STUDIES ON NEMATODES OF FOOD LEGUMES

Progress Report 1987/88

FOOD LEGUME IMPROVEMENT PROGRAM

International Center for Agricultural Research in the Dry Areas
(ICARDA)
Box 5466, Aleppo, Syria

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Preface

Investigations on nematodes of food legumes were continued in the 1987-88 season. Major emphasis was put on the study of the reaction of wild and cultivated germplasm lines to Heterodera ciceri. Moreover, experiments were also undertaken to ascertain the relationship between population densities of Pratylenchus thornei and yield of chickpea and to exploit the feasibility of crop rotation for control of Heterodera ciceri. Finally, the area surveyed for problems was extended to south Syria and Morocco with focus on nematode problems of chickpea.

These studies were conducted by Drs. M.C. Saxena, K.B. Singh and Said Silim of ICARDA, Aleppo, Syria, Drs. N. Greco and M. Di Vito of Istituto di Nematologia Agraria, Bari, Italy, and Dr. M. Solh of ICARDA, Rabat, Morocco. Technical assistance of Mr. Samir Hajjar is appreciated.

Contents

1. SUMMARY

1.1. Survey of plant parasitic nematodes of chickpea and faba bean in Morocco.

Ditylenchus dipsaci was found in all faba bean samples. Meloidogyne artiellia was found in 8% and Heterodera sp. in 7% of chickpea samples. The most widespread on chickpea were root lesion nematodes, Pratylenchus spp. (98%) and Pratylenchoides sp. (2%). Except for infestation of D. dipsaci, symptoms of nematode attack were not evident.

1.2. Survey of plant parasitic nematodes of chickpea and lentil in Syria.

Investigations carried in the provinces of Ezzra, Sweda, Tartous, Lattakia, Saleh and Idleb, showed that cysts nematodes were present only in one sample (Ezzra), while Pratylenchus spp. were the most frequently encountered nematodes (91% of samples infested) especially in the first two provinces. Ectoparasitic nematodes were the same as found in other areas of the country. No infestation of Meloidogine artiellia was observed.

1.3. Screening of chickpea germplasm lines for resistance to Heterodera ciceri.

No line of Cicer arietinum, among the 2,000 tested, was resistant to Heterodera ciceri, as all were found heavily infested by the nematode. Among the wild Cicer spp. 91% of C. bijugum lines had infestation rates ≤ 2 and therefore were considered resistant and of interest for a breeding program. Lines of the other wild Cicer spp. were on the other hand very susceptible to H. ciceri.

1.4. Relationship between symptoms caused by Meloidogyne artiellia on chickpea and grain yield under field condition in Syria.

Application of nitrogen fertilizer or the nematicide Aldicarb to chickpea, at late stage of infestation, did not increase yield of chickpea nor the intensity of the nematode attack symptoms. However, there was a clear negative correlation between severity of M. artiellia attack and yield of chickpea.

1.5. Relationship between population densities of Pratylenchus thornei and yield of chickpea under field condition in Syria.

Yield of chickpea in infested plots was significantly less than that of plots treated with Aldicarb. However, there was no clear correlation between rating score of nematode infestation in the infested plots and yield of chickpea or number of nematodes within roots.

1.6. Effect of soil solarization on Pratylenchus thornei.

Soil solarization is very effective for the control of P. thornei. A minimum of 88% control was obtained after two weeks of solarization and 100% after eight weeks.

1.7. The use of crop rotation for the control of Heterodera ciceri in Syria.

The population density of the nematode was 41 eggs/g soil in the plots planted to chickpea following lentil, 57 eggs/g soil in those in which chickpea had followed wheat, and 63 eggs/g soil when chickpea followed grasspea. In the plots planted with non host crops for one or two consecutive years, the nematode populations were 9-14 and 9 eggs/g soil, respectively.

1.8. Investigation on the decline of Heterodera ciceri.

The nematode population declined to 7.3% after a fallow period of two years. This decline is very large compared to that observed for other cyst forming nematodes.

2. INTRODUCTION

Investigations undertaken in 1983 on nematodes of chickpea and lentil revealed that Heterodera ciceri, Meloidogyne artiellia, and Pratylenchus thornei are among major constraint to production of these crops in Syria, but other nematode species may also occur. Unfortunately, the knowledge of the nematode problems of food legumes is limited to a few countries; therefore, more surveys were made during spring 1988 to get information on nematodes infesting chickpea in southern Syria and chickpea and faba bean in Morocco.

Food legumes are cultivated on marginal lands in many instances and therefore control measure must be effective and cheap. During 1988, nearly 2,000 germplasm lines of chickpea were screened to identify source of resistance to cyst nematode. Effectiveness of crop rotations for controlling Heterodera ciceri was also investigated.

While the effect of population densities of H. ciceri and M. artiellia on the yield of chickpea have been determined, that of P. thornei was still lacking and therefore an experiment under field conditions was arranged in March to estimate the potential damage that this nematode may cause to chickpea.

3. SURVEY

3.1. Survey of plant parasitic nematodes of chickpea and faba bean in Morocco.

The survey was carried by Dr. M. Di Vito in cooperation with Dr. Solh (ICARDA, Rabat) and Mr. L. Mabsoute (INRA, Dar Bouazza,

Morocco) in April 1988. Fifty nine samples (soil and roots) were collected in fields cultivated to chickpea and four aerial plant part samples in fields of faba bean crop. The sampled areas were the provinces of Rabat, Meknes, Fes, Casablanca, Safi and Rommani. Soil samples were processed by the sieving and decanting method combined with the Baermann funnels, while nematodes from aerial parts were extracted with the incubation method.

Root lesion nematodes were encountered in all chickpea root samples: 98% of Pratylenchus spp. and 8% of Pratylenchoides spp.. Meloidogyne artiellia was found in 8% of the samples and Heterodera spp. in 7% of the chickpea samples. It was not possible to identify the species of Heterodera because only juvenile stages were found in the roots. Ditylenchus dipsaci occurred in all faba bean samples. Infestation of this nematode was very high at Berjdid.

In other sampled fields symptoms of the nematode infestation were not evident.

Table 1. Nematodes per 5 g roots of legumes collected in Morocco, 1988.

Locality	Crop	Nematodes/5 g roots*				
		H.	M.	P.	Pr.	other nematodes
Ben Slimane	Chickpea	-	-	-	7434	
Ben Slimane	Chickpea	-	-	-	2073	
Ben Slimane	Chickpea	-	-	-	1957	
Ben Slimane	Chickpea	-	-	-	2048	
BEN Slimane	Chickpea	-	-	-	2228	
Ben Ahemed	Faba bean	-	-	-	-	D. dipsaci
Ain N'Zarkh	Chickpea	-	-	-	6703	
Settat	Chickpea	-	-	-	6549	
Settat	Chickpea	-	50	0	3141	
Settat	Chickpea	-	-	-	2197	
Ouled Said	Chickpea	-	-	-	3639	

Cont'd ...

Cont'd ...

Jemaa	Chickpea	-	-	-	8283	
El Jadida	Chickpea	-	-	-	396	
El Jadida	Chickpea	-	-	5570	-	
El Jadida	Chickpea	-	-	-	5221	
Sidi Bennour	Chickpea	-	-	-	6757	
Arba Ouled Amrane	Chickpea	-	-	-	2231	
Arba Ouled Amrane	Chickpea	-	15	-	2326	
Arba Ouled Amrane	Chickpea	-	-	-	4910	
Sept Maarif	Chickpea	-	-	-	6652	
Tlata Sidi Bouguedra	Chickpea	-	-	-	1236	
Safi	Chickpea	-	125	-	1831	
Safi	Chickpea	-	122	-	5691	
Safi	Chickpea	-	-	1650	2460	
Had Harrara	Chickpea	10	-	-	551	
Had Harrara	Chickpea	-	-	-	3124	
Jamat Shaim	Chickpea	-	-	-	5033	
Jamat Shaim	Chickpea	-	-	230	1489	
Jamat Shaim	Faba bean	-	-	-	-	D. dipsaci
Khemis Zemamra	Chickpea	-	-	-	6429	
Khemis Zemamra	Chickpea	-	-	-	2303	
Had Ouled Aissa	Chickpea	-	-	-	2572	
Jorf Al Asfar	Chickpea	-	-	-	2095	
Jorf Al Asfar	Chickpea	-	-	-	2217	
Azemmour	Chickpea	-	-	-	1522	
Berjdid	Faba bean	-	-	-	-	D. dipsaci (severe)
Berjdid	Faba bean	-	-	-	-	D. dipsaci (severe)
Berjdid	Chickpea	-	-	-	5027	
Berjdid	Chickpea	-	-	-	6425	
Berjdid	Chickpea	-	-		5347	
Barchouch	Chickpea	-	-	-	12462	
Barchouch	Chickpea	-	-	-	6684	

Cont'd ...

Cont'd ...					
Barchouch	Chickpea	-	-	-	12039
Rommani	Chickpea	-	-	-	4206
Rommani	Chickpea	-	-	-	2490
Maaziz	Chickpea	-	-		2058
Khemisset	Chickpea	-	-	-	2717
Khemisset	Chickpea	-	-	-	927
Sidi Slimane	Chickpea	-	-	-	4798
Zerara	Chickpea	-	-	-	5375
Kacem	Chickpea	-	-	-	2351
Zagota	Chickpea	-	-	-	2561
Zagota	Chickpea	-	-	-	4453
Zagota	Chickpea	9	-	-	2031
Zagota	Chickpea	-	-	-	2421
Ben Ammar	Chickpea	-	-	37	518
Fes	Chickpea	12	-	-	1739
Fes	Chickpea	-	200	-	2468
Doyet	Chickpea	35	-	-	3555
Meknes	Chickpea	-	-	-	6365
Meknes	Chickpea	-	-	1750	1428
Dar Bouazza (Casablanca)	Chickpea	-	-	-	16401
Dar Bouazza (Casablanca)	Chickpea	-	-	-	8112

* H.= Heterodera sp.; M.= Meloidogyne artiellia; P.= Pratylenchoides sp.; Pr.= Pratylenchus sp..

3.2. Survey of plant parasitic nematodes of chickpea and lentil in Syria.

In May 1988 soil and root samples were collected from fields cultivated to chickpea (34), lentil (7), vetch (2), and French bean (1). Sampled areas were the provinces of Ezzra, Sweda, Hamrat (near Zabadani), Tartous, Lattakia, Salla and Idleb. Soil

and root samples were processed as described earlier. The results show that M. artiellia, which is widespread in northern Syria, was not found in these areas. Only in one sample in the province of Ezzra, females of a cyst nematode were found on the roots of chickpea. Pratylenchus spp. were the most frequently encountered nematodes within the roots (91% of samples infested). However, populations of Pratylenchus spp. were rather large (up to 713 specimens/g roots) in the provinces of Ezzra and Sweda, where chickpea and wheat, both good hosts for the root lesion nematode, are rotated on the same land without any long term break. Pratylenchus spp. were on the other hand absent or in small number in the other areas. Finally, ectoparasitic nematodes in the soil samples did not differ from those found in other areas of Syria.

4. Screening chickpea germplasm lines for resistance to H. ciceri

Investigations undertaken in the past revealed that two lines of Cicer bijugum were lightly infested by H. ciceri. Therefore more lines of cultivated and wild Cicer spp. in the ICARDA germplasm collection were screened in the 1987-88 season to identify source of resistance to the nematode. The screening was carried out in plastic pots containing 3.5 dm^3 of soil infested with 20 eggs of the nematode/cm^3. Each pot was sown with five seeds and there were two pots for each chickpea line. The pots were arranged in a plastic-house with temperature maintained at 16-25^{o}C. All plants were uprooted 50 days after emergence, the roots gently washed in water and the presence of females rated according to a 0-5 scale, where 0=absence of females, 1=1-2 females, 2=3-5 females, 3=6-20 females, 4=21-50 females, and 5= more than 50 females.

Results showed that no line of C. arietinum, among the 2,000 tested, was resistant to the nematode as they were all rated 3-5. Among wild species (Table 2) 91% of the C. bijugum (21 out of 23) lines were rated $\leq$2 and considered resistant. Therefore, these

lines could profitabily be used in breeding program aiming to obtain cultivars of chickpea resistant to the nematode. All lines of C. chorassanicum (5), C. cuneatum (3), C. echinospermum (4), C. judaicum (47), C, pinnatifidum (30), C. reticulatum (23), and C. yamashite (2), were very susceptible to H. ciceri.

Table 2. Response of wild lines of Cicer spp. for resistance to Heterodera ciceri in plastic-house, Tel Hadya, Syria, 1987/88.

Cicer species	Lines tested	Lines found resistant	% of lines resistant
Cicer bijugum K.H. Rech.	23	21	91
Cicer chorassanicum (Bge) M. Pop.	5	0	0
Cicer cuneatum Hochst. ex Rich.	3	0	0
Cicer echinospermum P.H. Davis	4	0	0
Cicer judaicum Boiss.	47	0	0
Cicer pinnatifidum Jaub.et Sp.	30	0	0
Cicer reticulatum Ladiz.	23	0	0
Cicer yamashite Kitamura	2	0	0
Cicer arietinum L. (check)	1	0	0

5. YIELD LOSS ASSESSMENT

5.1. Relationship between symptoms caused by M. artiellia on chickpea and grain yield under field conditions in Syria.

Predicting yield losses that a nematode may cause to crops is a basic information required for the management of the parasite. This can be done relating population densities of the pest at planting or later expression of the symptoms and yield of the host

plant. In April 1988, a field infested with M. artiellia showing uneven symptom severity was selected at Tel Hadya. The field was divided in 45 plots of 1.5m^2 each and the symptoms on aerial parts of chickpea rated according to a 1-9 scale, where 1=plant completely green, 2=10% yellowing, 3=20% yellowing, 4=20-40% yellowing, 5=40-60% yellowing, 6=60-75% yellowing, 7=complete yellowing, 8= complete yellowing and 50% of plants dead, and 9=all plants dead. Then 15 plots received 40 Kg N/ha, 15 were treated with 10Kg Aldicarb/ha and 15 served as control. The symptoms of the nematode attack were rated again on 17 May and 22 June and biological and grain yields recorded at harvest of chickpea.

Application of a nitrogen fertilizer or the nematicide Aldicarb did not affect the yield of chickpea nor the intensity of symptoms of the nematode attack (Table 3). This suggests that an application of a fertilizer or of a nematicide at the appearance of symptoms of the nematode infestation does not increase yield nor reduce the severity of the disease. However, there was a clear negative correlation between severity of M. artiellia attack and yield of chickpea (Table 4).

Table 3. Effect of application of nitrogen and Aldicarb on the yield of chickpea and on symptom severity in a field infested with Meloidogyne artiellia, at Tel Hadya, Syria, 1987/88.

Treatment	Yield (g/1.5 m^2)		Symptoms rating*		
	Whole shoot	Grain	10 April	17 May	22 June
Control	275	104	4.5	4.2	5.3
N 40 Kg/ha	257	102	4.4	3.3	4.9
Aldicarb 10Kg/ha	263	97	3.4	3.9	5.3

* 1-9 scale; 1= no symptoms, 9= all plants dead.

Table 4. Relationship between rating of symptoms on the aerial part and yield of chickpea in a field infested with Meloidogyne artiellia, at Tel Hadya, Syria, 1987/88.

Rating of damage*	Yield (g/1.5 m^2)	
	Whole shoot	Grain
1	476	197
2	265	94
3	303	119
4	256	92
5	227	86
6	186	66
7	117	35

* 1-9 scale; 1= no symptoms of damage, 9= all plants killed.

5.2. Relationship between population densities of P. thornei and yield of chickpea under field conditions in Syria.

Although P. thornei has been found frequently associated with decline of chickpea growth in Syria, the extent of damage it may cause was not investigated. Therefore, a field infested with this nematode was selected in 1988 at Tel Hadya.

The field was divided in 100 plots of 6.75m^2 each. Soil samples of 1.5-2 Kg were collected from each plot and the nematode population density estimated. Chickpea cv ILC 482 was sown on 1 March 1988. Ten plots were treated with 5Kg Aldicarb/ha at sowing and 5Kg/ha of the same nematicide one month after plant emergence. Five root samples were collected on 15 April and appearance of symptoms caused by the nematode evaluated on a0-10 scale, according to the extent of necrotic roots. Nematodes within the roots were also extracted by incubating the roots at room

temperature. At harvest biological and grain yields were recorded and soil samples collected again to determine the reproduction of the nematode. Population of the nematode before planting was low and in several plots was below the detectable level. Therefore, only the root rating of the nematode symptoms was correlated with the yield of chickpea.

Results showed that yields in untreated plots were significantly less than in treated ones (Table 5). However, there was no clear correlation between rating score of the nematode infestation of non treated plots and yield of chickpea or numbers of nematodes within the roots. Moreover, nematodes in roots from treated plots were nearly absent. It can be concluded that rating of infestation symptoms is not a good parameter to predict yield losses caused by P. thornei nor to estimate number of nematodes within the roots.

Table 5. Effect of infestation severity of Pratylenchus thornei on chickpea, at Tel Hadya, Syria, 1987/88.

Root infestation rating	Yield (g/6.75 m^2)		Nematodes/g roots
	Whole shoot	Grain	
2*	2,431	1,348	0.1
3*	2,514	1,433	1.7
4	1,039	508	34.3
5	1,292	654	25.3
6	1,179	592	77.4
7	1,151	552	82.9
8	1,426	712	59.7

* Treated with 10 Kg Aldicarb/ha.

6. CONTROL

6.1. Effect of soil solarization on P. thornei

Heat is one of the means for controlling soil pathogens of plants. Recently, the use of solarization has been found promising to control plant parasitic nematodes. Usually nematodes do not survive more than 2-3 hours at 42-44°C. Soil solarization may cause a 10-15°C temperature increase in the top soil (15-20 cm depth), compared to air temperature, when used during summer months in warm areas. In Syria, temperature is rather high in summer (40-45°C max) and most of the lands are not cultivated in this period. Therefore, the feasibility of soil solarization for controlling P. thornei was assessed during summer 1988.

A field infested with the nematode at Tel Hadya was divided in 30 plots of 9 m^2. Soil samples were collected from each plot and the nematode population estimated. The plots were then irrigated and, except the control, covered with a transparent plastic film for 2, 4, 6, and 8 weeks from 7 August 1988 onwards. At the end of the solarization period, soil samples were collected again as before and processed to determine the nematode population. All plots will be sown to winter chickpea to evaluate the effect of the nematode control on yield.

The results achieved so far (Table 6) clearly show that soil solarization was very effective against P. thornei. A minimum of 88% control was obtained after two weeks of solarization and 100% control after 8 weeks.

This investigation has confirmed findings of preliminary tests done in the past in the same area.

Table 6. Effect of soil solarization on soil population of Pratylenchus thronei, at Tel Hadya, Syria, 1987/88.

Treatment	Nematodes/50 ml soil		% of control
	Before solarization	After solarization	
Control (not solarized)	259	237	-
2 weeks solarized	248	29	88.3
4 weeks solarized	297	11	96.2
6 weeks solarized	219	5	97.7
8 weeks solarized	240	0	100

6.2. The use of crop rotation for control of H. ciceri in Syria

Cyst forming nematode, Heterodera spp., generally has rather narrow host ranges. Heterodera ciceri, reported to be one of the major constraints of chickpea production in parts of northern Syria, only infests a few other leguminous plant species, such as grasspea, lentil, and pea. Its control by crop rotation is, therefore, suggested. To assess the efficacy of this method of control for H. ciceri, an experiment including six rotation sequences (Table 7) was started in 1986-87 at Tel Hadya. Even though it is too early to draw conclusions, these preliminary results indicate that crop rotation is highly effective in reducing the nematode soil population density. Results show that the population density of the nematode was 41 eggs/g soil in the plots planted to lentil in 1986-87 and chickpea in 1987-88, 57 eggs/g soil in those in which chickpea followed wheat, and 63 eggs/g soil in those in which chickpea followed grasspea, which is also good host for the nematode. In the plots planted to non host crop for one or two years the nematode populations were 9-14 and 9 eggs/g soil, respectively (Table 8).

Table 7. Crop sequences for the control of the chickpea cyst nematode, Heterodera ciceri.

Treatments	Crop sequences			
	I Year 86/87	II Year 87/88	III Year 88/89	IV Year 89/90
1	Lentil +	Chickpea +	Lentil +	Chickpea +
2	Wheat *	Chickpea +	Wheat *	Chickpea +
3	Chickpea +	Wheat *	Barley *	Chickpea +
4	Wheat *	Barley *	Wheat *	Chickpea +
5	Lathyris +	Chickpea +	Lentil +	Lathyrus +
4	Lathyrus +	Wheat *	Barley *	Lathyrus +

* Non host; + Host

Table 8. Effect of crop rotations on the soil population densities of Heterodera ciceri in Syria (second year, 1987/88).

Rotation				Eggs of the nematode/g soil
I	II	III	IV Year	
Le	- Ch - Le	- Ch		41
W	- Ch - W	- Ch		57
Ch	- W - B	- Ch		14
W	- B - W	- Ch		9
Lath	-Ch - Le	- Lath		63
Lath	-W - B	- Lath		9

Le = Lentil; Ch = Chickpea; W = Wheat; B = Barley; Lath = Lathyrus

7. Investigation on the decline of H. ciceri

The aim of this experiment was to ascertain the magnitude of H. ciceri decline in the absence of crops. The experiment was started in 1986 and will continue until 1990. Observations made so far indicate that the nematode population declined to 7.3% after two years, a rate of decline approximately double of that observed for other cyst forming nematodes elsewhere. Therefore, crop rotations shorter than those suggested in other countries would be able to provide satisfactory control of the nematode.