STUDIES ON NEMATODES OF FOOD LEGUMES PROGRESS REPORT 1986/1987

FOOD LEGUME IMPROVEMENT PROGRAM

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

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Preface

The cooperative research program on nematode of food legumes continued in 1986/87 to achieve more information on: the occurrence of nematodes of chickpea and lentil in Syria, the biology of *Heterodera ciceri* and *Meloidogyne artiellia*, the control of these nematodes by crop rotations and *Pratylenchus thornei* by using nematicides; the assessment of yield losses caused by *M. artiellia* to chickpea and the reaction of *Cicer* species to *H. ciceri*. These investigations were undertaken in Syria and Italy by Dr. M.C. Saxena, Dr. K.B. Singh, Dr. Said Silim and Mr. S. Hajjar of FLIP and Dr. N. Greco and Dr. M. Di Vito of Istituto di Nematologia Agraria, C.N.R., Bari, Italy.

Contents

1. SUMMARY

1.1. Meloidogyne artiellia survives dry and hot period as coiled anhydrobiotic second stage juveniles. Anhydrobiotic juveniles were recovered in water 24 hours after the extracting solution was washed away.

1.2. Experiments on the pathogenicity of Meloidogyne artiellia showed that this nematode is highly pathogenic to chickpea. The tolerance limit of winter chickpea to the nematode was 0.14 egg/cm^3 soil. Fifty percent of the yield was lost when the nematode population was 2.5 eggs/cm^3 soil and 85% when it was 8 eggs/cm^3. The estimated tolerance limit of spring chickpea was much lower (o.016 eggs/cm^3 soil) and 85% of the yield was lost at 1 egg/cm^3 soil. Maximum reproduction rate of the nematode was 26.

1.3. As this was the first year of cropping, no information was obtained on the effect of crop rotation on the yield of chickpea. However, Heterodera ciceri soil population at harvest of crops declined to 40% of that occurring at sowing in the plots sown with non host plants and to 64% in those sown to lentil. In the plots planted with chickpea and grasspea the nematode population increased to 2.5 times that at sowing.

1.4. Aldicarb was very effective in controlling Pratylenchus thornei on both winter and spring chickpea. However, higher yield increases were obtained with spring (76%) than with winter chickpea (25%). Number of nematodes in the chickpea roots was greatly suppressed by aldicarb especially in spring chickpea in which $\leq$10 nematodes per 10 g roots were found.

1.5. The screening of 2001 chickpea lines and of 20 wild lines of Cicer species revealed that 20 lines (1%) had low infestation (rating 2), 482 lines (24.1%) were rated 3 and 1499 (74.9%) were rated 4-5. Among the wild Cicer species only lines ILWC 8 and ILWC 34 of C. bijiqum were rated 2 and ILWC 7 was rated 3. The remaining lines of wild species were highly infested and rated 4-5.

2. INTRODUCTION

Investigations on nematodes of chickpea and lentil in Syria, being undertaken since 1982, have shown that the cyst nematode Heterodera ciceri, the root-knot nematode Meloidogyne artiellia, and the root lesion nematode Pratylenchus thornei are the most damaging to these pulses. In the past years the research was designed to give more insight in the biology and host range of the above nematodes, pathogenicity of H. ciceri, and chemical control of P. thornei. Attempts were also made to select chickpea and lentil lines tolerant or resistant to at least one of these nematodes. In the 1986/87 season more effort was laid on studying the biology and pathogenicity of M. artiellia and to screen chickpea germplasm for its resistance to H. ciceri. Moreover, field experiments were also established to confirm previous results on the chemical control of P. thornei on chickpea and to ascertain the feasibility of crop rotations in controlling cyst and root-knot nematodes.

3. BIOLOGY

3.1. Occurrence of anhydrobiosis in Meloidogyne artiellia.

It has been shown that some plant parasitic nematodes can survive in dry and hot period under anhydrobiosis. To investigate whether this possibility also exists for second stage juveniles of M. artiellia soil samples were taken from microplots at Bari when the soil was dry (moisture content 7.5% = pF 5) and juveniles extracted by centrifugation in a 1.25 M sugar solution (1.165 sp. gr.) or in a magnesium sulphate solution of equivalent sp. gr. Results revealed the presence of coiled second stage juveniles indicating anhydrobiosis. The percent coiled nematodes was 39% when extracted with sugar solution and significantly ($P \leq 0.05$) higher (64%) when extracted with magnesium sulphate solution. Anhydrobiotic juveniles recovered when the extracting solutions were washed away. A few juveniles were active after being transferred in water for two hours, 60-67 % became active after 24 hours and 83-86% after 96 hours.

3.2. Hatching and dynamics of *Heterodera ciceri*.

The management of a nematode requires information on its behaviour and its population decline in the absence of a host. Therefore four soil samples of 1.5 kg each were collected monthly from microplots infested with *H. ciceri* since the last May. Batches of 100 cysts from these samples were incubated for one month in a 3 mM zinc chloride solution at 20°C. Emerging juveniles were counted weekly and the hatching solution renewed at the same time. To investigate the dynamics of *H. ciceri* five soil samples were also collected quarterly from ten more microplots infested with the nematode (1 soil sample every two microplots) but left fallow. Cysts were extracted from each soil sample and their egg content estimated. From the preliminary results, it is too early to draw any major conclusions. It seems, however, that *H. ciceri* egg hatch is poor during hot and dry months, and that the nematode population during the first seven months has not changed substantially.

4. PATHOGENICITY

4.1. Relationship between population densities of *Meloidogyne artiellia* and yield of chickpea

It has been proved that *M. artiellia* is very noxious to chickpea. However, there was no information on the amount of yield loss that the nematode could cause in both winter and spring sown chickpeas. Therefore two experiments were undertaken to establish the relationship between a range of population densities (0.058 - 155.5 eggs/cm^3 of soil) of *M. artiellia* and yield of chickpea grown in microplots at Bari, Italy. Concrete lined microplots were bottom-less and measured 30x30x50 cm; they contained 36 dm^3 soil per plot. The soil was infested with several population densities of the nematode by mixing amount of infested soil with non infested soil. Microplots were fertilized and 130 of them were sown with six pregerminated ILC 482 chickpea seeds on December 1986 and another 130 on 2 March 1987. Microplots were thinned to 4 plants each soon after their emergence. They were irrigated only once in April because of drought and leafminer was controlled by spraying insecticides. At harvest (1st and 7th July 1987, for winter and spring chickpea, respectively) biological and grain yields were recorded. Moreover soil samples were also collected from each microplot and processed to estimate population densities of the nematode and to determine their reproduction rates. Results showed that M. artiellia is highly pathogenic to both winter and spring chickpea. A tolerance limit of 0.14 eggs of M.artiellia/cm^3 soil was derived for winter chickpea. Fifty percent of the yield was lost when the nematode soil population was 2.5 eggs/cm^3 soil and 85% when it was 8 eggs/cm^3 soil. The estimated tolerance limit of the spring chickpea was much lower (0.016 egg/cm^3 soil) and nearly 85% of the yield was lost at 1 egg/cm^3 soil. The reproduction rate of the nematode estimated after harvest of chickpea was about 26 at the lowest initial population densities and decreased as the initial population increased.

5. CONTROL

5.1. Control of Heterodera ciceri and Meloidogyen artiellia by crop rotation.

Because of high cost of nematicides and the pollution hazard associated with their use chemical control is rather difficult. Crop rotation instead, has proven effective in controlling many pests and diseases that have rather narrow host range. Therefore two experiments, one on a field infested with H. ciceri and the other on a field infested with M. artiellia were undertaken at Tel Hadya to control these nematode by crop rotation. There are six crop sequences replicated five times in each experiment (Table 1 and 2), with host and non host plant species for the two nematodes coming in sequence. The first set of results on the effect of crop rotation on chickpea yield will be available in June 1988.

However, the cyst nematode soil population observed in the end of July had declined to about 40% (Table 3) of that at sowing in the plots sown with a non host plant (wheat) and to 64% in those sown with lentil. In the plots planted to chickpea and grasspea, both very good hosts for H. ciceri, the nematode population at harvest was about 2.5 times that at sowing (Table 3). Lentil is also considered good host for H. ciceri and therefore the reduction of the nematode population observed in the plots planted with this pulse needs to be confirmed.

5.2. Chemical control of root lesion nematode (Pratylenchus thornei)

Pratylenchus thornei has a very wide host range making its control by crop rotation difficult. Therefore during the last three years attempts were made to reduce yield losses of chickpea by using nematicides. Two yield trials were established at Tel Hadya in 1986/87, one with winter chickpea and the other with spring chickpea, to control the nematode, by split application (at sowing of chickpea and at plant emergence) of different rates of aldicarb (Table 4). Each treatment was replicated six times in a randomized block design. Plots were 3.5 x4 m each having 7 rows 45 cm apart. Chickpea cv ILC 482 was sown in December, 1986 or February, 1987. Aldicarb application treatments increased grain yield by 12-25% on winter chickpea and by 51-76% on spring chickpea (Table 4). Numbers of nematodes in the chickpea roots were greatly suppressed by aldicarb especially in case of spring chickpea in which <10 nematodes/10g roots were observed (Table 4). These results confirm those obtained in the previous year and show that aldicarb is more effective on spring than on winter chickpea.

6. SURVEY

6.1. Survey of plant parasitic nematodes of chickpea and lentil in syria.

Investigation on the occurrence of nematodes of food legumes was extended in 1987 in the North-east of Syria, near the Iraqi and Turkish border and in the Ghab Valley, were chickpea and lentil are cultivated on large scale. Thirty seven root and soil samples were collected from the rhizosphere of the chickpea (18) and lentil (19). Pratylenchus spp. were the most frequently occurring nematodes extracted from the roots of lentil (37%) and chickpea (72%) and numbers were particularly high in the North-east of the country where up to 2200 specimens/g roots were found. Only two root samples of chickpea and one of lentil contained few juveniles of root-knot nematodes. Moreover, Rotylenchus sp. was encountered in four root samples of chickpea but not on lentil. Observations of soil samples revealed nearly the same nematofauna as observed in the past years, except that Heterodera ciceri was not found in these areas.

7. SCREENING

7.1. Reaction of chickpea germplasm lines to Heterodera ciceri.

Although yield losses caused by nematodes can be suppressed in different ways, the use of resistant varieties is the most easy, safe and effective control method. Unfortunately no cultivars of chickpea are known to be resistant to H. ciceri. Therefore, 2001 chickpea lines of C. arietinum including ILC 1-ILC 1297 (except ILC 141, 143, 151, 285, 435, 664, 793, 868, 945, 948, 1192, 1255 and 1271) and FLIp 81-32 to FLIP 81-66, FLIP 82-1 to FLIP 82-261, FLIP 83-1 to FLIP 83-126, FLIP 84-1 to FLIP 84-189 and FLIP 85-1 to FLIP 83-135 (except FLIP 82-86, 82-222, 84-10 and 84-16) and twenty accessions of wild species C. bijugum K.H. Rech., C. chorassanimcum (Bge) M. Pop., C. cuneatum Hochst., C. echinospermum P.H. Davis, C. judaicum Boiss, C. pinnatifidum Jaub. et Sp., C. pinnatifidum + judaicum, C. reticulatum Ladiz., and C. yamashitae Kitamura (Table 5) of the ICARDA germplasm were tested for their reaction to H. ciceri. Plastic pots containing 5.5 dm^3 of soil infested with 20 eggs of the nematode/cm^3 were placed on benches in a green-house maintained at 16-25^{o}C. Three groups of pots were sown with five seeds of each line on 24 October 1986, on 13 January and 17 March 1987, respectively. There were, two pots for each chickpea line. Chickpeas were left to grow for 50 days and then uprooted and their root infestation rated on a 0-5 scale, where 0 = no females on the roots, 1 = 1-2 females per root, 2 = 3-5 females, 3 = 6-20 females, 4 = 21-50 females, and 5>50 females. None of the chickpea lines was found free of nematodes, but 20 of them (1%) were rated 2 (Table 6 and 7), 482 (24.1%) were rated 3, and 1499 (74.9%) were rated 4 and 5. The root infestation was low (Table 5) on the wild Cicer species ILWC 8 and ILWC 34, rated 2, and on ILWC 7 which rated 3 and all accessions of Cicer bijugum, but high on the other wild Cicer species. However, their reaction to H. ciceri needs to be confirmed and their performance under field condition should be investigated. Lines with low infestation in the confirmatory tests will further be investigated for a better understanding of the mechanism of their resistance to the nematode.

Table 1. 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	Lathyrus +	Chickpea +	Lentil +	Lathyrus +
6	Lathyrus +	Wheat *	Barley *	Lathyrus +

* Non host; + Host

Table 2. Crop sequences for the control of the root-knot nematode *Meloidogyne artiellia*.

Treatments	Crop Sequences			
	I Year 86/87	II Year 87/88	III Year 88/89	IV Year 89/90
1	Wheat +	Chickpea +	Wheat +	Chickpea +
2	Oat *	Chickpea +	Oat *	Chickpea +
3	Chickpea +	Oat *	Lentil **	Chickpea +
4	Oat *	Lentil **	Oat *	Chickpea +
5	*Vicia sativa* +	Lentil +	Oat *	*Vicia sativa* +
6	*Vicia dasycarpa* **	Lentil **	Oat *	*Vicia dasycarpa* **

* Non host; ** Poor host; + Host

Table 3. Effect of different crops on soil population of *Heterodera ciceri* at Tel Hadya, Syria.

Crops	Eggs of *H. ciceri*/g soil		*H. ciceri* population at harvest as % of the population at sowing
	At sowing (17/11/86)	At harvest (7/7/87)	
Lentil +	13.6	8.7	64
Wheat *	12.6	4.5	36
Chickpea +	12.3	29.5	240
Wheat *	16.1	7.0	43
Lathyrus +	15.9	27.3	172
Lathyrus +	11.3	37.7	334

* Non host; + Host

Table 4. Effect of aldicarb on the number of *Pratylenchus thornei* found in the roots and on the yield of winter and spring chickpea.

Treatment	Nematodes/5g roots		Biological yields ($g/6.3\ m^2$)		Grain yields ($g/6.3\ m^2$)	
	Winter chickpea	Spring chickpea	Winter chickpea	Spring chickpea	Winter chickpea	Spring chickpea
Aldicarb 5+5 kg a.i./ha	10.8	1.7	4978	3308	2506	1789
Aldicarb 5+2.5 kg a.i./ha	57	10.3	4501	2894	2263	1535
Aldicarb 2.5+5 kg a.i./ha	33.4	4.3	4920	2983	2503	1605
Control	267.7	1183.3	4129	1929	2077	1016
LSD: $P \leq 0.05$	76.1	358.8	398	411	195	224

Table 5. Screening of different accessions of *Cicer* species for resistance to *Heterodera ciceri* at Tel Hadya, Syria, 1986/87.

Cicer species	Accession No.	Rating
Cicer bijugum	ILWC 7	3
Cicer bijugum	ILWC 8	2
Cicer bijugum	ILWC 34	2
Cicer chorassanimcum	ILWC 23	5
Cicer cuneatum	ILWC 37	5
Cicer echinospermum	ILWC 35	5
Cicer judaicum	ILWC 4	5
Cicer judaicum	ILWC 4-2	5
Cicer judaicum	ILWC 20	5
Cicer judaicum	ILWC 30	4
Cicer judaicum	ILWC 31	5
Cicer judaicum	ILWC 38	5
Cicer pinnatifidum	ILWC 9	5
Cicer pinnatifidum	ILWC 29	5
Cicer pinnatifidum	ILWC 29-1	5
Cicer pinnatifidum	ILWC 29-2	5
Cicer pinnatifidum + *judaicum*	ILWC 33	5
Cicer reticulatum	ILWC 21	5
Cicer reticulatum	ILWC 36	5
Cicer yamashitae	ILWC 3-1	4

Table 6. Screening chickpea germplasm lines for resistance to _Heterodera ciceri_ at Tel Hadya, Syria, 1986/87.

Rating Scale	No. of Accessions	% of total
0	0	0.0
1	0	0.0
2	20	1.0
3	482	24.1
4	531	26.5
5	968	48.4
Total	2001	100.0

Table 7. Chickpea lines found promising for their reaction to _Heterodera ciceri_ at Tel Hadya, Syria, 1986/87.

Entry	Rating	Entry	Rating
ILC 15	2	ILC 923	2
ILC 20	2	ILC 958	2
ILC 94	2*	ILC 1208	2
ILC 250	2	ILC 1259	2
ILC 633	2	ILC 1260	2
ILC 750	2	ILC 5141	2
ILC 751	2	ILC 5180	2
ILC 826	2	ILC 5251	2
ILC 844	2	ILC 5267	2
ILC 847	2	ILC 5270	2

* Resistance confirmed; for others requires reconfirmation.