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

by

I. PHILIS

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./m², respectively. The effectiveness of the emulsifiable nematicide fenamiphos at 4 g a.i./m², 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 m²; 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 2-(methylcarbamoyl) oxime] and oxamyl [Methyl N’N’-dimethyl-N-(methylcarbamoyloxy)-1-thiooxamiminate] 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 = \( \frac{8r^2}{3} \) deriving from the equation \( \frac{4t^2}{3} = \frac{4r^2}{3} \times 2 = \frac{8r^2}{3} \) (where \( \frac{1}{3}r \) band width and \( \frac{2}{3}r \) = 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>
<thead>
<tr>
<th>Nematicide</th>
<th>Application rate (g a.i./m²)</th>
<th>Amount/tree (g a.i.)</th>
<th>Method of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fenamiphos</td>
<td>4</td>
<td>60</td>
<td>Minisprinklers</td>
</tr>
<tr>
<td>Prophos</td>
<td>3</td>
<td>13</td>
<td>Soil incorporation</td>
</tr>
<tr>
<td>Aldicarb</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Oxamyl</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

TABLE I - Nematicides applied to established Valencia orange trees on sour orange rootstock at two locations.
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 \( Y = 230.4 + 1.104X + 0.0015X^2 \), 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).

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![Graph showing effect of nematicides on citrus nematode population](image1)

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

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

<table>
<thead>
<tr>
<th></th>
<th>1st year</th>
<th></th>
<th></th>
<th>2nd year</th>
<th></th>
<th></th>
<th>3rd year</th>
<th></th>
<th></th>
<th>4th year</th>
<th></th>
<th></th>
<th>Mean (1983-1986)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield</td>
<td>Yield</td>
<td>Yield</td>
<td>Yield</td>
<td>Yield</td>
<td>Yield</td>
<td>Yield</td>
<td>Yield</td>
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<td>Yield</td>
<td>Yield</td>
<td>Yield</td>
<td></td>
</tr>
<tr>
<td></td>
<td>kg per</td>
<td>Number</td>
<td>Fruit</td>
<td>kg per</td>
<td>Number</td>
<td>Fruit</td>
<td>kg per</td>
<td>Number</td>
<td>Fruit</td>
<td>kg per</td>
<td>Number</td>
<td>Fruit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tree</td>
<td>per tree</td>
<td>weight (g)</td>
<td>tree</td>
<td>per tree</td>
<td>weight (g)</td>
<td>tree</td>
<td>per tree</td>
<td>weight (g)</td>
<td>tree</td>
<td>per tree</td>
<td>weight (g)</td>
<td></td>
</tr>
</tbody>
</table>

**Lanitis**

Fenamiphos

Aldicarb 237a 995a 239a 255a

Lazitis

TABLE

Fenamiphos

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

Contro1

Contro1

Aldicarb 195a

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

Oxamyl

Table III - Details of exportable yield as affected by treatments.

<table>
<thead>
<tr>
<th>Nematicide</th>
<th>Average fruit weight (g)</th>
<th>Number of fruit per carton</th>
<th>Cartons/ha</th>
<th>% increase</th>
<th>Tons/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fenamiphos</td>
<td>184</td>
<td>78</td>
<td>5,300</td>
<td>4.7</td>
<td>75.9a</td>
</tr>
<tr>
<td>Prophos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aldicarb</td>
<td>192</td>
<td>74</td>
<td>5,079</td>
<td>0.3</td>
<td>72.3a</td>
</tr>
<tr>
<td>Oxamyl</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>179</td>
<td>81</td>
<td>5,062</td>
<td>73.5a</td>
<td></td>
</tr>
</tbody>
</table>

1 Fenamiphos was applied as a liquid EC formulation while aldicarb, oxamyl and prophos as 15, 10 and 100 g granular formulations, respectively.
2 Column figures followed by different letters are significantly different from each other (Duncan's multiple range test, P = 0.05).

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

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Literature cited


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