Nematol. medit. (1984), *12*: 53-64.

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NEMATODE PROBLEMS OF THE MEDITERRANEAN COASTAL STRIPE IN THE SYRIAN ARAB REPUBLIC

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Records of plant parasitic nematodes in Syria are scarse and scanty. Mamluk and Faust (1975) reported the occurrence of root-knot nematodes such as *Meloidogyne arenaria* (Neal) Chitwood, *M. incognita* (Kofoid *et* White) Chitwood and *M. javanica* (Treub) Chitwood in association with cotton and sugarbeet in various districts, and Tayar (1980) claims that losses in yield of tobacco are caused by *M. javanica* and that seed treatments with aldoxycarb would control infestations by *M. incognita* in cotton. The stem nematode, *Ditylenchus dipsaci* (Kuehn) Filipjev, was found to severely infest broadbean fields on the Mediterranean coast (Hanounik and Sikora, 1980).

A survey of plant parasitic nematodes was carried out in the period December 1981 - January 1983 on the Mediterranean coastal stripe. Control trials of the root-knot nematodes on tomato and cucumber were also conducted in the greenhouses of the F.A.O. project at Lattakia (Al-Hannadi) and Tartous (Amrit). The results of these investigations are here reported.

a) *Survey*

Materials and methods

Over one hundred samples were collected in different seasons from 70 locations. The samples consisted of soil, roots and, when

possible, stem and leaves. Each soil sample consisted of about 1 kg collected in the rhizosphere from different areas in the same field or orchard and kept in plastic bags. Nematodes were extracted by the Cobb wet sieve technique. After extraction the nematodes were fixed in 5% hot formalin. Aliquots of 2-3 g of roots were stained in boiling lactophenol acid fuchsin and clarified 24 hrs in clear lactophenol to detect the presence of endoparasitic nematodes which were then dissected from the roots.

Comminuted stems and leaves, usually about 5 g, were incubated in Petri dishes for 24 hrs.

Results and comments

Ditylenchus dipsaci was found in the stems of wheat at Sadcop and of broadbean plants at Drokeat.

From investigations made by the International Center for Agricultural Research in the Dry Areas (ICARDA), the stem nematode is considered to be widespread in broadbean fields in the coastal region, where it causes considerable damage (Hanounik and Sikora, 1980).

The spiral nematode, *Helicotylenchus dihystera* (Cobb) Sher, was the most widespread of the plant parasitic species, being found in the rhizosphere of various plants such as broadbean at Amrit and Drokeat, citrus at Borj-El-Kassab, Bussnada, Alawamie, Tartous, Doher Ed Diz and Zagren, cypress at Al-Hannadi, fig at Al-Hannadi, El Kangera and Addra, grapevine at Shrashir and Drokeat, mulberry at Boka, Arbrivir and Kandel, oat at Tartous, olive at Fidio, Kerssana, Banias, Masbah, Lattakia, Chamicea and Ballaron, onion at El Khrab and Joziyé, plum at Kangra, potato at Joziyé, and wheat at Karsana.

Large numbers of the nematode were recorded in the rhizosphere of woody host plants. Their effect on the growth and yield of these trees should be investigated.

Helicotylenchus dihystera is pathogenic on olive in Egypt (Diab and El Eraki, 1968) and in Italy (Vovlas and Inserra, 1981). Many specimens of *H. varicaudatus* Yuen were found in the rhizosphere of almond trees at Jablé.

Three species of root-knot nematodes were found in association with vegetable and flower crops. *Meloidogyne javanica* was the most common and was found on the roots of carnation in glasshouses at Boka, on cucumber in glasshouses at Al-Hannadi and Amrit and on

out-door tomatoes at Alsin and El Annabie and in glasshouses at Al-Hannadi. The species was detected also in a carnation glasshouse at Ghouta, Damascus. *Meloidogyne incognita* was found on the roots of cucumber plants in glasshouses at Chkhaab and Amrit and on out-door tomatoes at Shannkì. Galled roots of a mulberry tree at Arbrivir were shown to be infested by this species. *Meloidogyne arenaria* was found only once, and in association with *M. javanica*, at El-Hannadi in a glasshouse of tomatoes. Whenever *Meloidogyne* infestations were detected, the crops were patchy in appearance and plants were stunted; yields were low, indicating that these nematodes were affecting the crops.

Two species of lesion nematodes, namely *Pratylenchus neglectus* (Rensch) Filipjev *et* Schuur. Stekh. and *P. pratensis* (de Man) Filipjev were found in soil samples collected in a declining citrus grove at Daher Ed Diz. However, they are unlikely to be the cause of the stunting observed as nematodes were not detected in the roots examined.

The citrus nematode, *Tylenchulus semipenetrans* Cobb was consistently present in most of the citrus groves sampled. Females of the nematode were observed in large numbers (1500/g root) on the roots of declining orange trees at Bozjel Kassab. Juveniles of *T. semipenetrans* were also found in soil collected from the rhizosphere of Carrizo citrange and sour orange in nurseries at Al-Hannadi and Tartous, and in other citrus groves at Al-Hannadi, Alawamie, Al Ahraphie, Amrit, Daher Ed Diz and Zagren, and in olive groves at Fidio and Kerssana. This nematode was not detected in soil and root samples from the Government nursery at Amrit.

The distribution of the citrus nematode is worldwide and coincides with citriculture although the extent of losses differ (Siddiqi, 1974). It is also a pathogen of olive (Lamberti and Baines, 1970; Lamberti *et al.*, 1976) and of other crops such as persimon and grapevine (Lamberti *et al.*, 1976). Its role in citrus decline in Syria therefore should be investigated.

Xiphinema pachtaicum (Tulaganov) Kirjanova was the most common of the three species of *Xiphinema* found during the survey. It was found in the rhizosphere of almond at Jablé, apricot at Fidio, Australian pine at Amrit, citrus at Al-Hannadi, Bussnada, Al Ahraphie and Amrit, cypress at Fidio, fig at Fidio, El Kangera and Addra, grapevine at Shrashir, Shannki and Drokeat, mulberry at Boka, Arbrivir and Kandel, olive at Fidio, Kerssana, Alawamie, Shannki, Masbah and Chamicea and plum at Kangra.

Xiphinema pachtaicum is a widely distributed species in the Mediterranean region (Lamberti, 1981), but in spite of this, almost nothing is known about its role as a plant pathogen.

Xiphinema italiae Meyl was found in the rhizosphere of Australian pine and broadbeans at Amrit, citrus at Daher Ed Diz, olive at Shannki, and pomegranate at El Montar. It is interesting to note that the highest population densities of this nematode were observed in light dry soils.

Xiphinema italiae has been shown experimentally to transmit the grapevine fanleaf virus in Israel (Cohn *et al.*, 1970). Its role as a plant pathogen is, however, still unknown.

Xiphinema index Thorne *et* Allen, the natural vector of grapevine fanleaf virus, was found in the rhizosphere of fig trees at El Kangera and grapevines at Shrashir. It is likely to occur in most of the grapevine growing districts and thus merits investigation.

b) *Control trials*

Materials and methods

Nine trials for the chemical control of root-knot nematodes were carried out in the period January 1982 - March 1983.

Two unheated plastic houses infested with *Meloidogyne javanica* were selected on January 1982 at each of the two locations of the Integrated Agricultural Project: Al-Hannadi (Lattakia) and Amrit (Tartous). The plastic houses were located on sandy soil and each was divided into 20 plots, distributed at random in five blocks (replicates). A space of 0.5 m was left between plots, and 1.10 m between the plots and the walls of the plastic house. Three treatments were compared with an untreated control: methyl bromide (98% of methyl bromide + 2% of chloropicrin) applied under tarp at the rate of 100 g/m^2 and carbofuran (granules at 10% of active ingredient) at the rate of either 80 or 120 g of commercial formulation per square metre. The plastic tarp was removed from the methyl bromide treated plots two days after treatment, done two weeks before transplanting. Carbofuran was broadcast incorporated into the 10 top cm of the soil the day before transplanting. Each plot measured 5.80 $\times$ 2.30 m at Al-Hannadi and 8 $\times$ 2.40 m at Amrit. At Al-Hannadi cucumber cv. Byblos was planted on 28 February 1982; each plot with

30 six week old seedlings/plot spaced at 40 cm in the row and 80 cm between rows; tomato cv. Castle was planted on 13 March 1982 with 36 two month old seedlings/plot spaced at 30 cm in the row and 80 cm between rows. At Amrit cucumber cv. Byblos was planted on 22 February 1982 with 40 five week old seedlings/plot, spaced at 40 cm in the row and 100 cm between rows and tomato cv. Viresto on 15 February 1982 with 40 six week old seedlings/plot spaced at 40 × 100 cm.

Another experiment was carried out at Amrit in the period September-December 1982 to determine the most economical dose of methyl bromide on cucumber cv. CMR-MMR against *M. javanica*. The chemical was applied, under plastic tarp, at the rate of 0, 30, 60 and 90 g/m^2 10 days before transplanting. Four weeks old seedlings were transplanted on 16 September 1982, in plots 6 × 3.80 m each, spaced 40 × 100 cm. Each treatment was replicated four times.

Four other plastic-houses were treated in September 1982; again two at Al-Hannadi and two at Amrit. The nematicides listed in Table I were compared for the control of *M. javanica*. Plot size in both

Table I - *Soil treatments for the control of root-knot nematodes.*

Commercial product	Rate of application g or ml/m^2	% of active ingredient	Formulation	Time and method of application
Bromo-o-Gas	104	98 methyl bromide+ 2 chloropicrin	liquid fumig.	10 days before transplanting broadcast, under tarp.
Di-Trapex	40	80 1.3 dichloropropene 1.2 dichloropropane+20 methyl isothiocianate	» »	3 weeks before transplanting broadcast by injector gun.
Furadan	12	10 Carbofuran	granular	3 days before transplanting broadcast incorporated in the 10 top cm.
Mocap	12	10 Prophos	»	»
Nemacur	50	5 Phenamiphos	»	»
Temik	8	10 Aldicarb	»	»
Vydate	0.25	25 Oxamyl	liquid	diluted in 10 ml of water, broadcast by injector gun.

localities was 4 × 2.30 m and plants were spaced at 40 × 80 cm, and each treatment was replicated four times. At Al-Hannadi one plastic house was planted on 22 September 1982 with tomato cv. Tropic, and the other on 26 September 1982 with cucumber cv. Byblos. At Amrit, both houses were planted on 25 September 1982, one with tomato cv. Carmello and the other with cucumber cv. Lolita.

Throughout the experiment all the plots received the normal cultural practices, such as chemical fertilization, irrigation, pruning and fungicide and insecticide treatments.

The effects of the nematicidal treatments were evaluated by measuring the growth of the plants at different intervals, and recording yields. At the end of the experiment, the root systems of five plants from the centre of each plot were examined for the degree of galling, which was graded on a scale 0 to 5, with 0 representing no galling and 5 severe galling (Lamberti, 1971). All data were analyzed by Duncan's multiple range test.

Results and comments

There were no statistical differences between the heights of plants in the cucumber plastic house at Al-Hannadi in crops grown from February-June 1982 (Table II). Methyl bromide was the only treatment that significantly reduced galling on the root system and increased yield (Table II). In the plastic house cropped with tomato at Al-Hannadi

Table II - *Effect of nematicidal treatments on cucumber cv. Byblos at Al-Hannadi, February-June 1982.*

Treatment	Plant height (cm)		Yield	Degree of galling average of 10 plants plot
	15/3/82	30/3/82	kg/plot	
Methyl bromide	39 a	56 a	111.6 a	1.6 a
Carbofuran 8 g/m²	37 a	54 a	80.4 b	2.2 b
Carbofuran 12 g/m²	36 a	54 a	83.1 b	2.4 b
Control	34 a	49 a	69.9 b	2.4 b

N.B.: Numbers with the same letter in any column are not statistically different (P = 0.05).

from March-July 1982, nematicidal treatment did not differ significantly from the untreated control. This was probably due to the low level of nematode infestation. In fact, at the end of the experiment only two plants were found to be moderately galled in this plant house.

The application of nematicides was uneffective also in both plastic houses cropped with either cucumber cv. Byblos or tomato cv. Viresto at Amrit, in the period February-July 1982. Root galling was moderate, although generalized on cucumber roots, but there was no evidence of nematode attack on tomato, indicating that the cultivar grown is probably resistant.

The highest yield in the plastic house treated with different rates of methyl bromide and cropped with cucumber cv. CMR-MMR at Amrit in the period September-December 1982, was obtained in the plots that had received the lowest dose (30 g/m^2) of the chemical (Table III). However, the differences were not statistically different because of the high variability of the data. Treatments had no effect on plant height within three weeks from planting. The degree of galling was nil in the plots treated with the highest dose of the fumigant (90 g/m^2), insignificant (0.5) in those treated with the intermediate dose (60 g/m^2) and moderate, but not different from the control plants, in those treated at the lowest rate.

There were no significant differences in the average heights of plants grown in soil treated with various nematicides in the plastic house cropped with cucumber cv. Byblos in the period September-December 1982 at Al-Hannadi. The best yield in this experiment was

Table III - *Effect of different rates of application of methyl bromide on cucumber cv. CMR-MMR at Amrit, September-December 1982.*

Treatment	Plant height (cm) 3/10/82	Yield kg/plot	Degree of galling avcrage af 50 plants/plot
Methyl bromide 30 g/m^2	118 a	153 a	2.0 a
Methyl bromide 60 g/m^2	117 a	134 a	0.5 b
Methyl bromide 90 g/m^2	119 a	138 a	0.0 c
Control	118 a	121 a	2.1 a

N.B.: Numbers with the same letter in any column are not statistically different (P = 0.05).

Table IV - *Effect of nematicidal treatments on yield of cucumber cv. Byblos at Al-Hannadi, September-December 1982.*

Treatment	Yield kg/plot	% difference with respect to the control
Methyl bromide	21.8a	+ 67
Di-Trapex	20.1 ab	+ 54
Prophos	16.8 bc	+ 28
Oxamyl	15.4 c	+ 18
Carbofuran	15.0 c	+ 15
Aldicarb	13.9 c	+ 6
Control	13.0 c	—
Phenamiphos	12.7 c	— 3

N.B.: Numbers with the same letter in any column are not statistically different (P = 0.05).

Table V - *Effect of nematicidal treatments on growth in height of tomato cv. Tropic at Al-Hannadi, September-November 1982.*

Treatment	Plant height (cm)			
	7/10/82	22/10/82	3/11/82	24/11/82
Di-Trapex	50 a	83 a	100 a	124 a
Aldicarb	50 a	81 a	102 a	123 ab
Methyl bromide	50 a	83 a	99 a	121 abc
Oxamyl	50 a	81 a	95 a	116 bcd
Carbofuran	50 a	77 a	94 a	113 d
Phenamiphos	49 a	84 a	96 a	120 abcd
Prophos	41 b	72 a	91 a	115 cd
Control	41 b	78 a	96 a	119 abcd

N.B.: Numbers with the same letter in any column are not statistically different (P = 0.05).

obtained from the plots treated with either methyl bromide or Di-Trapex (Table IV). The degree of galling on the root systems was not determined.

Most of the chemicals positively affected the growth of the tomato plants cv. Tropic, in the experiment started at Al-Hannadi in September 1982 (Table V). This influence was apparent two weeks after planting but was not statistically significant with respect to the control when recorded later. Unfortunately the experiment had to be prematurely terminated in late January 1983, and thus no records of yields and degree of galling on the root systems were obtained.

No effect of nematicidal treaments was recorded in the experiments carried out from September 1982 to January 1983 on cucumber cv. Lolita, and from September 1982 to February 1983 on tomato cv. Carmello, at Amrit. However, there was no galling of the root systems of both crops grown in either treated or control plots. Tomato « Carmello » is known to be a cultivar resistant to *Meloidogyne* species.

Conclusions

It appears from this preliminary survey that most nematode pests present in the Mediterranean Region are also widespread in Syria. Further investigations should be carried out to determine their geographical distribution in the country and the frequency of the species of major economic importance.

Plant species attacked by *D. dipsaci* and biological races of the nematode should be determined to plan appropriate rotations that would restrict nematode populations to non pathogenic levels. The efficient control of the weeds, many of which may be hosts for the parasite, should not be overlooked.

Helicotylenchus dihystera is often associated with olive roots. Its role in some cases of decline observed should be studied to evaluate the possibility of obtaining economic increases in yield by application of nematicides.

Lesion nematodes, *Pratylenchus* species, were rarely found. However, their importance should not be overlooked and extensive surveys on fruit, leguminous and cereal crops might indicate that they are a limiting factor in their production.

The citrus nematode, *T. semipenetrans*, was found consistently

in declining citrus groves. Nevertheless, it would be unrealistic to consider this parasite to be the only cause of this syndrome. Therefore, multidisciplinary studies should be carried out to determine the presence of other pathogens, such as viruses and fungi, or the effect of environmental factors.

Species of *Xiphinema*, vectors or potential vectors of plant viruses, were also found during the survey. This investigation should be extended in future years, attempting to correlate the occurrence of virus disease with presence of longidorid and trichodorid nematodes in the rhizosphere of affected plants.

Infestations of *Meloidogyne* species undoubtedly constitute the most important nematode problem in the country. Much work must be done to determine the species and the distribution of races. The results will enable the planning of appropriate rotations and the introduction of suitable resistant cultivars. However, chemical control is the most feasible practice presently available for plastic houses.

Methyl bromide is one of the most used chemicals and it is frequently applied at rates exceeding 100 g/m^2. Doses in the range of 50 to 60 g/m^2 seem to provide satisfactory control of nematodes and to give economic increases of yields. Inorganic bromine accumulated in the soil after methyl bromide treatments is usually toxic to carnation but this can be removed by irrigation (1000 m^3/ha) before planting (Basile and Lamberti, 1977). Bromine residues are also accumulated in edible parts of plants grown in treated soils, but residues usually exceed the EPA (Environmental Protection Agency) limits only in fruits of tomato, eggplant and zucchini, and not in string bean, cucumber and pepper (Basile and Lamberti, 1981 and 1982). Therefore, these latter species could be the first to be grown immediately after a treatment done in August-September, in soil which in winter will be planted with tomato or eggplant without any further application of methyl bromide.

The author is greatly indebted to all those who assisted him in the implementation of his work by providing information, advice and facilities. Special thanks are due to Mr. J. J. Classens, Dr. N. Abdul-Hadi, Eng. M. Meyoub, Eng. Ana Zidan, Eng. Zalfa Nizam and Eng. Amal Husseidan with whom the author worked during his visits to Syria. The assistance of Mr. A. Hamersley (F.A.O. Project Coordinator), Dr. M. R. Kambar and of Dr. A. El-Kader Arabi of the Ministry of Agriculture and Agrarian Reform is also gratefully acknowledged.

Mrs. A. Agostinelli and Mr. F. Zacheo, of the Istituto di Nematologia agraria, C.N.R., Bari, Italy are thanked for their assistance in mounting and measuring the nematodes and in the statistical analysis of the data, respectively.

SUMMARY

A preliminary survey of plant parasitic nematodes was carried out in the period December 1981 - January 1983 on the Mediterranean coastal stripe in the Syrian Arab Republic. The results indicate that most nematode pests present in the Mediterranean Region are also widespread in Syria. Species of the genera *Ditylenchus, Helicotylenchus, Meloidogyne, Pratylenchus, Tylenchulus* and *Xiphinema* were found on the root or in soil samples collected from the rhizosphere of various crops. In control trials of the root-knot nematodes methyl bromide, at the rates of 50 to 60 g/m^2, gave satisfactory control of nematodes and economic yield increases of cucumbers. Application of fumigant and non volatile nematicides, in plastic houses, planted with either cucumbers or tomatoes did not affect statistically growth and yields because of the uneven infestations.

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Accepted for publication on 28 September 1983.