Control of Faba Bean Nematodes by Soil Solarization in Syria

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Abstract

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The effect of soil solarization on plant parasitic nematodes, *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Tylenchus* spp., *Heterodera ciceri*, and *Pratylenchus thornei*, was studied in dependency of duration of solarization in northern Syria. Soil covered by polyethylene reached a maximum temperature of 55°C in 1985 and 48°C at 5cm soil depth. While uncovered soil reached only a maximum temperature of 40°C in both years. Population densities of the nematodes were reduced by 83 to 100% by 40 days of soil solarization depending on the genus and year. However, *P.thornei* could re-establish its population density in one year.

Key words: nematode, soil solarization, Syria.

Introduction

Soil solarization is a technique for the control of soilborne pests using solar energy. Moist soil is covered by transparent polyethylene and heated by incoming radiation, the plastic sheet keeps soil moisture and reduces heat loss through evaporation.

Heat as a method to control nematodes is well known e.g. hot water treatments to kill nematodes in seed and planting material. Using soil solarization for controlling free-living and phytoparasitic nematodes has been reported by several authors (Cenis 1984, Grinstein et al. 1979, Porter & Merriman 1983, Siti et al. 1982, Stapleton & DeVay 1983) for different areas. The latest review on soil solarization was published by Katan 1987, where also a list of soil-borne pathogens, weeds and arthropods controlled by this method was given. Nematodes are pests that limit production of leguminous crops such as chickpea (*Cicer arietinum* L.), faba bean and lentil (*Lens culinaris* Medik.) which are staple food and of major economic importance in Syria (Greco et al. 1984). The control of these parasites by nematicides is possible but costly and may cause pollution. Moreover the use of crop rotations has limitations because most of the occurring nematodes species have rather wide host ranges, while food legume cultivars resistant to nematodes are few or lacking.

The objective of this study was to study the response of plant parasitic nematodes, to soil solarization, in dependency of duration of solarization under the conditions of Syria and to determine the initial and residual effect of the treatment.

Materials and Methods

Fields naturally infested with several plant parasitic nematodes at the principal research station of the International Center for Agricultural Research in the Dry Areas (ICARDA), Tel Hadya, Syria were used to test the effect of soil solarization. The most common nematodes in these fields were *Pratylenchus thornei* Sher et Allen and *Helicotylenchus* spp. Less common were *Tylenchorhynchus* spp., *Tylenchus* spp. and in 1986 also *Heterodera ciceri* Vovlas et al. Soil type was chromic luvisol, with 60% clay, 32% silt, 8% sand, 0.8% organic matter and a pH of 8.1. The plots were cultivated and sprinkler irrigated two days before the UV-stable polyethylene film (0.18 mm thick) was applied, during the hottest period of the year in July and August for 0,10,20, or 40 days in 1985 starting July 27th and 0,30, or 40 days in 1986 starting July 25th. A randomized block design with four replications was used. Plots were 2 by 10m. Recording-thermograph sensors were buried at 5,10 and 15cm depths during the solarization treatment. As a host plant for the parasites a locally well adapted cultivar of ILB 1814 faba bean (*ViciaFaba L.*)was sown at the end of October under rainfed conditions. In December 1985 and 1986 soil samples up to 15cm depth were taken in four replicates from each plot and nematodes extracted using Coolen's method (1979), identified and counted. In March 1986 and 1987, when faba bean plants were flowering their roots were examined for *P. thornei* by the incubation method(Young, 1954). To study the residual effect of solarization treatments given in 1985 on the root lesion nematode, the plots were left uncultivated after the harvest of the first crop and were sown again at the end of October 1986 with ILB 1814 faba bean as a bioindicator for the parasite infestation. Least significant difference (LSD) at 0.05 level of probability was used to compare the treatment means.

Results

At 5cm soil depth under polyethylene films the soil temperature reached an absolute maximum of 55°C in 1985 but only 48°C in 1986. The mean maximum temperatures of soil covered for 40 days in 1985 was about 51°C at 5cm depth, while in 1986 it was about 6°C lower (Table 1).

Table 1. Temperatures of PE-covered and uncovered soil at several depths

Time duration (days)	Soil depth (cm)					
	Covered			Uncovered		
	5	10	15	5	10	15
	Mean Maximum Temperatures (°C)					
			1985			
10	49.0	43.7	37.6	35.1	30.5	29.6
20	51.1	45.6	39.4	36.5	31.2	30.1
40	50.8	46.0	40.0	36.5	31.0	29.7
			1986			
30	44.5	41.2	39.7	35.0	33.3	30.0
40	44.5	41.5	39.9	36.2	34.3	30.4

At 15cm soil depth mean maximum temperature in both years reached 40°C. In the uncovered plots the mean maximum temperatures at 5 and 15cm depth reached about 36°C and 30°C in 1985 and 1986 respectively. Temperatures above 40°C lasted for around 13h a day at the 5cm depth, 14h at the 10cm depth, and 8h at the 15cm depth.

Nematodes up to 15cm depth were completely controlled with 40 days solarization in 1985 (Table 2). In 1986 the infestation level of the nematodes in the field was up to 7times higher than in 1985. Depending on the genus, they were reduced by 83 to 100% after 40 days solar heating (Table 3).

Table 2. Effect of different soil solarization periods on the number of nematodes occurring in the soil in December 1985.

Days of solarization	Nematodes/500cm^3 soil			
	Helicotylenchus spp.	*Pratylenchus thornei*	*Tylenchorhynchus* spp.	*Tylenchus* spp.
0	270 a	270 a	36 a	54 a
10	32 b	0 b	0 b	0 b
20	32 b	0 b	0 b	16 ab
40	0 c	0 b	0 b	0 b

Means in a column followed by the same letter are not significantly different at P = 0.05.

Table 3. Effect of different soil solarization periods on the number of nematodes occuring in the soil in December 1986.

Days of solarization	Nematodes/500 cm^3 soil				
	Helicotylenchus spp.	*H.ciceri*	*P.thornei*	*Tylenchorhynchus* spp.	*Tylenchus* spp.
0	885 a	16 a	481 a	278 a	170 a
30	15 b	0 b	15 b	16 b	0 b
40	98 b	0 b	30 b	0 b	29 b

Means in a column followed by the same letter are not significantly different at P = 0.05.

The root lesion nematode *P. thornei* on faba bean was controlled by 98% after 20 days of solarization in 1985 and by 100% after 30 and 40 days of solar heating in 1986 (Table 4).

Table 4. Influence of soil solarization on *Pratylenchus thornei* on faba bean at flowering stage

Duration of solarization (days)	Nematodes/10g roots	
	1985	1986
0	166.0 a	18 a
10	16.5 b	—
20	3.8 bc	—
30	—	0 b
40	0.3 c	0 b

Means in a column followed by the same letter are not significantly different at P = 0.05.

In the field solarized in 1985, which was sown again with faba bean in October 1986, despite the good control obtained the first year no residual effect of solarization on *P. thornei* was observed in 1986, since the nematode was able to re-establish its population. An average of 106 and 83 nematodes/10g roots were recovered in march from plants grown in the nonsolarized and solarized plots for 40 days, respectively.

Seed and straw yield of faba bean increased significantly with increasing duration of solarization (Table 5). Because of the tremendous infestation of the crop by broomrape (*Orobanche crenata* Forsk.) yield data could not be related to nematode infestation alone.

Table 5. Effect of soil solarization on yield of faba bean (ILB 1814)

Days of solarization	Faba bean	
	Seed yield (t/ha)	Straw yield (t/ha)
	1985/86	
0	0.74 a	1.49 a
10	0.99 a	1.76 ab
20	1.54 b	1.99 b
40	1.70 b	1.83 b
	1986/87	
0	0.60 a	1.74 a
30	0.97 a	3.58 b
40	2.04 b	5.91 c

Means in a column followed by the same letter are not significantly different at P = 0.05.

Discussion

The present trials demonstrated the efficacy of soil solarization in controlling nematodes under the condition of northern Syria. The population density of the phytoparasitic nematode *P. thornei* in faba bean roots, was significantly reduced throughout the first growing season and therefore, confirms the results reported from Grinstein et al. 1979. In the second season, sixteen months after solarization treatment, this nematode had re-established quite well. The long-term effect of solarization on nematode control for a second or even the third crop has not been sufficiently studied. Re-colonization studies concentrated so far only on the first crop after solar heating (Grinstein et al., 1979, Siti et al. 1982, Stapleton & DeVay, 1983). The possible long-term effect of soil solarization on nematode control and subsequently on yield increase is of economic importance. Yet using soil solarization for controlling nematodes only may not be economically feasible in countries such as Syria. However, since several pests and diseases may concomitantly occur in the soil of the same field, soil solarization has the advantage of being simple, non-hazardous, besides controlling a wide range of soil-borne pests and diseases.

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الملخص

ساوربون، ج، موهان ساكسينا، وحسن مصري. 1990. مكافحة الديدان الثعبانية التي تصيب الفول في سورية بوساطة تعقيم التربة بالطاقة الشمسية. مجلة وقاية النبات العربية 8 (1): 40 - 38.

تمّ في شمالي سورية، دراسة أثر طول مدة تعقيم التربة بالطاقة الشمسية في مكافحة الديدان الثعبانية الطفيلية التي تصيب محصول الفول وهي: *Helicotylenchus* spp.، *Tylen-chorhynchus* spp.، *Tylenchus* spp.، *Heterodera ciceri* و *Pratylenchus thornei*. وقد وصلت درجة حرارة التربة، المغطاة برقائق بلاستيكية، على عمق 5 سم 55°م في عام 1985 و 48°م في عام 1986، بينما كانت أعلى درجة حرارة للتربة غير المغطاة 40°م، في كلا العامين. وقد انخفضت كثافة مجتمعات تلك الديدان، نتيجة تعقيم التربة بالطاقة الشمسية، بمعدّل 83 - 100% وذلك تبعاً للجنس والعام. وتمكنت *P.thornei* من إعادة كثافة مجتمعها خلال عام واحد.

كلمات مفتاحية: نيماتودا، تعقيم التربة بالطاقة الشمسية، سوريا.

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