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EFFICACY OF SIP 5561 AND SOIL SOLARIZATION FOR MANAGEMENT OF *MELOIDOGYNE INCOGNITA* AND *M. JAVANICA* ON TOMATO

by
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Summary. The efficacy of an organophosphate compound (SIP 5561) and soil solarization to manage *Meloidogyne incognita* and *M. javanica* on tomato was compared with that of fenamiphos at 10 or 15 kg a.i./ha and D-D at 300 l/ha in two fields in southern Italy. SIP 5561 at 5 and 10 kg/ha applied 7 days before transplanting delayed root infection by *M. incognita* and *M. javanica* for about two months. These treatments, however, did not have any effect on final nematode population densities and tomato yields which did not differ from those of control plots. Yield increases ($P = 0.05$) of 58 and 45% compared to the controls were obtained in the plots treated with D-D and fenamiphos, respectively. Soil solarization for 6 and 8 weeks from late June to mid August and D-D suppressed *M. incognita* densities by more than 99%.

Root-knot nematode (*Meloidogyne* spp.) infections on tomato (*Lycopersicon esculentum* Mill.) are common in Italy and cause severe crop damage (Lamberti, 1979; Di Vito *et al.*, 1981). Root-knot nematodes can be managed effectively by chemical treatments but many of the nematicides, especially fumigants, are expensive, pose human and environmental risks or have been withdrawn from use. Management of root-knot nematodes with biodegradable nematicides of low toxicity or with a nonchemical approach, such as soil solarization (Grinstein *et al.*, 1979), has received much attention in recent years (Katan *et al.*, 1987).

This paper reports: i) the results of two chemical field trials for the management of *Meloidogyne incognita* (Kofoid *et* White) Chitw. and *M. javanica* (Treub) Chitw. on tomato with a new organophosphate compound (SIP 5561); and ii) data from a soil solarization experiment to suppress an infestation of *M. incognita* in the field in southern Italy.

Materials and methods

I. *Field trials at Castellaneta.* A field with 89% of sand and heavily infested by *M. incognita*, was rototilled and divided into 8 m^2 (2 m x 4 m) plots in a randomized block design with six replicates per treatment.

Treatments were: 1) D-D (1,2 dichloropropane-1,3 dichloropropene); 2) fenamiphos 10 G a.i. (ethy 1 4-methylthio-m-tolylisopropilphosphoramidate); and 3) SIP 5561 10 G a.i. Untreated plots served as controls.

D-D at 300 l/ha was hand injected at 20 cm depth, with soil temperature of 13-15 °C, on 9 April, 1986. The soil was compacted and irrigated to reduce fumigant volatilization. Fenamiphos and SIP 5561 at 10 kg a.i./ha granular formulations were broadcast as a single application on the plots on 29 April, 1986. All plots were rototilled, to incorporate the nematicides and the fertilizer, and to disperse the fumigant in the D-D treated plots. Tomato cv. Chico III seedlings were transplanted on 3 May in two rows of 12 plants each, spaced 60 cm apart. Split applications of SIP 5561 and fenamiphos before (29 April) and one month after planting (9 July) were also included.

Soil samples in a composite of 24 1.5-cm diam and 30 cm deep cores were collected from each plot on 28 April, 9 July and after harvest. Four roots per plot were also collected on 9 July and again after harvest. Plants were irrigated by a separate furrow per plot. Fungicides and insecticides were applied periodically as necessary. Tomatoes were harvested twice on 14 and 28 August.

II. *Field Trial at Torchiarolo.* In 1987, a field with a similar soil texture as that of the previous experiment and infested with *M. javanica* was divided into plots and treated as discussed previously. The effects of 2.5, 5, and 10 kg a.i. of SIP 5561/ha, applied one week before transplanting, were compared with that of 15 kg a.i. of fenamiphos/ha and 300 l D-D/ha. Untreated plots served as control. D-D was injected on 22 April 1987 (average soil temperature 15-20 °C) and the granular nematicides were broadcast on 6 May. Tomatoes were transplanted on 13 May and harvested on 6 and 20 August. Soil samples were collected on 21 April from control and D-D treated plots and on 5 May, 20 July, and 2 September from all plots.

III. *Soil solarization experiment.* In the same locality as experiment I a field was divided into 36,5 m^2 (2 m x 2.5 m) plots. The influence of solarization was compared to D-D (300 l/ha) and aldicarb (2-methyl-2-(methylthio) propionaldeyde O-methylcarbamoyloxime) granular formulation of 10 kg a.i./ha. Untreated plots served as control. Treatments

TABLE I - Effect of volatile and non volatile nematicides on *Meloidogyne incognita* and tomato yield

Treatment	Eggs and second stage juveniles/cm^3 soil		Gall index		Swollen life stages/10 g roots		Eggs and second stage juveniles/10 g roots		Yield
	Before transplanting	At harvest	9/7/86	At harvest	9/7/86	At harvest	9/7/86	At harvest	(kg/8 m^2)
DD 300 l/ha	5* a	52 ab	0.1 a	2.5 a	0.2 a	1,063 a	205 a	182,380 a	40.1 a
Fenamiphos 10 kg a.i./ha	5 a	15 b	0.0 a	2.0 a	0.4 a	473 a	6 a	87,853 a	36.9 ab
Fenamiphos 5+5 kg a.i./ha	6 a	18 b	0.1 a	1.6 a	0.2 a	392 a	337 a	57,634 a	36.7 abcd
SIP 5561 10 kg a.i./ha	5 a	30 b	0.0 a	2.1 a	0.0 a	722 a	0 a	81,131 a	31.9 bcd
SIP 5561 5+5 kg a.i./ha		23 b	0.4 a	2.6 a	2.6 a	1,043 a	1,827 a	108,874 a	28.7 cd
Control	6 a	95 d	2.3 b	4.3 b	367.5 a	1,963 a	102,861 b	177,856 a	25.4 d

Values are means of six replicates. Figures on the same colum followed by the same letters are not significantly different (P = 0.05) according to Duncan's multiple range test.
* Significantly (P = 0.05) less than the nematode population observed in the same plots before treating, according to Student's *t* test.

were replicated six times in a randomized block design. Solarized plots were established for 4, 6 and 8 week periods after irrigation and covering with 50 µm thick clear polyethylene sheets on 24 June. D-D and aldicarb plots were injected and broadcast, respectively, on 23 June.

Soil temperatures at 10, 20, and 30 cm deep were continuously recorded during solarization, in covered and non-covered plots. Plots were not planted but soil samples were taken to determine nematode mortality. Soil samples composite of 40 soil cores (1.5-2 kg each) were collected, as described, from the centre square metre of all plots before treatment (20 June) and at the end of each solarization period, from the control and solarized plots. D-D and aldicarb plots were sampled four weeks after treatment. Nematodes present in the soil after treatment were expressed as per cent of those found before treatment. The reverse of the percentages were considered as mortality of the nematode.

Nematode Extraction and Statistical Analysis: Nematodes were extracted from soil samples by Coolen's method (Coolen, 1979 as modified by Di Vito *et al.*, 1985). Eggs were extracted from 10 g root sub-samples by the NaOC1 method (Hussey and Barker, 1973) and then processed by Coolen's method to extract the remaining eggs and swollen stages of the nematode. A root gall index of tomato root was determined on a 0-5 scale (Di Vito *et al.*, 1979).

All data were statistically analysed and means compared using Duncan's multiple range test or Student's *t* test.

Results and discussion

I. *Field trial at Castellaneta.* Soil nematode densities in treated and control plots did not differ at planting (Table I) and nematode infection was delayed for about two months after transplanting. At this time, 9 July, the root gall indices and root nematode densities were smaller $P = 0.05$) in treated plots compared with the control plots (Table I). At harvest, root nematode densities in all treated plots did not differ from those of the controls (Table I). However, at harvest root galling was less ($P = 0.05$) in the treated plots than in the controls. Tomato yields were greater ($P = 0.05$) in the D-D and fenamiphos single application plots than in the other treatments and the controls (Table I).

II. *Field trial at Torchiarolo.* Nematode densities were not uniform in all the plots when chemicals were applied (Table II). Two months after planting, soil nematode densities did not differ in treated plots (except for SIP 5561 low rate), and were smaller ($P = 0.05$) than those of the controls, indicating that the chemicals delayed nematode infection (Table II). There was a significant increase in soil nematode densities at harvest in all treated plots except for the D-D treatment (Table II). However, the root gall indices of chemical treatments were significantly lower, compared with the controls, except for the low rate of SIP 5561 (Table II). Only D-D and fenamiphos applications significantly increased tomato yields compared to that of the control plots (Table II).

The results of the two experiments indicate that SIP 5561 at 5 and 10 kg/ha delayed root invasion by *M. incognita* and *M. javanica* for about two months after application as did fenamiphos and D-D. The nematostatic activity of SIP 5561, however, did not last until harvest, allowing root-knot nematodes to increase their densities to the same level as that of the controls, which resulted in yield losses.

III. *Soil solarization experiment.* Weather conditions during the first four weeks of this experiment were not favourable for solarization. Mean maximum soil temperature at 10 cm depth in tarped plots was in the range 35-39 °C during the first four weeks, but increased to 41-43 °C the-

TABLE II - Effect of volatile and non volatile nematicides on *Meloidogyne javanica* and tomato yield

Treatment	Eggs and J2/50 cm^3 soil			Eggs and second stage juveniles /10 g roots at harvest	Females and other juvenile stages/10 g roots at harvest	Gall index	Yield ($kg/8m^2$)
	Before treatment	Two months after planting	At harvest				
SIP 5561 2.5 kg a.i./ha	31.3 bc	895.5 ab	692.5 a	103,562 a	137 ab	2.9 ab	37.9 bc
SIP 5561 5 kg a.i./ha	70.0 a	675.1 b	798.0 a	62,725 a	116 b	2.5 bc	37.7 bc
SIP 5561 10 kg a.i./ha	30.0 c	399.8 b	447.0 a	41,124 a	89 bc	2.3 bc	38.4 bc
Fenamiphos 15 kg a.i./ha	23.5 c	617.0 b	373.0 a	42,837 a	66 bc	1.8 c	41.4 ab
DD 300 l/ha	52.5 ab	171.0 b	146.7 a	385 b	0 c	0.1 d	45.3 a
Control	65.8 a	1,581.0 a	1,584.8 a	118,639 a	230 a	3.4 a	36.0 c

Values are means of six replicates. Figures in the same column followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test.

reafter. At 20 and 30 cm depth the temperatures during the last four weeks were 39-41 and 35-37 °C, respectively. Soil temperatures in untarped plots were 6-9 °C less.

Although no crop was planted in this experiment, data on nematode mortality clearly showed the efficacy of soil solarization for the management of *M. incognita* (Table III). In plots solarized for six and eight weeks nematode mortality was similar to that of the D-D treatment and greater (P = 0.05) than that of the controls (Table III). Solarization for 4 weeks at temperatures reported here was less (P = 0.05) efficient in suppressing nematode densities (Table III).

In a previous experiment (Greco *et al.*, 1985) soil solarization was not effective in managing *M. javanica* under field conditions in southern Italy. The results of this trial, however, suggest that in late June and early July soil solarization can be very effective in suppressing root-knot nematode populations to manageable levels on winter vegetables that are planted in late summer. These crops, growing during cooler months escape damage from late root-knot infections which are suppressed by cold weather.

TABLE III - Effect of soil solarization on the mortality of *Meloidogyne incognita*

Treatment		% egg and juvenile mortality
Soil solarization	4 weeks	82.9 ab
Soil solarization	6 weeks	99.3 b
Soil solarization	8 weeks	99.8 b
DD 300 l/ha		99.8 b
Aldicarb 10 kg a.i./ha		82.4 ab
Control		53.3 a

Values are means of six replicates. Figures in the same column followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test.

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