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EFFECT OF NEMATICIDAL TREATMENTS ON POPULATION DENSITIES OF *TYLENCHULUS SEMIPENETRANS*

by
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Summary. The effects of 1,3 dichloropropene, aldicarb and fenamiphos on population densities of the citrus nematode *Tylenchulus semipenetrans* were studied at Acireale, Sicily on *Citrus aurantium* seedlings. Results showed that treatments reduced the number of migratory stages of the nematode in soil in the first and second year after the treatments, but were little effective against females feeding on roots, whose number in some cases was higher than in control. Plants growth was not affected by the nematode although fresh weights and trunk diameters increased in some of the plants treated with aldicarb.

The nematode *Tylenchulus semipenetrans* Cobb is a widespread pest of citrus occurring in all the Mediterranean region (Inserra, 1977). Previous investigations carried out to assess its influence on yield of marketable fruit production have shown differences varying with the geographical areas in which the experiments were undertaken or the type of soil and climate (Cohn and Minz, 1965; Inserra, 1977; Philis, 1988; Duncan, 1989). Although *T. semipenetrans* occurs in citrus orchards of southern Italy, at population densities comparable with those causing crop losses in other areas of the world (Inserra, 1977), chemical treatments intended to reduce nematode numbers rarely resulted in significant yield increases (Lo Giudice, unpubl.). The present investigation was undertaken to determine the efficacy of various nematicidal treatments on *T. semipenetrans* populations in semi-controlled conditions and to assess the relationship between plant growth and population levels in the agronomic and climatic conditions of eastern Sicily.

Materials and methods

The experiment was carried out at Acireale (Catania) starting in April 1987. Forty concrete containers (50 x 70 x 50 cm) were filled with soil naturally infested with *T. semipenetrans* (71.5 % sand; 15.1 % lime; 13.4 % clay; pH = 7.95). Each block consisted of ten randomly disposed containers, each one representing a single treatment replicated four times. The soil in each container was sampled before treatments were applied to determine the numbers of the migratory stages of *T. semipenetrans*.

Treatments were applied as indicated in Table I. Granular nematicides fenamiphos and aldicarb were broadcast and incorporated into the soil; the fumigant 1,3 dichloropropene (1,3 D) was applied by an injector gun at 25 cm depth. Air and soil temperatures at the time of the treatments were recorded together with soil humidity in the twelve following days.

On May 2, 1987, one month after the first treatment, six month old seedlings of sour orange (*Citrus aurantium* L.), grown in nematode free organic mixture, were transplanted in each container. Fertilizer was applied and the plants were watered; weed control of *Oxalis pes-caprae* was done by hand.

The containers were sampled again in December 1987, June 1988 and June 1989, before nematicides were applied, at a depth of 5-40 cm, using a 4 cm diam. core sampler, to determine *T. semipenetrans* densities. Three subsamples were collected from each container. Migratory stages were extracted from 250 ml soil aliquots by Cobb's sieving technique. Mature females were counted using a one ml counting chamber after staining the roots in hot acid fucsin lactophenol and subsequent maceration for 20 sec. in a blender.

Plant height (length of shoots) was measured in December 1987; shoots were cut and total epigeal fresh weights were measured in June 1988 and June 1989. At planting time seedlings with 4 mm trunk diameters were selected and then trunk diameters were measured at two and six months and one year intervals until June 1989. Growth parameters were expressed as the average of four containers, each being the average of six plants; nematode densi-

ties were expressed as an average of four containers. All data were analyzed statistically by Student's t-test.

Results and discussion

The number of migratory stages of *T. semipenetrans* in the soil before treatments did not vary statistically among the blocks. The average percent moisture in the soil at the time of the treatments was 29.7; field capacity and wilting point were respectively 31.79 and 23.9%. Air and soil temperatures were 25°C and 21°C whereas maximum and minimum temperatures registered in the twelve days following the treatments were 28 and 7°C (air) and 23.5 and 10.5°C (soil), respectively.

TABLE I - *Nematicides, rates (kg. a.i./ha) and times of application.*

Treatment	Nematicide	Rates	Times of application
1	1, 3 D	300 l/ha	April 1987
2	1, 3 D	300 l/ha	April 1987
	Aldicarb	8 kg/ha	September 1987
	Aldicarb	8 kg/ha	March 1988
	Aldicarb	8 kg/ha	May 1988
	Aldicarb	8 kg/ha	September 1988
3	1, 3 D	300 l/ha	April 1987
	Fenamiphos	20 kg/ha	September 1987
	Fenamiphos	20 kg/ha	March 1988
	Fenamiphos	20 kg/ha	May 1988
	Fenamiphos	20 kg/ha	September 1988
4	Aldicarb	10 kg/ha	April 1987
5	Aldicarb	10 kg/ha	April 1987
	Aldicarb	8 kg/ha	September 1987
	Aldicarb	8 kg/ha	May 1988
6	Aldicarb	10 kg/ha	April 1987
	Aldicarb	8 kg/ha	September 1987
	Aldicarb	8 kg/ha	December 1987
	Aldicarb	8 kg/ha	May 1988
	Aldicarb	8 kg/ha	September 1988
7	Fenamiphos	30 kg/ha	April 1987
8	Fenamiphos	30 kg/ha	April 1987
	Fenamiphos	20 kg/ha	September 1987
	Fenamiphos	20 kg/ha	May 1988
9	Fenamiphos	30 kg/ha	April 1987
	Fenamiphos	20 kg/ha	September 1987
	Fenamiphos	20 kg/ha	March 1988
	Fenamiphos	20 kg/ha	May 1988
	Fenamiphos	20 kg/ha	September 1988

No statistical differences were observed in December 1987 between population densities of *T. semipenetrans* in the treated and the untreated soil, although numbers of migratory stages had generally decreased in the treated containers. However, soil populations appeared consistently reduced in all treated containers in June 1988. At this time densities of the females in the roots of plants grown in soil treated one month before transplanting with 1,3 D and then twice with fenamiphos (treatment 3), or twice with either aldicarb or fenamiphos (treatment 5 and 8) or finally three times with fenamiphos, were slightly but significantly ($P = 0.05$) reduced compared with the control (Table II). Conversely, the numbers of mature females of the nematode occurring in the roots of plants treated three times with aldicarb (treatment 6) were significantly higher compared to the control (Table II). In June 1989, after one or two additional applications of fenamiphos (treatments 3, 8 and 9) soil populations of *T. semipenetrans* were significantly lower than in the control, but root female densities had increased appearing sometimes significantly higher than the control (Table II).

Differences in the growth parameters varied erratically and only with the aldicarb applications were those of statistical significance (Table II). Granular nematicides applications at rates not higher than 30kg/ha reduced but did not eradicate nematode populations even when applied at short time intervals, and thus were less effective than fumigants applications in the field (Lo Giudice and Inserra, 1978), or fenamiphos applied at 50 kg/ha two days before transplanting (Vovlas *et al.*, 1975; Lo Giudice *et al.*, 1981). The failure of aldicarb to maintain nematode populations at low densities for long periods has been reported for aldicarb and some other nematode species in field conditions and this is explained by degradation and translocation of the nematicide in the soil or nematode recovery or tolerance (Weaver *et al.*, 1988; Gourd and Schmitt, 1988; Dickson and Hewlett, 1988; Nordmeyer and Dickson, 1989).

Increase in the numbers of *T. semipenetrans* females in some of the aldicarb treated blocks one year after the treatment contrasts with the reduction of the migratory stages, suggesting that the latter being in the soil are exposed more to the effects of the nematicide than the females feeding on the roots. The increase in the number of females with the lowest rates of aldicarb can be explained in part by a growth stimulation effect induced by aldicarb on treated plants, whose higher root density could support an increasing number of parasites because of the higher availability of food sources (Seinhorst, 1966; Barker and Powell, 1988).

TABLE II - *Effect of treatments on numbers of* Tylenchulus semipenetrans *migratory stages in soil, females in the roots and plant growth.*

Treatment	Migratory stages/250 ml soil		Females/g root		Plant fresh weight (g)	Diameter of trunk (mm)	
	June 1988	June 1989	June 1988	June 1989	June 1989	Dec. 1987	June 1988
Control	17175	5938	41.7	327	157.5	9.2	14.5
1	4381**	4129	41.5	569*	145.5	9.1	13.6
2	1095**	5234	45.6	385	179.4	9.4	14.3
3	5113**	3247*	31.6**	247	152.6	9.4	15.0
4	4612**	7577	48.2	763*	142.4	9.2	13.7
5	1466**	6504	27.8*	1203*	184.1*	9.6	15.0
6	1700**	5233	64.2***	516	180.4*	10.1**	15.8*
7	3687**	5879	52.7	322	142.5	9.0	14.0
8	4625**	3839*	32.6**	642	137.0	8.9	13.3
9	5200**	2258**	21.2***	928	167.4	9.3	15.0

Numbers with asterisks differ statistically from control according to Student's t-test; * for P = 0.05; ** for P = 0.01; *** for P = 0.001.

Conclusions

The rates of the nematicides used in the trial were inadequate for the control of *T. semipenetrans* under the conditions of the experiment. The data concerning the growth parameters of sour orange seedlings, even in presence of high final population densities of the nematode, confirm that *T. semipenetrans* is not a serious pest in the climatic and agronomic conditions of eastern Sicily, and might cause a problem to citrus groves only when interacting with some other non favourable factors, such as low soil fertility levels, high salinity or other concomitant pathogens and parasites.

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