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CONTROL OF THE CITRUS NEMATODE (*TYLENCHULUS SEMIPENETRANS* COBB) IN VALENCIA ORANGE GROVES IN CYPRUS

by
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Summary. In two experiments with Valencia orange trees, the citrus nematode (*Tylenchulus semipenetrans* Cobb) was effectively controlled with the granular nematicides prophos, aldicarb and oxamyl, applied annually in the soil at 3, 3 and 2 g a.i./m^2, respectively. The effectiveness of the emulsifiable nematicide fenamiphos at 4 g a.i./m^2, applied with minisprinklers, lasted for three years. The most evident nematicidal effect on yield was an increase in average fruit weight (size) while in one of the trials total yield, over the 4-year experimental period, significantly increased by 9.8, 15.6 and 10.9% using the nematicides prophos, aldicarb and oxamyl, respectively.

In Cyprus, citrus is an important crop ranking second only to potatoes in foreign exchange earnings. At present there are about 6,300 ha of citrus in the government-controlled area of which 1,500 ha are Valencia oranges, yielding approximately 35,000 tons valued at CY£3.7 million (Anon., 1984). The citrus nematode (*Tylenchulus semipenetrans* Cobb) is present in all of the citrus plantations in Cyprus (Philis, 1969). Heavily infested trees exhibit symptoms of poor growth, small leaves, die-back of twigs and reduced fruit size.

Trials were undertaken to test the effectiveness of several nematicides for the control of the citrus nematode in established Valencia orange groves and to determine their effect on yield.

Materials and methods

Two experiments were carried out in the Limassol area, one at Lanitis and the other at Fassouri Plantations. Both experiments were initiated in mid 1982 with Valencia orange (*Citrus sinensis* L.) trees grafted on sour orange rootstock (*Citrus aurantium* L.). At both sites, the soil texture was 25% sand, 26% silt and 49% clay. At Lanitis farm there were three treatments, while at Fassouri there were four treatments, including the control (Table I). Each treatment for both experiments comprised a plot of three trees replicated four times in a randomized complete block design. Tree spacings at Lanitis and Fassouri were 5.7 × 5.7 m and 5.4 × 7.5 m, and the trees were 24 and 18 years old, respectively. Nematode counts and yield data were collected for four years.

Fenamiphos emulsifiable concentrate was applied in the irrigation water through minisprinklers, using a venturi-type injector (Eliades and Hadjiloucas, 1985). Each covered an area of approximately 15 m^2; only one application was made at the beginning of the trial. The granular nematicides prophos (= Ethyl S,S - Dipropyl Phosphorodithioate), aldicarb [2-methyl -2- (methylthio) propionaldehyde = (methylcarbamoyl) oxime] and oxamyl [Methyl *N'N'* - dimethyl -N- (methylcarbamoyloxy -1- thiooxamimidate] were applied annually in early June with a hand applicator in two bands, one on either side of each tree, and incorporated into the soil to a depth of 7-10 cm. The treated area per tree (Ta) for the granular nematicides was determined by the formula $Ta = \frac{8r^2}{9}$, deriving from the equation $\frac{1}{3}r \cdot \frac{4}{3}r = \frac{4}{9}r^2 \times 2 = \frac{8r^2}{9}$ (where $\frac{1}{3}r$ band width and $\frac{4}{3}r$ = band length). The width and length of each treated band for both trials was 0.7 × 2.9 m. Following the application of granular nematicides, all plots, including the controls, were irrigated with sprinklers to wet the main effective root

TABLE I - *Nematicides applied to established Valencia orange trees on sour orange rootstock at two locations.*

Nematicide	Application rate (g a.i./m^2)	Amount/tree (g a.i.) Lanitis	Amount/tree (g a.i.) Fassouri	Method of application
Fenamiphos	4	60	—	Minisprinklers
Prophos	3	—	13	Soil incorporation
Aldicarb	3	13	13	»
Oxamyl	2	—	8	»
Control	—	0	0	—

zone at 0.8 m depth. Plots were weed free at the time of nematicide application.

Nematode numbers were determined from two soil samples taken from each side of the tree at 8-15 cm depth. Second stage juveniles (J_2) and males were extracted from 250 g of soil by a combination of the sieving-decanting and Baermann funnel methods. Counts were made prior to treatment and twice yearly (spring-autumn) thereafter. The number of fruits per carton, for both sites, was estimated by the equation $Y = 230.4\text{-}1.104X + 0.0015X^2$, where X = fruit weight. No discards, caused either by small fruit size or disease, were observed during the entire experimental period.

Results and discussion

All nematicides significantly reduced the nematode populations in the soil, their mean effectiveness over a 4-year period ranging from 63 to 80%. At Lanitis, the average nematode control from fenamiphos and aldicarb was 63 and 79% while at Fassouri prophos, aldicarb and oxamyl reduced the population by 80, 79 and 70%, respectively. The nematode population remained at low levels for three consecutive years following the single application of fenamiphos while in the fourth year numbers in both treatments showed an increase (Fig. 1).

At Lanitis, the nematode population in untreated soil declined sharply after the initiation of the experiment, most probably due to «ceiling effects» of the nematode population at that experimental site (Reynolds and O'Bannon, 1963), while at Fassouri, the relatively small decline of the population in untreated soil may indicate that peak damage had not yet occurred. In both trials, with granular nematicides, nematode populations remained fairly constant, indicating that repeated applications at recommended rates did not increase the level of control but maintained populations at low levels compared with untreated trees (Fig. 2).

At Lanitis, the average fruit weight over a 4-year period was significantly increased by aldicarb (7.2%) while fenamiphos had no significant effect (Table II). Such increase was due to the 15.9% increase obtained in the third year after treatment. However, total fruit weight and numbers of fruits per tree did not increase while at Fassouri, prophos, aldicarb and oxamyl significantly increased total yields over a 4-year period by 9.8, 15.6 and 10.9%, respectively, compared to yields from untreated control trees. Maximum significant increases in total weight of 34 and 33% were achieved with prophos and oxamyl, respectively, in the third year after treatment (Table II).

Fruit quality from treated trees at both sites was of a higher grade due to increased fruit weight (size). As Valencia oranges are exported in standard size cartons, any increase in the size of fruit will contribute to premium grades. This was evident at Lanitis where the total yield of aldicarb-treated trees over the 4-year period was slightly lower than yields of the controls, but the exportable yield (cartons) was higher than the control yields (Table III). Many cases concerning yields response due to successful citrus nematode control refer to increase in the number of boxes of fruit (O'Bannon and Tarjan, 1969; O'Bannon and Reynolds, 1963; Reynolds, 1969; Timmer, 1977).

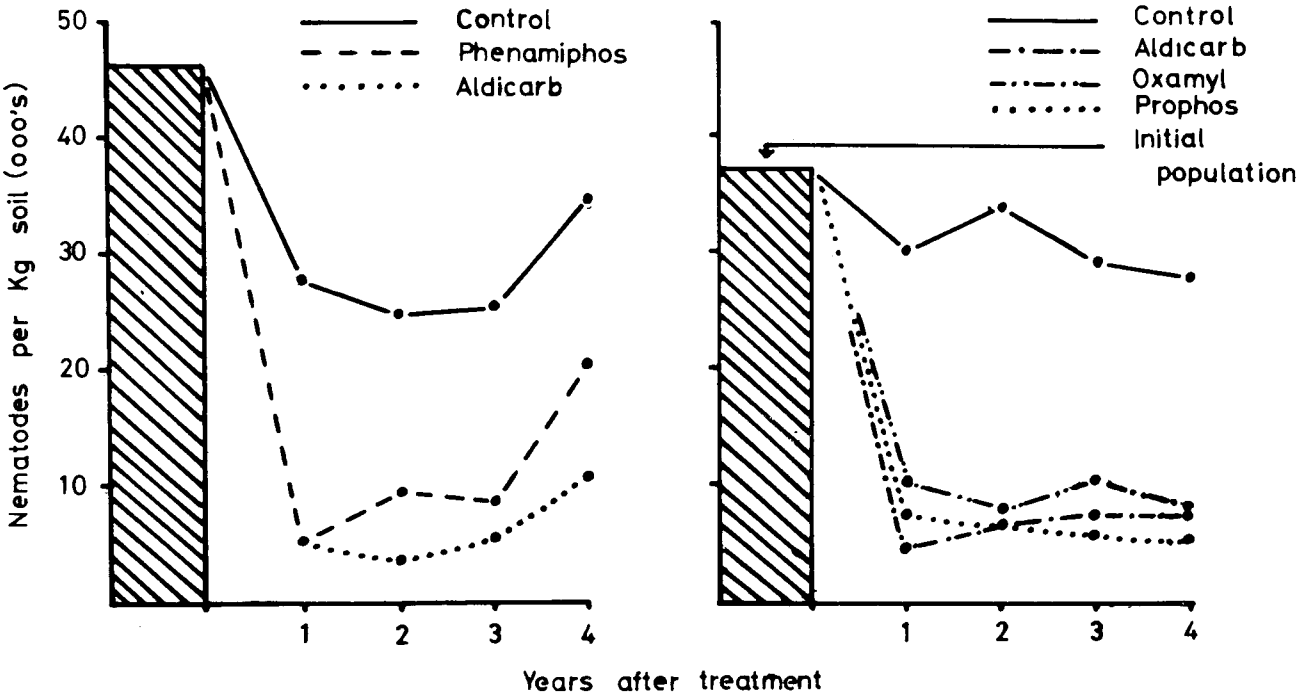

Fig. 1 - Effect of nematicides on citrus nematode population (Means of spring and autumn sampling).

TABLE II - *Effect of nematode control on yield of Valencia orange at Lanitis and Fassouri farms.*

	1st year Yield			2nd year Yield			3rd year Yield			4th year Yield			Mean (1983-1986) Yield		
	kg per tree	Number per tree	Fruit weight (g)	kg per tree	Number per tree	Fruit weigbt (g)	kg per tree	Number per tree	Fruit weight (g)	kg per tree	Number per tree	Fruit weight (g)	kg per tree	Number per tree	Fruit weight (g)
Lanitis															
Fenamiphos[1]	248a[2]	1043a	238a	252a	1451a	173a	244a	1244a	196ab	267a	1776a	150a	253a	1378a	184ab
Aldicarb	237a	995a	239a	255a	1322a	193a	207a	948a	218a	266a	1746a	152a	241a	1253a	192a
Control	237a	1109a	214a	242a	1395a	173a	241a	1282a	188b	260a	1681a	155a	245a	1367a	179b
C. V.	6.9	13.9	8.4	8.1	10.2	8.4	9.7	16.3	5.9	6.9	10.5	4.4	4.3	5.7	3.1
Fassouri															
Prophos	212a	1226a	173b	161a	812a	198a	179a	933a	192b	207a	1009a	205a	190a	1017a	188a
Aldicarb	195a	1003b	194a	191a	983a	194a	149b	733b	203a	264a	1530a	172a	200a	1062a	188a
Oxamyl	199a	1135ab	175b	171a	869a	197a	173a	902a	192b	224a	1224a	183a	192a	1032a	186a
Control	180a	1107ab	163b	156a	863a	181a	148b	818ab	181c	210a	1181a	178a	173b	992a	174b
C. V.	13.5	10.0	7.1	17.8	22.5	7.6	9.0	10.0	3.2	17.9	25.2	8.6	11.4	14.9	6.2

[1] Fenamiphos was applied as a liquid EC formulation while aldicarb, oxamyl and prophos as 15, 10 and 10% granular formulations, respectively.
[2] Column figures followed by different letters are significantly different from each other (Duncan's multiple range test P = 0.05).

TABLE III - *Details of exportable yield[1] as affected by treatments.*

Nematicide[2]	Lanitis					Fassouri				
	Average fruit weight (g)	Number of fruits per carton[3]	Cartons/ha	% increase	Tons/ha	Average fruit weight (g)	Number of fruits per carton	Cartons/ha	% increase	Tons/ha
Fenamiphos	184	78	5,300	4.7	75.9a[4]	—	—	—	—	—
Prophos	—	—	—	—	—	188	76	3,211	13.3	45.6a
Aldicarb	192	74	5,079	0.3	72.3a	188	76	3,353	18.3	48.0a
Oxamyl	—	—	—	—	—	186	77	3,216	13.5	46.1a
Untreated	179	81	5,062	—	73.5a	174	84	2,834	—	41.5b

[1] Refers to 300 and 240 trees/hectare for Lanitis and Fassouri, respectively.
[2] Based on 15 and 4.3 m^2 treated area per tree for fenamiphos and granular nematicides, respectively.
[3] Refers to exportable cartons 40x30x25 cm (ext.).
[4] Column figures followed by different letters are significantly different from each other (Ducan's multiple range test P = 0.05).

Overall production was approximately 30% greater at Lanitis than at Fassouri (Table III). This was due primarly to the greater number of trees per hectare and their larger size.

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