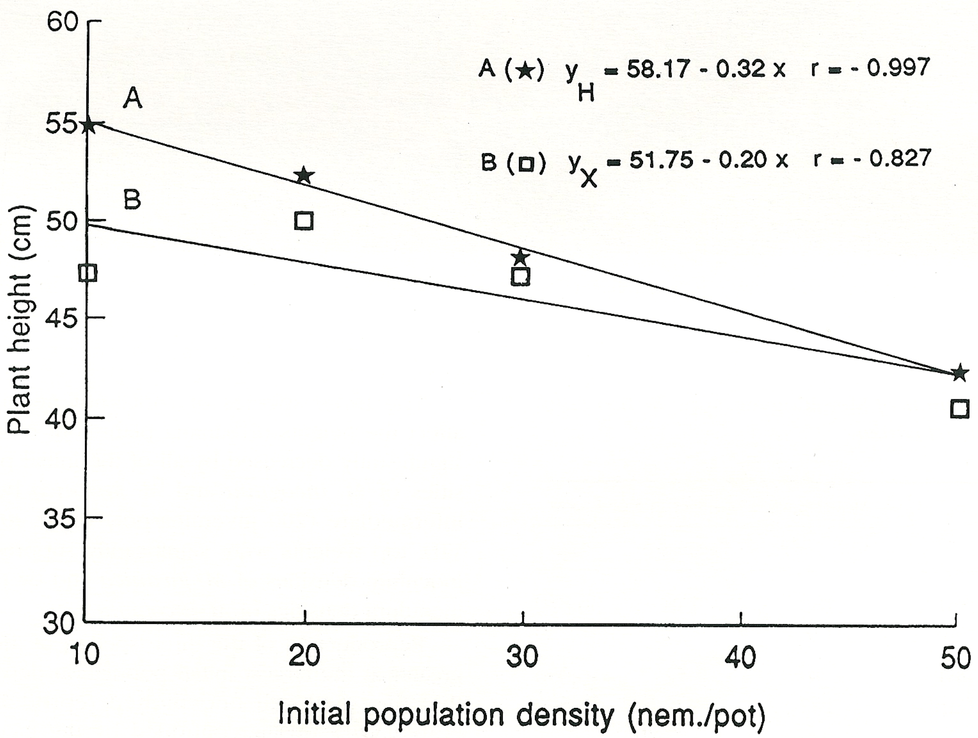

Fig. 12 - Correlation between initial population density of *X. ifacolum* (A, significant for P = 0.01) and of *H. seinhorsti* (B, significant for P = 0.05) and heights of pineapple plants.

of them was under reproductive stress. Of the three populations tested, *M. javanica* showed the greatest rate of reproduction; no differences occurred between *M. arenaria* and *M. incognita*.

Heights and weights of the pineapple plants grown in the presence of any of the three species of *Meloidogyne* were not significantly different from the control. Root galling was moderate (Fig. 11) and *M. javanica* had the highest reproduction rate (Table IX).

Also, when pineapple was grown in pots infested either by *H. seinhorsti* or by *X. ifacolum*, the heights of the plants were not significantly different from the control. However, a significant negative correlation occurred between initial densities of either nematode species and final plant height (Fig. 12). Root and top weights were significantly suppressed by *H. seinhorsti* (Fig. 13) or *X. ifacolum* (Fig. 14) compared to control plants (Table X). Reproduction of both species, although slow, occurred to some extent.

The first experiment of cacao grown in soil infested by different population densities of *X. ifacolum* did not produce any significant differences in plant growth and data are therefore omitted. In the second experiment, when both *H. seinhorsti* and *X. ifacolum* were tested, a significant negative correlation was observed between initial nematode density and final heights of plants (Fig. 15). Both nematode species significantly suppressed plant

TABLE V - *Effect of* Meloidogyne spp. *on the height of papaya seedlings in Sri Lanka.*

Nematode species	Initial population density (Nem./pot)	Mean plant height (cm) on										
		6 Jan.	6 Feb.	6 Mar.	6 Apr.	6 May	6 Jun.	6 Jul.	6 Aug.	6 Sept.	6 Oct.	6 Nov. 1980
M. arenaria												
	100	14.1**	15.9**	17.6**	19.1**	21.1**	24.2**	25.8**	27.4**	29.5**	31.6**	32.6**
	200	13.0**	15.0**	16.9**	18.6**	21.0**	24.3*	26.8*	29.0*	31.4	33.2*	34.6*
	400	13.0**	14.7**	16.0**	17.5**	19.4**	23.0**	25.7**	27.9**	30.3**	32.8*	34.1**
M. incognita												
	100	13.3**	14.8**	16.4**	18.0**	19.6**	23.6**	25.8**	27.6**	29.5**	31.7**	33.3**
	200	13.4**	15.5**	17.1**	18.8**	20.2**	24.1**	26.2*	28.3**	30.8*	32.8*	33.2**
	400	14.2**	15.9**	17.9**	19.9**	21.3**	23.8**	25.3**	27.9**	29.6**	31.6**	32.4**
M. javanica												
	100	15.3*	16.7**	18.3**	20.4	21.8	23.8**	24.2**	25.2**	27.7**	29.4**	30.3**
	200	14.8**	16.5**	18.0**	19.7*	20.9**	23.9**	25.5**	27.0**	29.9**	31.8**	32.7**
	400	14.2**	15.3**	17.3**	18.8**	20.1**	22.9**	24.6**	26.0**	27.7**	29.8**	30.3**
Control		17.4a	20.0a	21.0a	22.2a	23.9a	26.9a	28.9a	31.3a	33.5a	36.1a	37.4a
Mean initial pop. density for all *Meloidogyne* species	100	14.2 b	15.8 b	17.4 b	19.2 b	20.8 b	23.9 b	25.3 b	26.7 b	29.0 b	30.9 b	32.1 b
	200	13.9 b	15.6 b	17.3 b	19.2 b	20.7 b	24.0 b	26.2 b	28.1 b	30.7 b	32.6 b	33.5 b
	400	13.8 b	15.3 b	17.1 b	18.6 b	20.3 b	23.2 b	25.2 b	27.3 b	29.2 b	31.4 b	32.3 b
Means for *Meloidogyne* species												
M. arenaria		13.4 b	15.2 b	16.8 b	18.4 b	20.3 b	23.8 b	26.1 b	28.1 b	30.1 b	32.5 b	33.8 b
M. incognita		13.6 b	15.4 b	17.1 b	18.9 b	20.3 b	23.8 b	25.8 b	27.9 b	30.0 b	32.0 b	33.0 b
M. javanica		14.7 b	16.2 b	17.9 b	19.6 b	20.9 b	23.5 b	24.8 b	26.1 b	28.4 b	30.3 b	31.1 b

Statistically different from control according to the Student's *t* test * for P = 0.05; ** P = 0.01; data flanked in the columns by the same letters are not statistically different for P = 0.05, according to Duncan's multiple range test.

TABLE VI - *Effect of* Meloidogyne spp. *on the growth of papaya seedlings in Sri Lanka.*

Nematode species	Initial population density (Nem./pot)	Mean weight (g) of plants			Mean diam of stems (mm)	Degree of galling mean root index
		Roots	Top	Total		
M. arenaria						
	100	13.4	18.8**	32.2	7.9**	3.7**
	200	15.7**	23.0	38.7	9.4	3.6**
	400	14.6**	22.8	37.4	8.6**	4.0**
M. incognita						
	100	11.3	21.7	33.0*	8.1**	3.8**
	200	13.9*	18.1**	32.0*	7.9**	3.6**
	400	14.4*	14.9**	29.3**	7.1**	4.5**
M. javanica						
	100	8.4**	14.7**	23.1**	7.5**	4.2**
	200	14.8**	18.4**	33.2	7.8**	3.6**
	400	12.1	16.4**	28.5**	6.8**	4.5**
Control		12.0a	23.4a	35.4a	9.9a	0.0a
Mean initial pop. density for all *Meloidogyne* species	100	11.0a	18.4 bc	29.4 b	7.8 b	3.9 b
	200	14.8 c	19.8 c	34.6a	8.4 c	3.6 b
	400	13.7 b	18.0 b	31.2 b	7.5 b	4.2 b
Means for *Meloidogyne* species						
M. arenaria		14.6a	21.5a	36.1a	8.6 b	3.8 b
M. incognita		13.1a	18.2 b	31.4 b	7.7 c	4.0 b
M. javanica		11.8a	16.5 b	28.3 b	7.4 c	4.1 b

Statistically different from control according to the Student's *t* test * P = 0.05; ** for P = 0.01; data flanked in the columns by the same letters are not statistically different for P = 0.05, according to Duncan's multiple range test.

weight but not stem diameter, compared to the control plants (Table XI).

The rate of reproduction of *H. seinhorsti* and *X. ifacolum* was slow, as only juveniles of the first species, and first and second stage juveniles of the second species, were observed.

Conclusions

The results of this work indicate that in Sri Lanka *H. seinhorsti* should be regarded as an economically important pest of various crops such as rice, cowpea, pepper, eggplant, tomato, black gram and soybean as well as of perennials such as pineapple and cacao. Black pepper must also be added as it has been previously shown to be affected by nematodes (Lamberti and Ekanayake, 1983b). *H. seinhorsti* did not actively reproduce in the pots; however, larger population densities occurred with perennials which were grown for about one year than in pots cropped with herbaceous plants for only 3-4 months. Its life cycle, even in the field, might take longer than six months.

X. ifacolum had an adverse effect on the growth of two cultivars of soybean, on seedlings of cacao and, to a lesser extent, on suckers of pineapple. This species, which is widespread throughout the Afro-Asian tropics, is a major parasite of many crop plants in western Africa (Lamberti *et al.*, 1987a, 1991, 1992a, 1992b).

Large numbers of *X. ifacolum* were recovered from pots cropped with perennials which had been grown for

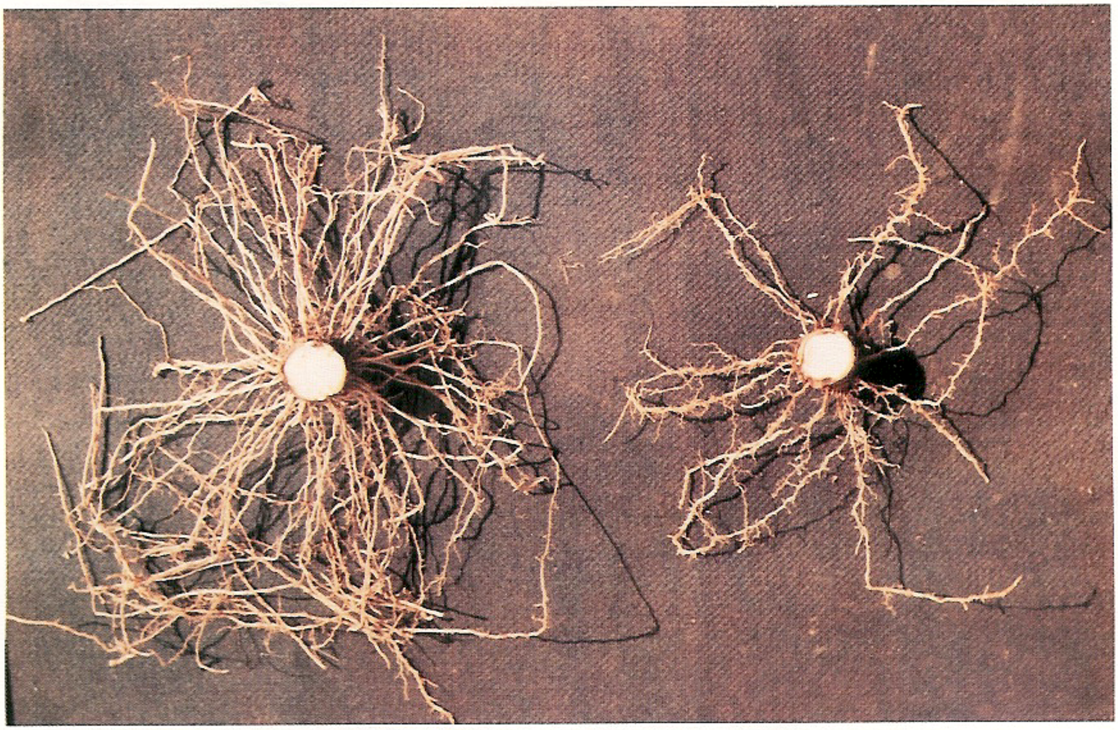

Fig. 13 - Root system of a pineapple plant grown in soil infested by *H. seinhorsti* (control at left).

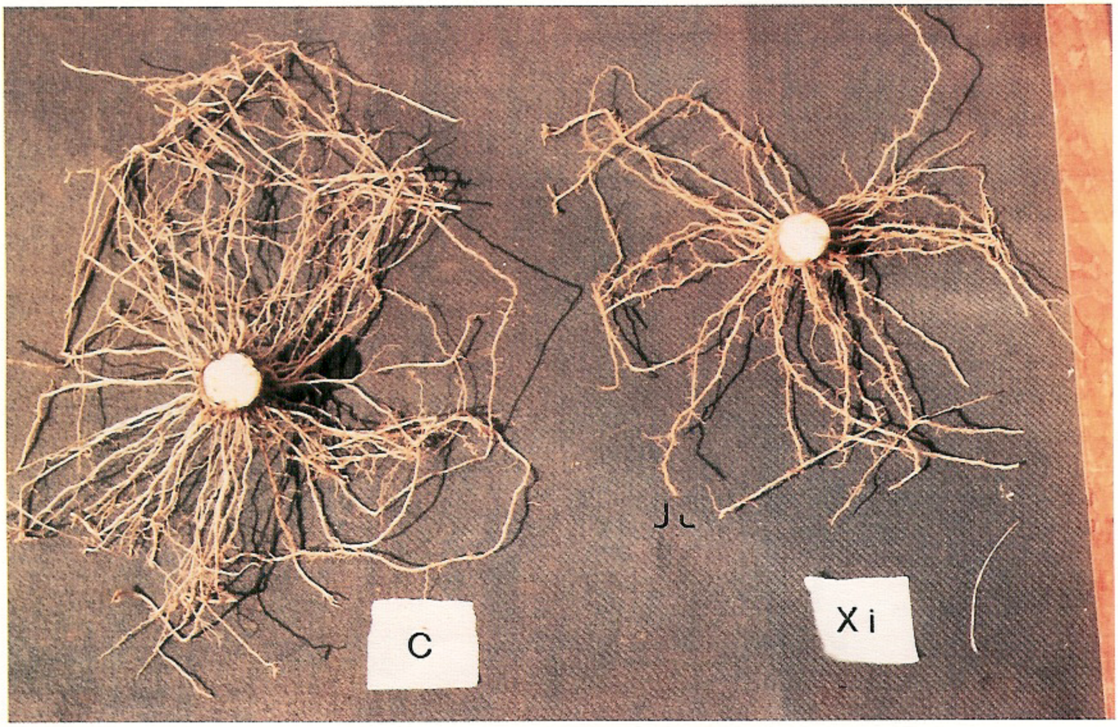

Fig. 14 - Root system of a pineapple plant grown in soil infested by *X. ifacolum* (control at left).

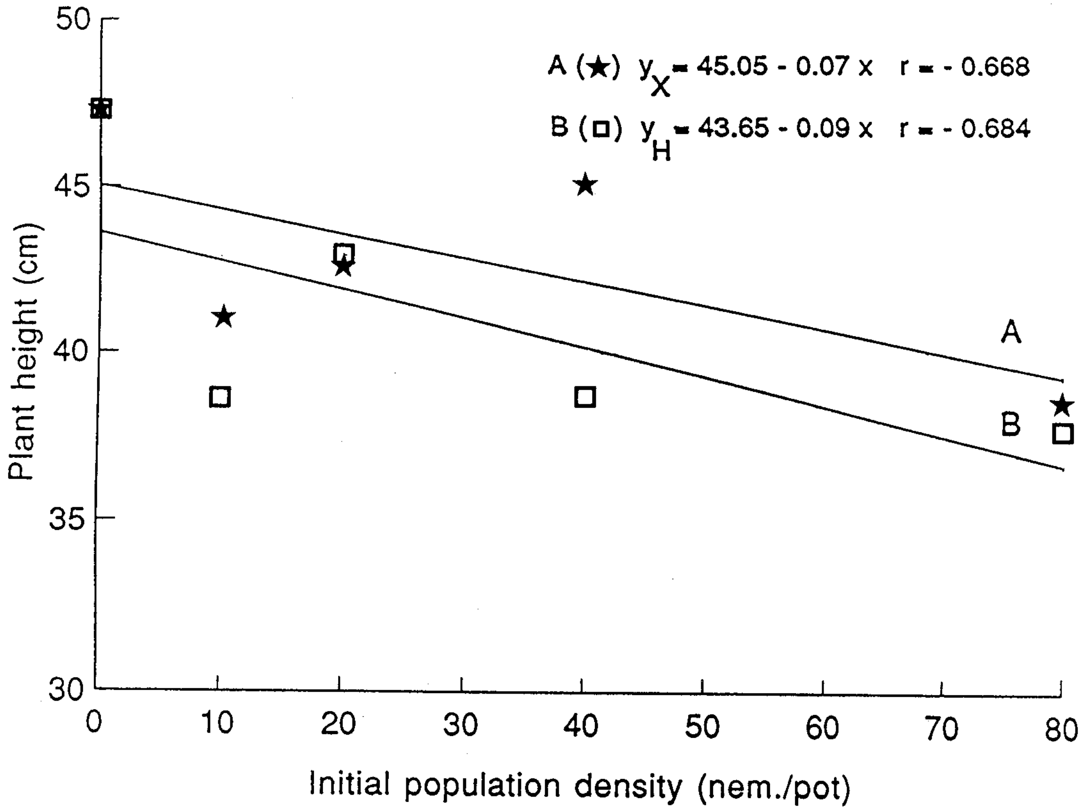

Fig. 15 - Correlation between initial population density of *X. ifacolum* (A, significant for P = 0.05) and of *H. seinhorsti* (B, significant for P = 0.05) and cacao plant heights.

TABLE VII - *Effect of* Meloidogyne spp. *on the growth of banana suckers in Sri Lanka.*

Nematode species	Initial pop. density (Nem./pot)	Mean weight (kg) of plants			Degree of galling mean root index
		Roots	Top	Total	
M. arenaria					
	100	0.45	4.63	5.08	1.0
	200	0.38**	4.14	4.52	1.6**
	400	0.46	4.20	4.66	3.2**
M. incognita					
	100	0.38**	4.44	4.82	0.6
	200	0.39*	4.03*	4.42*	1.0*
	400	0.41*	3.67*	4.08*	1.4**
M. javanica					
	100	0.31*	3.89*	4.20*	1.0*
	200	0.41*	3.85*	4.26*	2.2**
	400	0.41*	3.97*	4.38*	3.8**
Control		0.53A	5.09a	5.62a	0.0a
Means for *Meloidogyne* species					
M. arenaria		0.43 B	4.32ab	4.75a	1.9 bc
M. incognita		0.39 B	4.05ab	4.44 b	1.0 b
M. javanica		0.36 B	3.90 b	4.26 b	2.3 c

Statistically different from control according to the Student's *t* test * for P = 0.05; ** for P = 0.01; data flanked in the columns by the same letters are not statistically different according to Duncan's multiple range test (small letters for P = 0.05; capital letters for P = 0.01).

TABLE VIII - *Reproduction of* Meloidogyne spp. *on banana in Sri Lanka.*

Nematode species	Initial pop. density (Nem./pot)	Numbers of nematode stages in 5 g of root				
		Egg masses	Eggs	Adult females	♀J	♂J
M. arenaria						
	100	4.2	1,232	9	27	23
	200	14.8	4,060	19	21	12
	400	25.2	6,506	32	25	14
M. incognita						
	100	3.8	1,018	9	4	3
	200	9.2	2,900	17	20	13
	400	18.0	4,952	33	39	26
M. javanica						
	100	4.8	1,294	10	11	10
	200	23.6	5,780	38	18	18
	400	38.8	2,900	56	19	13
Mean initial pop. density for all *Meloidogyne* species	100	4.3A	1,181a	9.3A	14a	12a
	200	15.9 B	4,247 b	24.7 B	20ab	14a
	400	27.3 C	4,786 b	40.3 C	26 b	16a
Means for *Meloidogyne* spp.						
M. arenaria		14.7a	3,933a	20A	24a	16a
M. incognita		10.3a	2,959a	20A	21a	14a
M. javanica		22.4 b	3,325a	35 B	16a	14a

Data flanked in the columns by the same letters are not statistically different according to Duncan's multiple range test (small letters for P = 0.05; capital letters for P = 0.01).

TABLE IX - *Reproduction of* Meloidogyne spp. *on pineapple in Sri Lanka.*

Nematode species	Degree of galling mean root index	Number of nematode stages in 1 g of root						Reproduction rate (*Pf/Pi*)
		Egg masses	Eggs	Eggs/Egg masses	Adult female	♀J	♂J	
M. arenaria	2.6a	3.3a A	721a	216a	5a	2.7a	2.2a	57a
M. incognita	2.9a	1.8 b A	391a	213a	4a	2.6a	2.4a	29a
M. javanica	2.7a	6.6 c B	1,596 b	240 b	10 b	3.4a	2.1a	126 b

Data flanked in the columns by the same letters are not statistically different according to Duncan's multiple range test (small letters for P = 0.05; capital letters for P = 0.01).

TABLE X - *Fresh weight of pineapple plants grown in soil infested by* H. seinhorsti *or* X. ifacolum *in Sri Lanka.*

Nematode species	Initial pop. density (Nem./pot)	Weight (g)			Numbers of nematode/ Kg soil at the end of the experiment
		Root	Top	Total	
H. seinhorsti	10	32.1**	177	209*	1a
	20	40.2*	176	216	2ab
	30	32.9**	168*	201*	4 b
	50	40.3*	168*	208*	12 c
X. ifacolum					
	10	48.5	206	255	2a
	20	37.9*	196	234	5a
	30	38.4*	196	234	10 b
	50	38.6*	154**	193**	23 c
Control		52.6	213	266	

Statistically different from control according to the Student's *t* test * for P = 0.05; ** for P = 0.01; data flanked in the columns by the same letters are not statistically different for P = 0.05, according to Duncan's multiple range test.

TABLE XI - *Fresh weight of cacao plants grown in soil infested by* H. seinhorsti *or* X. ifacolum *in Sri Lanka.*

Nematode species	Initial pop. density (Nem./pot)	Weight (g)			Stem diameter (mm)	Numbers of nematode/ Kg soil at the end of the experiment
		Root	Top	Total		
H. seinhorsti	10	10.3**	28.9**	39.2**	10	2.5a
	20	10.6**	38.5*	49.1**	11	4.4ab
	40	13.8**	42.9*	56.7**	10	6.0 bc
	80	10.9**	31.7**	42.6**	12	7.7 c
X. ifacolum	10	16.4	41.2	57.6	10	1.1a
	20	13.5**	35.1**	48.6**	9	3.0ab
	40	14.5*	30.5**	45.0**	10	7.6 b
	80	12.5**	29.3**	41.8**	10	19.5 c
Control		18.5	50.1	68.6	12	

Statistically different from control according to the Student's *t* test * for P = 0.05; ** for P = 0.01; data flanked in the columns by the same letters are not statistically different for P = 0.05, according to Duncan's multiple range test.

long periods. Reproduction of this nematode in the field probably follows the same pattern as *H. seinhorsti.*

The three populations of root-knot nematodes, *M. arenaria* race 1, *M. incognita* race 1 and *M. javanica* negatively affected the growth of the two cultivars of soybean; however, *M. javanica* appeared to be more pathogenic on cv. Pb1 and *M. arenaria* and *M. incognita* on cv. Caribe.

Reproduction of *M. arenaria* seemed to be equal on the two cultivars, that of *M. incognita* greater on cv. Caribe than on cv. Pb1 and that of *M. javanica* greater on cv. Pb1 than on cv. Caribe.

All three species of *Meloidogyne* suppressed growth of papaya seedlings but *M. incognita* and *M. javanica* were more pathogenic than *M. arenaria.* A weaker pathogenic effect of *M. arenaria* compared to *M. javanica* on papaya has been previously shown (Lamberti *et al.*, 1980).

M. incognita and *M. javanica* suppressed growth of banana suckers but *M. arenaria* did not, although it induced gall formation as severe as the other two species on the root systems.

M. javanica reproduced on banana more intensively than *M. arenaria*, and *M. incognita* produced similar numbers of egg masses and mature females.

Finally, root-knot nematodes did not affect the growth of pineapple suckers, although all three populations tested induced gall formation on the root systems and reproduced actively with a reproduction rate much higher for *M. javanica*.

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