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# EFFECT OF CERTAIN SYSTEMIC NEMATICIDES ON THE INTERACTION BETWEEN *TYLENCHULUS SEMIPENETRANS* AND *ACAULOSPORA TRAPPEI* ON SOUR ORANGE AND CLEOPATRA MANDARIN

by
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**Summary.** In a pot experiment sour orange was more susceptible to the citrus nematode *Tylenchulus semipenetrans* than Cleopatra mandarin. The presence of the VA mycorrhizal fungus *Acaulospora trappei* reduced the numbers of nematode juveniles on sour orange and Cleopatra mandarin roots by 42% and 43% respectively. Chemical control of the citrus nematode with the nematicides aldicarb, oxamyl and phenamiphos was more effective in the presence of mycorrhizae. The nematicides also decreased the number of mycorrhizal spores in the soil and roots. *A. trappei* alone or in combination with the citrus nematode caused a significant increase in the length, fresh and dry weight of shoots and roots of the two rootstocks.

The purpose of this study was to assess the influence of *Acaulospora trappei* Ames and Lind infested roots of sour orange, *Citrus aurantium* L., and Cleopatra mandarin, *C. reticulata* Blanco, on population levels of the nematode *Tylenchulus semipenetrans* Cobb and to compare the specificity of some systemic nematicides on nematode-vesicular arbuscular mycorrhizae fungus (VAM) interaction.

## Materials and methods

Three-months old seedlings of sour orange and Cleopatra mandarin were transplanted into 15 cm diameter clay pots containing one Kg of autoclaved sandy clay soil, two seedlings / pot. The treatments were as follows:

1) Nematode free seedlings in *A. trappei*-free soil.
2) Seedlings inoculated with *A. trappei* (15 spores/pot) alone.
3) Seedlings inoculated with nematodes (7500 juveniles/pot) alone.
4) Seedlings inoculated with nematodes and VAM together (7500 $J_2$ and 15 spores/pot).
5) Seedlings inoculated with nematodes and VAM together in addition to one of the nematicides aldicarb 10% G, oxamyl 10% G and phenamiphos 10% G, each at 4 ppm ( = 0.4 g a.i./m).
6) Seedlings inoculated with nematodes and one of the nematicides at the same rate as in 5 above.

Treatments were in four replicates and pots were arranged in a complete randomized block design and watered daily. Plants were harvested nine months after nematode and VAM inoculation. The length and weight of shoots and roots, number of nematode $J_2$/pot, number of females/g root, number of VAM spores in 250 g soil and N, P and K content in leaves were determined. Microscopic examination of the roots was undertaken to detect the presence of VAM in the roots.

Spores of VAM fungi were collected by the wet sieving and decanting method (Gerdemann and Nicolson, 1963). One gram of fresh root samples were cleared and stained according to Kormanik *et al.* (1980).

The leaves of the two plants in each pot were washed with tap water followed by distilled water, then dried to a constant weight at 70°C and ground in a stainless steel rotary knife mill to 833 μm sieve size. One half gram was digested with HCl according to Chapman and Pratt (1961). Aliquots were taken for the determination of N, P and K. Potassium was measured using a flame photometer and phosphorous was determined colorimetrically by the stannous chloride method (Tooth *et al.*, 1948). Total nitrogen was measured by the micro-Kjeldahl method (Lepper, 1950).

## Results and discussion

The results presented in Tables I and II show that sour orange was more susceptible to citrus nematode infestation than Cleopatra mandarin in the presence of nematode only. The fungus/nematode combination led to a significant reduction in the number of nematode juveniles in the soil and females in the roots, by 42.2% and 42.5% in sour

orange respectively and by 43% and 41% in Cleopatra mandarin respectively compared with plants infested with the nematode only. Nematicides significantly reduced the numbers of *T. semipenetrans* $J_2$ and females on the two rootstocks compared to pots not receiving nematicides. The nematicides were generally more effective in reducing the number of nematode females in the presence of *A. trappei* but not always significantly (Table I). Seedlings in symbiotic association with *A. trappei* had fewer citrus nematodes than non-mycorrhizal plants with or without nematicides.

Plant growth was greater and nematode infestation less in treatments with VAM than those without (Table II). High citrus nematode densities caused rapid deterioration of the root system as found by Natour *et al.* (1975). Mycorrhizal fungus alone or in combination with the nematode resulted in an increase in the length, fresh and dry weights of both rootstocks in comparison with the untreated control.

TABLE I - *Effect of aldicarb, oxamyl and phenamiphos* on the citrus nematode* Tylenchulus semipenetrans *and the VAM fungus* Acaulospora trappei *on sour orange and Cleopatra mandarin.*

| Treatments | $J_2$ /750 g | Females /g root | Percentage reduction | | Mycorrhizal spores/ 250 g/ soil | Mycorrhizal** | |
|---|---|---|---|---|---|---|---|
| | | | $J_2$ | Females | | Forms/1 V | cm root A |
| Control (Sour orange) | 0 | 0 | – | – | 0.0 | 0 | 0 |
| Nematode | 6804 | 214 | – | – | 0.0 | 0 | 0 |
| Mycorrhizae | 0 | 0 | – | – | 32.0 | + + | + |
| Nematode + VAM | 3926 | 132 | 42.2 | 42.5 | 41.5 | + + + | + + |
| Nematode + Aldicarb | 370 | 67 | 94.5 | 68.6 | 0.0 | 0 | 0 |
| Nematode + VAM + Aldicarb | 266 | 54 | 96.0 | 74.7 | 25.0 | + | 0 |
| Nematode + Oxamyl | 147 | 29 | 97.8 | 86.2 | 0.0 | 0 | 0 |
| Nematode + VAM + Oxamyl | 121 | 26 | 98.2 | 87.7 | 27.3 | + | + |
| Nematode + Phenamiphos | 258 | 35 | 96.1 | 83.4 | 0.0 | 0 | 0 |
| Nematode + VAM + Phenamiphos | 215 | 24 | 96.8 | 84.6 | 23.3 | + | 0 |
| L.S.D. | | | | | | | |
| 0.05 | 384 | 8 | | | | | |
| 0.01 | 536 | 10 | | | | | |
| Control (Cleopatra mandarin) | 0 | 0 | – | – | 0.0 | 0 | 0 |
| Nematode | 4926 | 164 | – | – | 0.0 | 0 | 0 |
| Mycorrhizae | 0 | 0 | – | – | 30.0 | + + | + |
| Nematode + VAM | 3250 | 96 | 43.0 | 41.0 | 39.0 | + + + | + + |
| Nematode + Aldicarb | 277 | 35 | 94.3 | 78.4 | 0.0 | 0 | 0 |
| Nematode + VAM + Aldicarb | 225 | 29 | 95.4 | 83.3 | 23.3 | + | + |
| Nematode + Oxamyl | 120 | 25 | 97.7 | 84.4 | 0.0 | 0 | 0 |
| Nematode + VAM + Oxamyl | 93 | 18 | 98.1 | 88.7 | 25.0 | + | 0 |
| Nematode + Phenamiphos | 214 | 47 | 95.6 | 70.8 | 0.0 | 0 | 0 |
| Nematode + VAM + Phenamiphos | 146 | 36 | 76.0 | 77.7 | 22.5 | + | 0 |
| L.S.D. | | | | | | | |
| 0.05 | 342 | 9 | | | | | |
| 0.01 | 494 | 11 | | | | | |

* Treatment rate µg/g;
** V = Vesicular, A = Arbuscular, +, + +, + + +, = light, medium, high density of mycorrhizae colony.

TABLE II - *Effect of citrus nematode on plant growth of sour orange and Cleopatra mandarin rootstocks in presence of mycorrhizae association.*

| Treatments | Sour orange | | | | | | Cleopatra mandarin | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length (cm) | | Fresh weight (g) | | Dry weight (g) | | Length (cm) | | Fresh weight (g) | | Dry weight (g) | |
| | Root | Shoot | Root | Shoot | Root | Shoot | Root | Shoot | Root | Shoot | Root | Shoot |
| Control | 14.1 | 12.5 | 0.9 | 1.8 | 0.7 | 0.7 | 10.1 | 10.4 | 0.8 | 1.1 | 0.6 | 0.0 |
| Nematode | 10.9 | 10.1 | 0.4 | 1.6 | 0.4 | 0.6 | 6.8 | 8.6 | 0.2 | 1.0 | 0.2 | 1.0 |
| Mycorrhizae | 19.9 | 18.5 | 2.5 | 3.7 | 2.0 | 2.3 | 17.6 | 16.7 | 2.3 | 2.6 | 1.6 | 2.1 |
| Nematode + Mycorrhizae | 17.7 | 15.6 | 1.5 | 2.8 | 1.3 | 1.3 | 14.5 | 13.5 | 1.4 | 1.8 | 0.9 | 1.7 |
| Nematode + Aldicarb | 11.8 | 11.2 | 0.9 | 1.7 | 0.7 | 1.0 | 9.3 | 10.1 | 0.7 | 1.0 | 0.6 | 1.0 |
| Nematode + Mycorrhizae + Aldicarb | 15.2 | 14.0 | 1.9 | 2.4 | 1.6 | 1.6 | 13.6 | 13.4 | 1.4 | 2.2 | 0.9 | 1.6 |
| Nematode + Oxamyl | 11.3 | 12.1 | 1.4 | 1.8 | 0.8 | 1.7 | 9.4 | 8.4 | 0.8 | 1.1 | 0.6 | 0.9 |
| Nematode + Mycorrhizae + Oxamyl | 14.9 | 14.9 | 2.0 | 2.6 | 1.5 | 1.8 | 14.3 | 13.5 | 1.5 | 1.9 | 1.2 | 1.6 |
| Nematode + Phenamiphos | 12.2 | 9.8 | 1.3 | 1.7 | 0.9 | 1.1 | 9.2 | 10.4 | 0.7 | 1.0 | 0.7 | 0.8 |
| Nematode + Mycorrhizae + Phenamiphos | 15.8 | 13.3 | 1.8 | 2.5 | 1.4 | 1.7 | 13.4 | 13.3 | 1.6 | 1.9 | 1.2 | 1.4 |
| L.S.D. 0.05 | 3.16 | 2.79 | 0.55 | 0.75 | 0.30 | 0.58 | | | | | | |
| L.S.D. 0.01 | 4.10 | 3.62 | 0.72 | 0.98 | 0.52 | 0.78 | | | | | | |

TABLE III - *Effect of citrus nematode on N, P and K leaf contents of sour orange and Cleopatra mandarin rootstocks in presence of mycorrhizae association.*

| Treatments | Sour orange | | | Cleopatra Mandarin | | |
|---|---|---|---|---|---|---|
| | N | P | K | N | P | K |
| | % nutrient (dry weight) | | | | | |
| Control | 1.80 | 0.27 | 1.18 | 1.79 | 0.14 | 1.21 |
| Nematode | 1.68 | 0.21 | 1.04 | 1.72 | 0.29 | 1.05 |
| Mycorrhizae | 1.72 | 0.47 | 1.27 | 1.74 | 0.44 | 1.19 |
| Nematode + Mycorrhizae | 1.52 | 0.32 | 1.07 | 1.80 | 0.49 | 1.16 |
| Nematode + Aldicarb | 1.60 | 0.19 | 1.05 | 1.75 | 0.26 | 1.07 |
| Nematode + Mycorrhizae + Aldicarb | 1.70 | 0.29 | 1.11 | 1.80 | 0.34 | 0.95 |
| Nematode + Oxamyl | 1.63 | 0.19 | 1.02 | 1.80 | 0.26 | 1.01 |
| Nematode + Mycorrhizae + Oxamyl | 1.68 | 0.27 | 1.13 | 1.79 | 0.30 | 1.15 |
| Nematode + Phenamiphos | 1.68 | 0.20 | 1.03 | 1.69 | 0.25 | 1.07 |
| Nematode + Mycorrhizae + Phenamiphos | 1.72 | 0.32 | 1.12 | 1.76 | 0.30 | 1.11 |
| L.S.D. 0.05 | 0.09 | 0.05 | 0.12 | | | |
| L.S.D. 0.01 | 0.12 | 0.08 | 0.19 | | | |

The N, P, K contents of sour orange leaves were significantly lower in the plants infected with nematodes compared with the uninfected plants, while P content of Cleopatra mandarin leaves was somewhat higher than the control. Inoculation either with mycorryzal spores alone or in combination with nematodes induced a significant increase in P content in the leaves of both rootstocks compared with control and nematode only infested plants. The presence of VAM together with the citrus nematode in plant roots did not affect K content of the leaves of sour orange and had no effect on N content of the leaves of Cleopatra mandarin, compared with the control and nematode only infested plants (Table III).

The application of the nematicides had no effect on the N, P, K content of the leaves of either rootstock, but P was increased significantly in the leaves of sour orange.

It is well recognized that plant growth responses to endomycorrhizae is often the results of increased P nutrition (Holves, 1966; Kleinschmidt and Gerdemann, 1972; Mosse, 1973). They suggested that lack of sufficient P uptake in non-mycorrhizal plants may account for the stunting and chlorosis as significantly higher concentrations of P were found in all mycorrhizal plants compared with those without the fungus.

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