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NEMATODES OF COOL-SEASON FOOD LEGUMES IN NORTH AFRICA

by

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Summary. Preliminary surveys undertaken in Morocco, Algeria and Tunisia during 1988 to 1990, revealed the presence of several nematode species associated with chickpea, faba bean, lentil, and pea. Root-lesion nematodes were the most widespread nematodes on all crops. *Pratylenchus thornei*, *P. penetrans*, and *P. mediterraneus* though occurred in all countries, were dominant in Morocco, Algeria, and Tunisia, respectively, and were suspected to be responsible for the decline of legume crops. *P. crenatus* and *P. neglectus* were also present in Algeria, but *Pratylenchoides leiocauda* was most widespread in Algeria and *P. ritteri* was found in two chickpea samples in Tunisia. *Zygotylenchus guevarai* was present in few samples in all countries. *Heterodera goettingiana* was detected in all countries, but only in a few samples of faba bean and pea it was in large numbers. Nematode specimens, mostly juveniles, were also found in the roots of chickpea, but severe damage was observed only on faba bean and pea. *Meloidogyne artiellia* was also present in all countries, but symptoms of the nematode attack were evident only on chickpea, especially in Morocco. All stem and leaf samples of faba bean contained many *Ditylenchus dipsaci* specimens which were often associated with severe tissue necrosis and distortions. Other nematodes, found in the soil, but never associated with crop decline, were species of *Helicotylenchus*, *Hoplolaimus*, *Paratylenchus*, *Rotylenchus*, *Rotylenchulus*, *Tylenchus* and *Tylenchorhynchus*. *Paralongidorus* sp., *Trophurus* sp., and *Xiphinema pachtaicum* were each found only in one sample.

Nematodes cause severe damage to food legumes in many countries (Greco, 1985; Greco and Di Vito, 1988; Greco and Sharma, 1990; Sikora and Greco, 1990). Among them *Heterodera goettingiana* Liebscher is highly damaging to pea (*Pisum sativum* L.) and faba bean (*Vicia faba* L.) in almost all Mediterranean countries (Di Vito and Greco, 1986). Information on nematodes infecting chickpea (*Cicer arietinum* L.) and lentil (*Lens culinaris* Medic.) is limited. The root-knot nematode (*Meloidogyne artiellia* Franklin) infects chickpea in Italy, Spain and Syria (Di Vito and Greco, 1988a), while the chickpea cyst nematode, *H. ciceri* Vovlas, Greco *et* Di Vito, has been reported on chickpea and lentil only in Syria (Vovlas *et al.*, 1985). This nematodes occur along with the root-lesion nematodes, mostly *Pratylenchus thornei* Sher *et* Allen, but also with *P. mediterraneus* Corbett, and *Pratylenchoides alkani* Yuksel. Other nematodes are of minor importance (Greco *et al.*, 1984; 1992). However, little is known about nematodes of food legumes in North Africa. Therefore surveys were conducted during 1988 to 1990 to identify the nematodes associated with these crops in Morocco, Algeria, and Tunisia and to serve as a basis for future investigations aiming at elucidating the role that these pathogens play in the legume production in these countries.

Materials and methods

The surveys were undertaken in the major chickpea, faba bean, and lentil areas of Morocco in 1988, Algeria in 1989, and Tunisia in 1990 during April and May when these crops were actively growing and nematodes were supposed to be in large numbers. Two samples were also collected in pea crops. A 2 kg soil sample was collected from the rhizosphere of 4-5 plants in each sampled field. However, soil samples were not collected in Algeria because of lack of facilities for extracting nematodes. Root samples were collected from the same sites. Faba bean shoot samples were also collected.

Samples were collected preferably in fields showing crop yellowing and stunting and at regular distances between samples where no symptoms were evident.

Nematodes were extracted from 500 cm³ soil using the Cobb's wet sieving and Baermann's funnel method, fixed in 5% hot formalin and counted. Roots were incubated in jars (Young, 1954) to extract endoparasitic migratory nematodes which were then preserved in 5% formalin. Endoparasitic sedentary and remaining migratory nematodes were extracted later using the Coolen's method (1979). Nematodes from aerial plant parts were extracted using

the incubation method; they were then counted and about 20 specimens per sample and species were mounted in lactophenol. Perineal patterns of females of *Meloidogyne* spp. and of cysts of *Heterodera* spp. were also prepared. Slides were then examined microscopically for species identification. The key proposed by Handoo and Golden (1989) was used to identify *Pratylenchus* spp., and that of Sher (1970) for *Pratylenchoidea* spp. However, since soil analysis adds little to information acquired from root and shoot analysis, only data of nematodes found in plants are presented here.

Results

MOROCCO

A total of 59 soil and root samples including 58 in chickpea and 1 in a faba bean fields were collected. Aerial plant part samples were collected from four faba bean fields. The sampled area was located between Rabat and Safi on the Atlantic coast and between Settata and Fes in continental Morocco (Table I; Fig. 1).

Cyst nematodes: *H. goettingiana* was the only cyst nematode species found in Morocco. It was detected from

TABLE I - *Nematodes in root samples collected in Morocco in 1988.*

Location	Crop	Total samples collected	Infested samples (1)						
			H.	M.	Pm.	Pp.	Pt.	Pz.	Zg.
1 Sidi Slimane	Chickpea	1							1
2 Zerara	"	1							1
3 Kacem	"	1							1
4 Zagota	"	4	1				4		
5 Beni Ammar	"	1					1		
6 Fes	"	3	2	1					3
7 Meknes	"	2							1
8 Khemisset	"	1							1
9 Maaziz	"	1				1			
10 Rabat	"	1							1
11 Merchouch	"	3					3		
12 Rammani	"	2							2
13 Ben Slimane	"	5					5		
14 Benahemed	Faba bean	1					1		
15 Settata	Chickpea	4		1			4		
16 Oulad Said	"	1					1		
17 Jemaa	"	1					1		
18 Birjdid	"	3				3			
19 Dar Bouazza	"	2							2
20 El Jorf-Lesfar	"	2			1		1		
21 Azennour	"	1					1		
22 El Jadida	"	3					3		
23 Sidi Bennour	"	1					1		
24 Sept Maarif	"	4		1		3	1		1
25 Sidi Boughedra	"	1					1		
26 Safi	"	3		2			3		
27 Had Harrara	"	2	1				2		
28 Jamat Shaim	"	2			2				
29 Khémis Zémanra	"	3					3		
Total		59	4	5	3	7	36	13	2
Percentage			7	8	5	12	61	22	3

(1) H. = *Heterodera goettingiana*; M. = *Meloidogyne artiellia*; Pm. = *Pratylenchus mediterraneus*; Pp. = *Pratylenchus penetrans*; Pt. = *Pratylenchus thornei*; Pz. = *Pratylenchus zaeae*; and Zg. = *Zygotylenchus guevarai*.

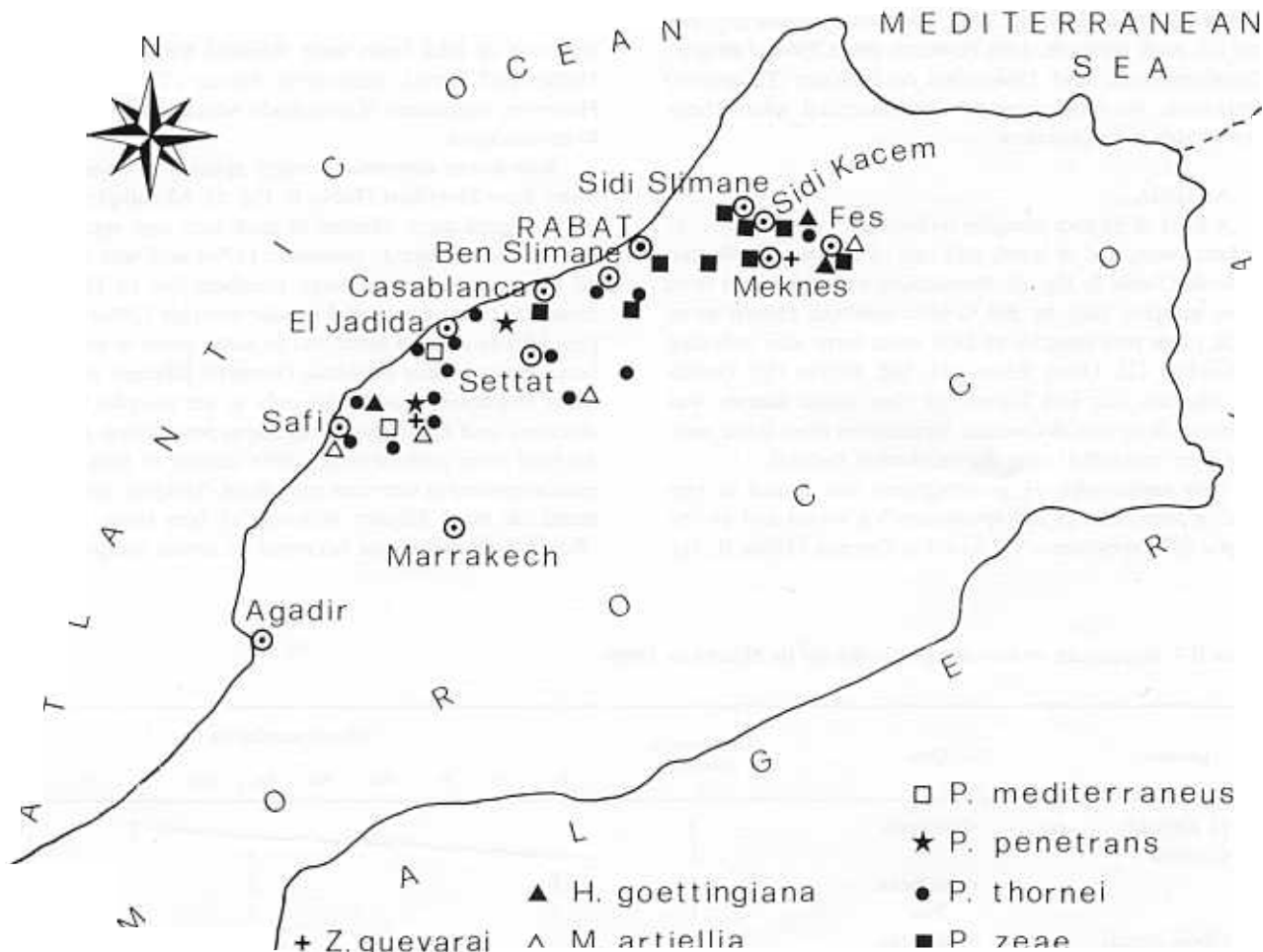


Fig. - Distribution of endoparasitic nematodes in chickpea and faba bean crops in Morocco from root observations made in 1988.

four samples of chickpea collected at Had Harrara (1), Zagota (1), and Fes (2) (Table I). In these sites, infested plants did not show symptoms of nematode attack and only a few adult nematodes were present in the roots.

Root-knot nematodes: only *M. artiellia* was detected. It was found only in roots of chickpea in five samples (8%) at Fes (1), Settat (1), Sept Maarif (1), and Safi (2) (Table I). Symptoms of nematode attack (yellowing and stunting) were obvious in all infested fields and especially at Safi.

Root-lesion nematodes: all root samples of chickpea and faba bean were infested with root-lesion nematodes. Infestation was often severe; roots were largely or completely necrotized and shoots showed poor growth and yellowing. Generally one species of root-lesion nematode per sample was observed, but combined infestation of these with cyst and root-knot nematodes was also fre-

quent. The most common species recovered was *P. thornei* (61%) (Table I) on both chickpea and faba bean. Up to 12,000 *P. thornei* specimens/5 g roots were present in several root samples, such as those from Merchouch. Specimens resembling *P. zeae* Graham were observed in 13 root samples (22%) of both crops. Less frequent were *P. penetrans* (Cobb) Filipijev et Schuurmans Stekhoven (12%), *P. mediterraneus* (5%) and *Zygotylenchus guevarai* (Tobar Jimenez) Brawn et Loof (2%), all in roots of chickpea (Table I; Fig. 1).

Stem and bulb nematode: *Ditylenchus dipsaci* (Khuen) Filipijev was extracted from all faba bean aerial plant part samples. In two fields at Birjdid, one at Benahemed, and one at Jamat Shaim symptoms of nematode attack (leaf and stem necrosis and stem and pod distortions) were very evident and damage was severe.

Other nematodes: analysis of soil samples also revealed the presence of several other plant parasitic nematodes with *Helicotylenchus* spp. and *Tylenchorhynchus* spp. being the most frequent. Less common were *Tylenchus* spp., *Tropburus* spp., and *Xiphinema pachtaicum* (Tulaganov) Kirjanova. No crop damage was observed when these nematodes were prevalent.

ALGERIA

A total of 32 root samples including 15 of chickpea, 11 of faba bean, five of lentil, and one of pea were collected in fields (Table II; Fig. 2). Nematodes were extracted from these samples only by the Coolen method. Eleven more aerial plant part samples of faba bean were also collected at Guelma (1), Oued Zenati (1), Sidi Dahon (1), Tessala (2), Mascara (2), and Tiared (3). One shoot sample was collected from pea at Guelma. Nematodes from these samples were extracted using the incubation method.

Cyst nematodes: *H. goettingiana* was found in one field of faba bean (1,225 specimens/5 g roots) and in one of pea (620 specimens/5 g roots) at Guelma (Table II; Fig.

2), in both of which plants were showing severe symptoms of nematode attack.

Root-knot nematodes: two root samples of chickpea and one of faba bean were infested with *M. artiellia* at Hattab and Tiared, north-west Algeria (Table II; Fig. 2). However, symptoms of nematode attack were evident only on chickpea.

Root-lesion nematodes: eight species of these nematodes were identified (Table II; Fig. 2). All samples collected in Algeria were infested at least with one species. The most common was *P. penetrans* (47%) and was found on all four crops often in large numbers (up to 11,000/5 g roots). *P. thornei* occurred in nine samples (28%) of chickpea, faba bean, and lentil and in some cases in large numbers. *Pratylenchus neglectus* (Rensch) Filipijev et Schuurmans Stekhoven was found only in six samples (19%) of chickpea and faba bean. Specimens resembling *P. crenatus* Loof were present in one root sample of faba bean, *P. mediterraneus* in one root sample of chickpea, and *P. pratensis* (de Man) Filipijev in a root of faba bean. *Pratylenchoides leiocauda* Sher occurred in seven samples (22%)

TABLE II - Nematodes in root samples collected in Algeria in 1989.

Location	Crop	Total samples collected	Infested samples (1)											
			H.	M.	Pc.	Pm.	Pn.	Pp.	Ppr.	Pt.	Pr.	Zg.		
1 El Arrouch	Chickpea	2				1						1	1	1
2 Guelma	"	1								1				
	Faba bean	1	1							1				
	Pea	1	1							1				
3 Oued Zenati	Faba bean	1								1				
4 Ben Ammidan	Chickpea	1								1				
5 Mila	"	1								1				
6 Khroub	"	1								1				
7 Sidi Dahon	"	1							1					
	Faba bean	2			1			2		1				1
8 Aghal	Chickpea	2								2				
9 Sidi Bel Abbes	Faba bean	1								1				1
10 Tessala	Chickpea	2										1	2	
	Faba bean	1										1		
11 Mascara	"	2										2	1	
12 Tiared	Chickpea	2		1				1	1			1		
	Faba bean	3		1				1	1	1		1		
	Lentil	5						1	1			2	1	
13 Hattab	Chickpea	2		1						1				1
	Total	32	2	3	1	1	6	15	1	9	7	2		
	Percentage		6	8	3	3	19	47	3	28	22	6		

(1) H. = *Heterodera goettingiana*, M. = *Meloidogyne artiellia*, Pc. = *Pratylenchus crenatus*, Pm. = *Pratylenchus mediterraneus*, Pn. = *Pratylenchus neglectus*, Pp. = *Pratylenchus penetrans*, Ppr. = *Pratylenchus pratensis*, Pt. = *Pratylenchus thornei*, Pr. = *Pratylenchoides leiocauda*, and Zg. = *Zygotylenchus guevarai*.

of chickpea, faba bean, and lentil. Finally, *Z. guevarai* was found only in one faba bean root sample (Table II; Fig. 2).

Stem and bulb nematodes: all aerial plant part samples of faba bean and pea were infested with *D. dipsaci*. Severe damage in faba bean was observed at Guelma, Mascara and Tiared, where the largest number of nematodes were extracted.

TUNISIA

The survey was conducted in ten locations (Table III; Fig. 3) in north Tunisia. Thirty root and soil samples were

collected in fields planted to chickpea (22), faba bean (5), lentil (2), and pea (1). Aerial plant samples were collected in other 18 faba bean fields at Mateur (5), Oued Meliz (2), Beja (4), Oum Donil (1), Menzel Temine (1), Fermaia (3), Tabarka (1), and Nefza (1).

Cyst nematodes: specimens of cyst nematodes were extracted from roots of faba bean (1), chickpea (4), and lentil (1) (Table III; Fig. 3). Although only juveniles stages were found, most probably the species was *H. goettingiana*. About 300 nematodes were extracted from 5 g chickpea roots.

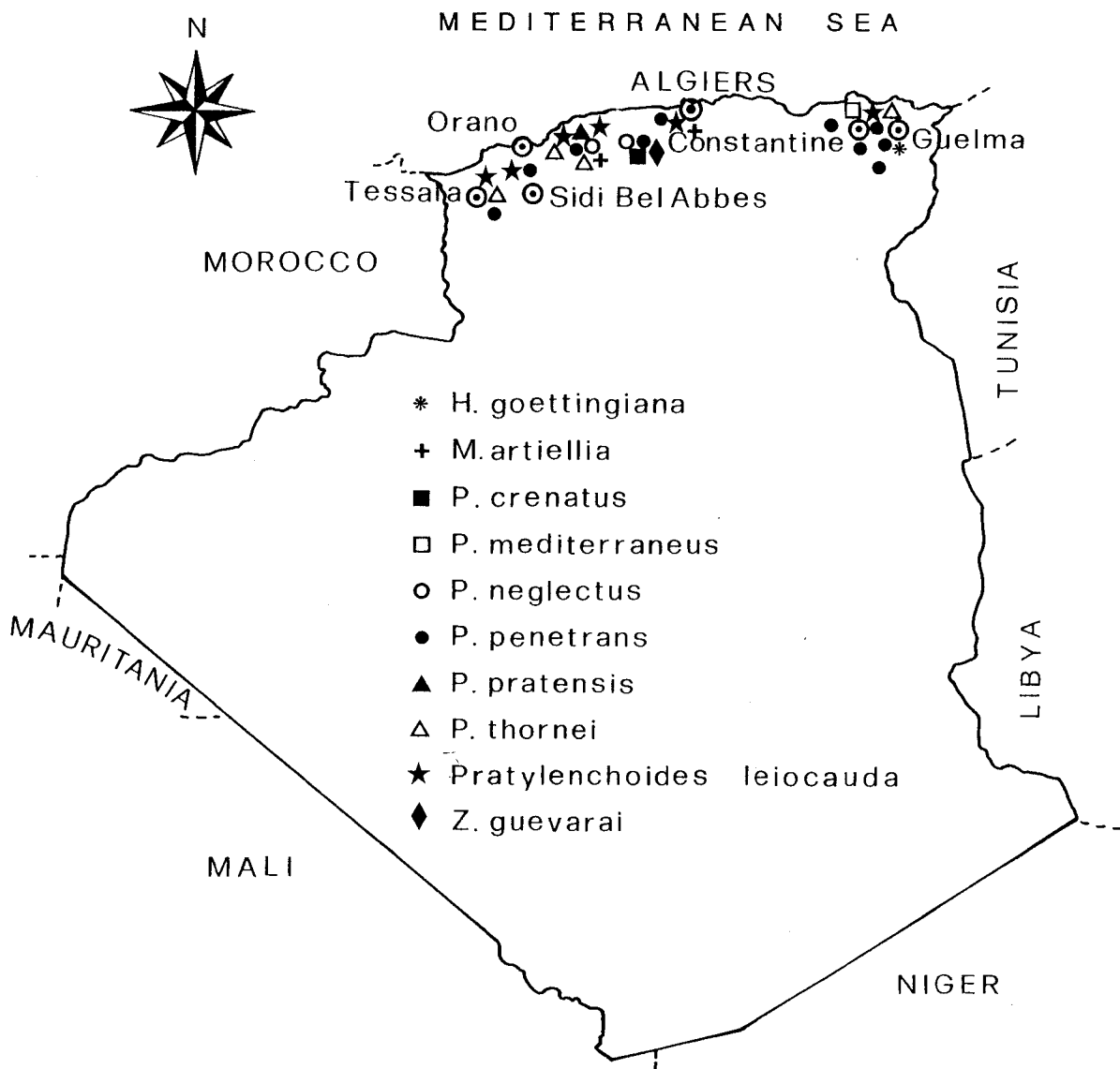


Fig. 2 - Distribution of endoparasitic nematodes in chickpea, faba bean and lentil crops in Algeria from root observations made in 1989.

Root-knot nematodes: only one root sample of chickpea collected at Oued Meliz was infested with *Meloidogyne artiellia* (Table III; Fig. 3).

Root-lesion nematodes: these nematodes were the most widespread and 29 out of 30 root samples were found infested. The most common species were *P. mediterraneus*, which occurred in all sampled crops, and *P. thornei* present in eight samples of chickpea and in one of faba bean. Both nematodes were present in 30% of the root samples. *P. penetrans* was found in one root sample of pea and in six of chickpea. Numbers of nematodes within the roots were often large and associated with poor growth and yellowing of the plants. *Pratylenchoides ritteri* Sher occurred in two root samples of chickpea (up to 500 specimens/5 g), while *Z. guevarai* was found in one root sample of faba bean and in two of chickpea (Table III; Fig. 3).

Stem and bulb nematode: all faba bean samples were infested with *D. dipsaci*. However, infestation and symptoms of the nematode attack were conspicuous only at Oued Meliz, Fermana, and Tabarka.

Other nematodes: *Helicotylenchus* spp., *Tylenchus* spp., and *Tylenchorhynchus* spp. were the most widespread in

the soil samples. Specimens of *Rotylenchulus* spp., *Hoplolaimus* spp., *Paratylenchus* spp., and *Rotylenchus* spp. were also present in a few samples. In a chickpea field at Nefza a large number of *Trophurus* sp. were found. Juvenile stages of *Paralongidorus* sp. occurred in the rhizosphere of chickpea at Oum Donil. However, there were no clear symptoms on the aerial plant parts to be associated with the presence of these nematodes.

Discussion

Surveys conducted in Algeria, Morocco and Tunisia demonstrated that several plant parasitic nematodes were commonly associated with food legumes in North Africa. Among them, root-lesion nematodes were present in nearly all sampled fields. Although information on yield loss in food legumes due to these nematodes is limited, the large numbers of *Pratylenchus mediterraneus*, *P. penetrans*, and *P. thornei* extracted from the roots of chickpea and their association with extensive root necrosis, indicate that these nematodes are highly damaging to this crop. According to Di Vito *et al.* (1992) up to 55% of chickpea yield can be

TABLE III - *Nematodes in root samples collected in Tunisia in 1990.*

Location	Crop	Total samples collected	Infested samples (1)						
			H.	M.	Pm.	Pp.	Pt.	Pz.	Zg.
1 Oued Meliz	Chickpea	1		1	1				
	Faba bean	1			1				1
2 Fermana	Chickpea	1	1		1				
	Faba bean	2	1						
	Lentil	1	1		1				
3 Tabarka	Chickpea	1			1				
4 Nefza	"	1						1	
5 Beja	"	6	1		2		3		2
	Faba bean	1			1			1	
	Pea	1				1			
6 Sid Nsir	Chickpea	1	1		1				
7 Mateur	"	5				3	2		
	Faba bean	1			1				
	Lentil	1					1		
8 Benzel Bouzefa	Chickpea	1					1		
9 Oum Donil	"	1					1		
10 Menzel Temine	"	4	2		1	1	1		
	Total	30	7	1	9	7	9	2	3
	Percentage		23	3	30	23	30	7	10

(1) H. = *Heterodera goettingiana*; M. = *Meloidogyne artiellia*; Pm. = *Pratylenchus mediterraneus*; Pp. = *Pratylenchus penetrans*; Pt. = *Pratylenchus thornei*; Pr. = *Pratylenchoides ritteri*; and Zg. = *Zygotylenchus guevarai*.

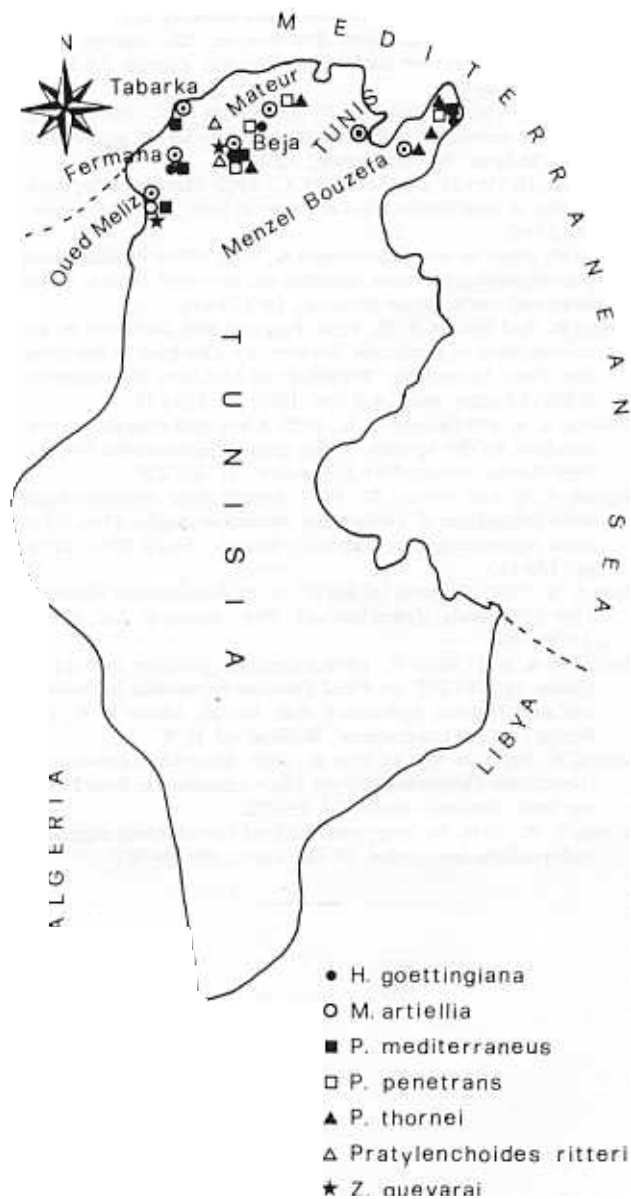


Fig. 3 - Distribution of endoparasitic nematodes in chickpea, faba bean and lentil crops in Tunisia from root observations made in 1990.

lost in fields infested with *P. thornei*. Although the level of damage caused by these nematodes is less than that caused by cyst and root-knot nematodes, their wide distribution contribute to their economic importance at the country level. However, the effect of the other nematodes on the yield of the sampled crops is not yet documented. *Pratylenchus* spp. have wide host ranges thus making their control by crop rotation difficult.

The pea cyst nematode (*H. goettingiana*) is very damaging to pea and faba bean and severe yield loss is to be expected when population densities of the nematode are larger than 0.5 or 1 egg/g soil, which represent the tolerance limits of the two crops, respectively (Greco *et al.*, 1991). Although specimens of this nematode were extracted from roots of chickpea and lentil, no crop damage occurred on these crops as they are poor hosts for this nematode (Alcala *et al.*, 1970; Di Vito *et al.*, 1980). Growing faba bean, grasspea (*Lathyrus sativus* L.), pea, or vetch (*Vicia sativa* L.), which are the main hosts for *H. goettingiana*, not more than once every 4-5 years would prevent damage caused by this cyst nematode (Di Vito and Greco, 1986).

The root-knot nematode (*M. artiellia*), although present in all the tree countries, was not common. Symptoms of nematode attack were evident only on chickpea, confirming its susceptibility to this nematode. Growing legumes, crucifers, or cereals crops, all good hosts for *M. artiellia* (Di Vito *et al.*, 1985), would increase nematode infestation and yield losses. Severe yield losses of chickpea and wheat may occur in fields with nematode population densities of more than 0.1 and 0.4 egg/cm³ soil in both crops, respectively (Di Vito and Greco, 1988a; 1988b). Rotating legumes with plant species belonging to the other botanical families will reduce nematode population densities and thus increase yield.

The stem and bulb nematode (*D. dipsaci*) is abundant and very damaging to faba bean and several other plant species in the Mediterranean basin (Sikora and Greco, 1990). It was extracted in large numbers from all shoots of faba bean showing symptoms of nematode infestation. Plant quarantine regulations of many countries require that imported faba bean seed stocks are free of the nematodes. Sowing seeds free of nematodes, weed control and the use of crop rotations are recommended to limit the spread of and damage caused by this nematode. The potential of *D. dipsaci* as a pest of lentil and pea must also be studied (Inserra and Vovlas, 1979; Greco *et al.*, 1992).

Other nematodes found in the soil were not associated with crop decline and, therefore, are considered of minor agricultural importance.

These surveys cannot be considered exhaustive. Therefore, investigations should be undertaken on dynamics of different nematode species under local environmental conditions, the host range of local populations of the root-lesion nematodes, *Pratylenchus* spp., and yield losses of infested crops, to obtain insight on the role that nematodes play in legume production in North Africa.

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