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Istituto di Nematologia Agraria, C.N.R. — 70126 Bari, Italy[1]
International Center for Agricultural Research in Dry Areas (ICARDA) — Aleppo, Syria

EFFECTIVENESS OF SOIL SOLARIZATION FOR CONTROL OF *HETERODERA CICERI* AND *PRATYLENCHUS THORNEI* ON CHICKPEA IN SYRIA

by
M. Di Vito[1], N. Greco[1] and M.C. Saxena[2]

Summary. A field experiment was conducted during summer 1989 to investigate the effect of soil solarization on the control of *Heterodera ciceri* and *Pratylenchus thornei* and yield of chickpea in Syria. The soil populations of both nematodes were greatly reduced in all solarized plots and nematode numbers were also reduced in chickpea roots collected in mid April. The fresh weight of the plants and grain yields of chickpea were significantly increased in plots solarized for 6 or 8 weeks.

Soil solarization has been tested against *Pratylenchus thornei* Sher *et* Allen on chickpea (*Cicer arietinum* L.) in Syria (Greco *et. al.*, 1990), but no information is available on the effect of this control method on *Heterodera ciceri* Vovlas, Greco *et* Di Vito. Therefore a field trial was undertaken in 1989-90 to assess the efficacy of soil solarization against *H. ciceri* and to confirm its effect on *P. thornei*.

Materials and methods

The experiment was established in soil infested by the two nematodes at Tel Hadya. The field was divided in 24 plots of 9 m^2 (4 x 2.25) each, spaced 50 cm apart. The experimental design was a randomized block with four replications. Treatments consisted of mulching the plots with transparent polyethylene film 50 µm thick for 2, 4, 6 or 8 weeks or no polyethylene cover but application of 10 kg a.i./ha of aldicarb, a half dose at sowing and the other half after the emergence of the chickpeas. Four plots were untreated as controls. To improve heat conductivity, the field was irrigated before covering the plots on 12 July 1989. Soil temperatures at 5, 15, and 30 cm depth were recorded daily at 2 p.m. in mulched and in non-mulched plots (Fig. 1) during the mulching period. The plots were rotavated later and chickpea cv. Ghab 1 was sown on 15 January 1990. There were five rows per plot spaced 45 cm apart. Normal maintenance procedures were applied to the plants throughout the growing season.

Soil samples were collected from each plot at the beginning of the experiment, before sowing, and at harvest of the chickpea crop. Also, five chickpea roots were collected from the central row of each plot at flowering (mid-April 1990). Root lesion nematodes from 500 cm^3 soil subsamples were extracted by Coolen's method (1979). Cysts of *H. ciceri* were extracted from 200 g air dried subsamples, from soil samples collected before sowing and after crop harvest, using a Fenwick can. The cysts were counted and their egg content determined (Seinhorst and den Ouden, 1966). The roots were comminuted in a blender and centrifuged by Coolen's method to extract both cyst and root lesion nematodes, which were then counted.

The total shoot and grain yield of chickpea from each plot was weighed. Data were statistically analysed and comparisons made with LSD's.

Results

Temperatures recorded at 2 p.m. at 5, 15 and 30 cm depth were much higher in mulched than in control plots. The average maximum temperature was 50°C at 5 cm depth (Fig. 1) and approximately 7 and 15°C less at 15 and 30 cm depth, respectively. The average maximum temperatures recorded at 5, 15 and 30 cm depth in the non mulched plots were 43, 35 and 28°C, respectively (Fig. 1). However, maximum soil temperatures would be reached later than at 2 p.m. at Tel Hadya and they are presumed to be higher than those reported in Fig. 1.

Soil populations of *P. thornei* were greatly suppressed in the plots solarized for 6-8 weeks and in those treated with aldicarb (Table I). Therefore, root invasion by the nematode was much reduced and significantly fewer specimens (one third of the control) were extracted from the roots of chickpea grown in the plots solarized or treated with aldicarb (Table I).

Although at crop harvest the soil population of *H. ciceri* increased in all solarized plots it was inversely correlated with the duration of the solarization period and was 25, 58, 60 and 71% less than that of the control, in the plots solarized for 2, 4, 6 or 8 weeks, respectively (Table II). Soil solarization for 6-8 weeks and aldicarb greatly suppressed the invasion of the chickpea roots by *H. ciceri*. Numbers of nematode females in the roots ranged from 40 to 60% of the total specimens in the control and solarized plots, but they were only 3% in the plots treated with aldicarb (Table II). This clearly indicates that aldicarb delayed the root invasion of the nematode, thus avoiding root damage at the early development stage of plant.

The control of nematodes by solarization and aldicarb treatments resulted in an increase of the fresh weight of the plants and grain yields (Table III). However, significant yield increases were observed only in the plots treated with aldicarb or solarized for 8 weeks, which gave approximately twice and three times, respectively, the grain yield of the control (Table III).

TABLE I - *Effect of soil solarization on* Pratylenchus thornei *on chickpea at Tel Hadya, Syria.*

Treatment	Nematodes/50 cm³ soil			Nematodes/10g chickpea roots (in April)
	Before treatment	At sowing	At harvest	
Control	169	13.0	11.1	693.0
Solarization				
» 2 weeks	98	3.5	8.1	230.0
» 4 »	107	1.0	8.0	189.0
» 6 »	78	3.5	1.5	307.0
» 8 »	50	1.2	2.7	221.0
Aldicarb 5 + 5 Kg a.i./ha	92	7.0	1.7	7.5
LSD P≤0.05	N.S.	N.S.	6.7	290.5
P≤0.01	N.S.	N.S.	N.S.	402.3

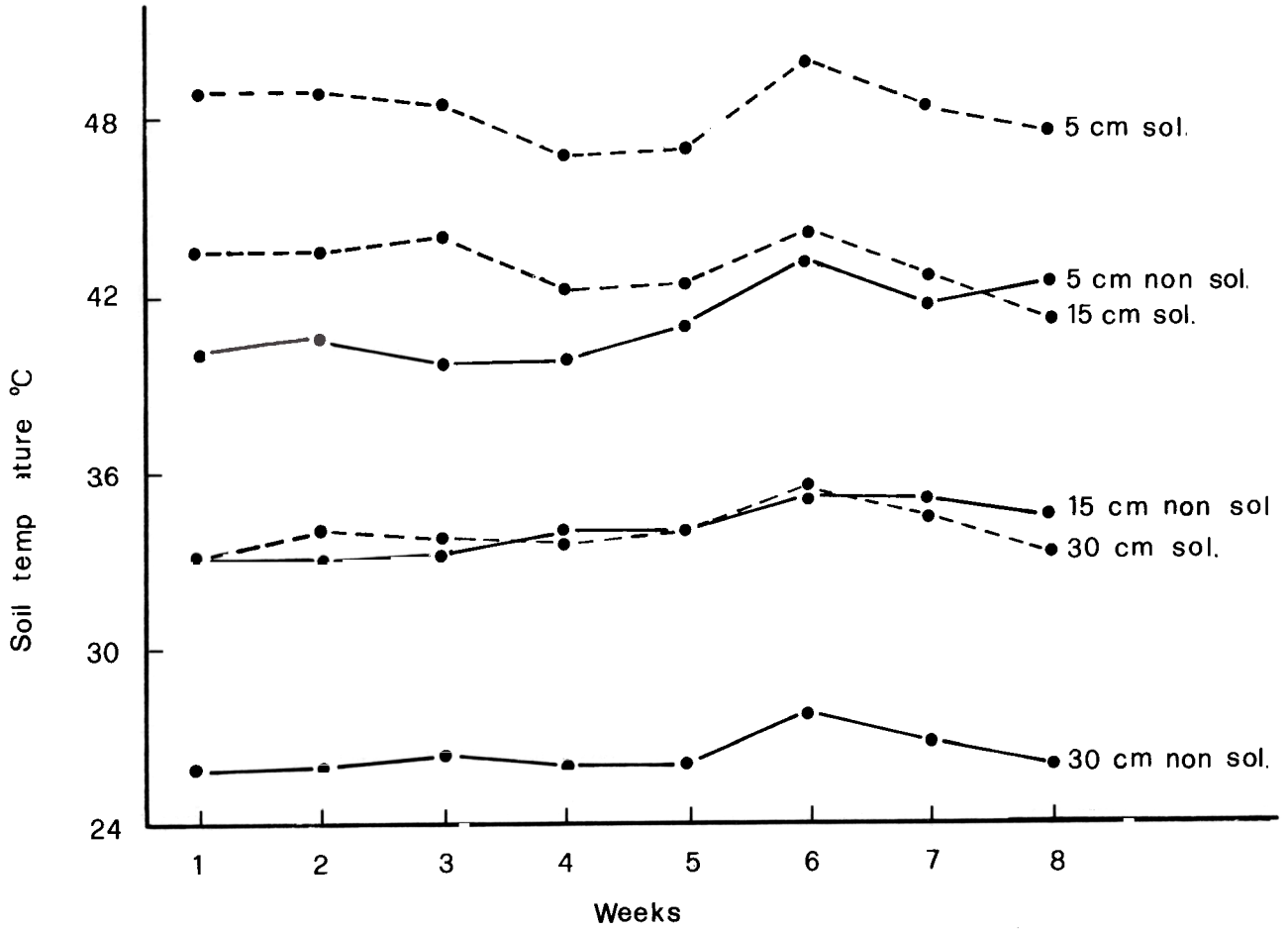

Fig.1 - Mean maximum temperatures at 5, 15 and 30 cm depth in solarized (sol.) and non solarized (non sol.) plots at Tel Hadya (Syria), in July and August 1989.

TABLE II - *Effect of soil solarization on* Heterodera ciceri *on chickpea at Tel Hadya, Syria.*

Treatment	Eggs/g soil		Nematodes/10 g chickpea roots (in April)		
			Juveniles	Females	Total
Control	10.6	42.5	2,076	1,565	3,641
Solarization					
» 2 weeks	9.0	32.1	2,479	1,625	4,105
» 4 »	6.1	17.8	1,566	2,352	3,918
	4.8	14.5	745	497	1,242
» 8 »	2.7	12.2	545	509	1,054
Aldicarb 5 + 5 Kg a.i./ha	9	6.9	1,370	42	1,412
LSD P≤0.05	N.S.	18.6	1,259	907	1,718
P≤0.01	N.S.	N.S.	N.S.	1,289	2,443

TABLE III - *Effect of soil solarization on yields of chickpea grown in plots infested with* Heterodera ciceri *and* Pratylenchus thornei *at Tel Hadya, Syria.*

Treatment	Fresh weight of the plants (Kg/ha)	Grain yield (Kg/ha)
Control	1,966	670
Solarization 2 weeks	1,864	628
4	۲,۴۴۲	۹۶۲
6	2,725	1,026
» 8 »	3,149	1,822
Aldicarb 5 + 5 Kg a.i./ha	2,844	1,129
LSD P≤0.05	876	430
P≤0.01	1,245	612

Conclusions

This experiment has confirmed the efficacy of soil solarization against *P. thornei* on chickpea in Syria (Greco *et al.*, 1990). Moreover, soil solarization when persisting for 6-8 weeks appears to be effective in reducing the invasion of the chickpea roots by *H. ciceri*. The yield increases of chickpea obtained in solarized plots were associated with the suppression of *H. ciceri* rather than of *P. thornei*, suggesting that the cyst nematode was much more damaging to chickpea in the experimental field. Greco *et al.* (1988) related population densities of *H. ciceri* to yield of chickpea and according to them the yield obtained in our control plots, which were infested with 10.6 eggs of the nematode/g soil, would be approximately 65% of that in non infested soil. Yield increases in the plots treated with aldicarb were probably due to the complete elimination of nematode damage with the nematicide. The level of yield from plots solarized for 8 weeks indicates that this method of control not only prevents damage by nematodes but may also suppress the adverse effect of other soil-borne pathogens.

Soil solarization may not be suitable on chickpea in many countries because of the low benefit, but additionally this method of control is also effective against several soil-borne fungi (Katan, 1987) and weeds, including broome rape (Sauerborn and Saxena, 1987). Thus its use on high yielding field crops could be economic in other areas and would help in reducing the use of pesticides.

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