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REPRODUCTION OF EIGHT POPULATIONS OF *HETERODERA CICERI* ON SELECTED PLANT SPECIES

by

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Summary. Investigations were undertaken in 1994-96 to asses differences in the reproduction of eight populations of the chickpea cyst nematode, *Heterodera ciceri*, from Jordan, Lebanon, Syria and Turkey on twenty-one plant species. Two sets of plastic pots, containing soil artificially infested with 20 eggs/g of the nematode, were prepared and seeds of each plant species or line were sown and kept in a plastic-house at 20 ± 2 °C. The plants in the first set were uprooted two months after emergence to count nematode life stages in the roots, while the other set was left for a further month to determine the population densities of nematodes in soil. All plants were infested but females and cysts occurred in large numbers only in the roots of chickpea, lentil, grass pea, pea and in some plants of *Cicer reticulatum* and *C. bijugum*. Few females were found in the roots of haricot bean. In the roots of *C. pinnatifidum*, annual medics and alfalfa large number of females occurred only of the populations from Kirbasi (Turkey) and Tel Hadya (Syria). Density of all nematode populations in soil, generally increased only in pots sown to chickpea, lentil, grass pea, pea and in some pots planted with *C. reticulatum* and *C. bijugum*; there was little increase of the Tel Hadya population on annual medics and alfalfa and of this population and that from Kirbasi on *C. pinnatifidum*. Results indicate that differences exist between reproduction potential of populations of *H. ciceri* from different geographical origin.

The chickpea cyst nematode (*Heterodera ciceri* Vovlas, Greco *et* Di Vito) causes severe damage to chickpea and lentil and also affects pea and grass pea. So far the nematode has been reported from Jordan, Lebanon, Syria and Turkey (Vovlas *et al.*, 1985; Di Vito *et al.*, 1994; Anonimous, 1995); however, its presence in other surrounding countries has not been determined. The tolerance limit of chickpea to the nematode was estimated to be 1 egg/g soil with 16 and 32 eggs/g soil causing 50% and 80% yield loss, respectively (Greco *et al.*, 1988; 1993). The control of the nematode with nematicides, soil solarization (Di Vito *et al.*, 1991) and crop rotation (Saxena *et al.*, 1992) is possible but each of these has its limitations. Moreover, the use of nematicides and soil solarization is un-economical because chickpea is very often planted on marginal lands. Host resistance seems to be the most convenient way to limit yield losses caused by the nematode. However, in species of the *Heterodera trifolii* Goffart group, to which *H. ciceri* belongs, twelve races have been identified for *Heterodera glycines* Ichinoe (Riggs and Schmitt, 1988) and up to five host races in *H. trifolii* (Cuany and Dalmasso, 1975; Mass *et al.* 1982a, b). Moreover, most of the available sources of resistance to cyst nematodes confer resistance to only a pathotype or race of the same species. Therefore, information on the occurrence of nematode pathotypes or races and their reaction to available sources

of resistance is a prerequisite before any breeding programme is started. Resistance to the chickpea cyst nematode was found in lines of *Cicer bijugum, C. pinnatifidum* and *C. reticulatum* (Singh *et al.*, 1989; Di Vito *et al.*, 1996). This resistance was tested only to a Syrian population of the nematode and there is no information on the occurrence of host races or pathotypes in *H. ciceri*. Therefore, nematode populations were collected in different chickpea production areas in the Middle East countries and evaluated for their host preference and reproduction to ascertain whether pathotypes or races exist in *H. ciceri*.

Materials and methods

The investigations were conducted from November to April during the 1994/95 and 1995/96 seasons in a plastic-house. Eight nematode populations, identified as *Heterodera ciceri* Vovlas, Greco *et* Di Vito, were studied; four from Turkey, two from Syria, one each from Lebanon and Jordan (Table I).

Nematode populations were reared on the line ILC 1929 of chickpea (*Cicer arietinum* L.) in a plastic-house. Cysts were extracted from the soil using a can similar to that described by Caswell *et al.* (1985) and kept separately. Cysts and soil debris were dried, mixed with an appropriate amount of steam sterilised sand and used as inoculum. Nematode density of each population was determined by sieving four subsamples of 10 g each through a 25 mesh sieve nested onto a 60 mesh sieve and sprayed with water. Cysts and debris on the 60 mesh sieve were filtered on a nematode paper filter and the cysts separated, crushed according to Bijloo's modified method (Seinhorst, 1966) and eggs counted. Appropriate amounts of this inoculum and NPK fertiliser were then incorporated into steam sterilised potting soil (50% sand, 19% silt, 31% clay), to give a population density of 20 eggs/g soil. Two hundred plastic pots, each containing one litre of soil, were prepared for each nematode population and arranged on two benches. Ten pots, five per bench, were sown with each of the tested plants. Number of seeds per pot varied according to seed size and was four for large seeds and ten for small seeds. Only one carnation seedling per pot was planted.

Among the tested plants (Table II), chickpea, lentil, grass pea, pea, annual medics and alfalfa were selected because they had been reported as hosts for *H. ciceri* (Mamluk *et al.*, 1983; Greco *et al.*, 1986), bean and soybean because they

TABLE I - *Populations of* Heterodera ciceri *tested and their geographical origin.*

Population number	Geographical origin		Crop plant
	Country	Detail and locality	
1	Syria	Idleb	Chickpea
2	Turkey	L12, Bismil	Lentil
3	Turkey	23/91, Kiziltepe	Chickpea
4	Turkey	36, Kirbasi	Chickpea
5	Turkey	69, Kadinahani	Chickpea
6	Syria	C11, Tel Hadya	Chickpea
7	Jordan	Irbid	Chickpea
8	Lebanon	Swairi, Bekaa Valley	Chickpea

TABLE II - *Average number of females per root system of six populations of* H. ciceri *during 1994/1995.*

Plant species and cultivar or line	Nematode population						
	1	2	3	4	5	6	Mean
Chickpea (*Cicer arietinum* L.), Ghab 1	742	322	182	952	1607	152	660
Lentil (*Lens culinaris* Medic.), Idleb 1	215	97	169	368	224	208	214
Grass pea (*Lathyrus sativus* L.), IFLA 347	320	150	442	355	970	145	397
Pea (*Pisum sativum* L.), IFPI 83	321	439	569	1120	706	1309	744
Faba bean (*Vicia faba* L.), ILB 163	0	0	2	0	2	1	1
Haricot bean (*Phaseolus vulgaris* L.), Local Syrian	49	66	34	54	9	10	37
Cowpea (*Vigna unguiculata* Walp.), Local Syrian	0	0	0	1	0	0	0
Lupin (*Lupinus albus* L.), Rabatab Sudan	32	6	32	6	5	9	15
Soybean (*Glycine hispida* Moench.), Evans	0	0	1	0	0	0	0
Vetch (*Vicia sativa* L.), Lolita	0	1	0	4	6	16	5
Annual medics (*Medicago rigidula* Desr.), IFMA 811	0	2	1	476	6	47	89
Alfalfa (*M. sativa* L.), Casalina	0	9	4	177	1	102	49
Spanish espercet (*Hedysarum coronarium* L.), Grimaldi	0	1	0	2	0	0	1
Crimson clover (*Trifolium incarnatum* L.), Diogene	0	6	0	30	0	1	6
Red clover (*Trifolium pratense* L.), Collestrada	0	0	0	5	2	2	2
White clover (*Trifolium repens* L.), Comunali	0	0	0	0	0	1	0
Cicer reticulatum Ladiz., ILWC 119	216	107	446	180	1005	50	334
C. bijugum Rech., ILWC 62	62	20	40	235	119	109	98
C. bijugum, ILWC 71	84	5	55	76	127	62	68
C. pinnatifidum Jaub *et* Sp., ILWC 213	4	1	4	99	13	100	37
C. pinnatifidum, ILWC 252	0	0	10	212	5	81	51
Carnation (*Dianthus caryophyllus* L.), from Holland	0	0	0	0	0	2	0
Grand mean	93	56	91	198	219	110	127.7
LSD at P = 0.05	126.2	83.4	88.2	267.7	358.8	144.3	69.33
SED	63.2	41.7	44.1	134.6	179.6	72.2	42.05
Significance	*	*	*	*	*	*	*

* Significance at $P \leq 0.05$.

are well known hosts for *H. glycines*, and carnation and *Trifolium* spp. because they are hosts for *H. trifolii*, all cyst nematodes of the same group. The line ILWC 119 of *C. reticulatum*, ILWC 62 and ILWC 71 of *C. bijugum* and ILWC 213 and ILWC 252 of *C. pinnatifidum* were used because they were resistant to the nematode in previous tests (Di Vito *et al.*, 1996). The remaining leguminous plants were tested to confirm their non-host or poor host status for the nematode. As the Idleb population is from the main chickpea growing areas in Syria, it has been used extensively for screening chickpea breeding material for cyst nematode resistance and it is possible that it might have undergone genetic change under the pressure of resistant chickpea progenies.

Plastic-house temperature was maintained at 20 ± 2 °C and pots were irrigated as required. Six nematode populations (Populations 1 to 6) were used in 1994/95 and those from Jordan (Population 7) and Lebanon (Population 8), in comparison with one from Syria (Population 1), in 1995/96.

Plants from one bench were uprooted 60 days after emergence when most of them were in the flowering to early podding stage. Roots were gently washed free of soil, weighed, fixed in 3% formalin in small plastic bottles (30-100 ml). All root samples were then processed ac-

cording to Coolen's method (Coolen, 1979) to extract and count nematodes, which were classified according to developmental life stages. This was done to ascertain the degree of nematode invasion of the root and the life stage the nematode could attain on different plants.

To evaluate the effect of tested plants on nematode reproduction, plants of the second bench were left for a further month to allow most of the female nematodes to develop to cysts. Then all plants were cut at ground level, the soil left to dry for a further ten days and then thoroughly mixed. Nematode cysts were extracted in a Fenwick can from 200 g sub-samples per pot. Futher separation of the cysts from soil debris was made with Seinhorst's flotation method (Seinhorst, 1974) in which a 1.25 specific gravity magnesium sulphate solution was used, instead of ethyl alcohol, for a complete recovery of newly formed full cysts. All cysts were then counted, crushed and their egg content determined. The reproduction rate of the nematode in each pot was calculated by dividing the nematode population after harvest with that at sowing (20 eggs/g soil).

For each nematode population, data were collected on the number of females and juveniles per root, and number of eggs per gram of soil. Statistical analysis for different traits, interactions and combined over different populations was done for both the experiments to determine the host range and population behaviour.

Results

Test conducted in 1994/95

The number of females per root system revealed significant differences among selected plant species and nematode populations (Table II). The highest number of females/root system was observed on pea, chickpea, grass pea, *C. reticulatum* and lentil. Faba bean, cowpea, soybean, vetch, Spanish espercet, crimson clover, white clover, and carnation showed almost no development of females in the roots (Table II). Other species, including haricot bean lupin, annual medics, alfalfa, *C. bijugum* and *C. pinnatifidum* exhibited some development of females in the roots.

Populations 4 and 5 from Turkey gave the highest root infestation. Population 6 from Tel Hadya, 1 from Idleb, Syria and Population 3 from Turkey were moderate in their aggressiveness and Population 2, also from Turkey, was the least aggressive.

The analysis of variance (ANOVA) for number of juveniles per root system (Table III) revealed statistical significant differences among different plant species and nematode populations.

The number of juveniles per root system was highest in chickpea followed by pea, grass pea, *C. reticulatum* and red clover (range 1141-2172 juveniles/root system). Carnation, lupin, faba bean, cowpea, soybean and Spanish espercet supported very few juveniles (range 8-161) per root system. Other species exhibited intermediate infestations (range 267-813 juveniles per root system).

The highest number of juveniles per root was recorded for Population 5 from Turkey (1143) followed by Population 4 from Turkey (748), Population 1 from Syria (539), Population 6 from Syria (528), Population 3 from Turkey (526), and Population 2 from Turkey (298).

The number of eggs per gram of soil (Table IV) indicated that there were differences between nematode populations and between plant species. The number of eggs per gram of soil was highest for Population 6, followed by Population 1, Population 2, Population 4, Population 3, and Population 5.

Among the plant species, the highest number of eggs in the soil was recorded in chickpea followed by pea, grass pea, *C. reticulatum, C. bijugum* and lentil (range 68-200 eggs/g soil). The reproduction rate of the nematode on these

plant species was well above one and ranged from 2 (Population 6 on lentil) to 24 (Population 6 on pea) (Table IV). In other species there were relatively few eggs per gram of soil and the reproduction rate of the nematode was less than one.

All nematode populations reproduced on some plants of *C. reticulatum*, although populations from Idleb (1), Bismil (2), Kiziltepe (3) and Kirbasi (4) reproduced much less than on chickpea. Nematode reproduction on *C. bijugum* was more on the line ILWC 62, especial-

TABLE III - *Average number of juveniles per root system in six populations of* H. ciceri *during 1994/1995.*

Plant species and line	Nematode population						Mean
	1	2	3	4	5	6	
Chickpea	4015	360	382	1392	6302	582	2172
Lentil	659	367	437	205	294	206	361
Grass pea	1550	365	1508	857	3682	783	1458
Pea	661	666	1695	1872	2019	2137	1508
Faba bean	56	7	54	41	94	25	46
Haricot bean	254	411	190	532	80	134	267
Cowpea	31	21	81	75	191	146	91
Lupin	34	24	154	4	25	42	47
Soybean	151	166	180	135	272	62	161
Vetch	389	632	577	1279	1177	802	810
Annual medics	71	81	124	944	489	362	345
Alfalfa	187	317	459	937	816	970	615
Spanish espercet	71	18	52	135	436	52	128
Crimson clover	167	559	780	1350	966	930	792
Red clover	335	737	935	1787	1862	1186	1141
White clover	104	161	404	339	989	1548	358
Cicer reticulatum	1545	519	987	1124	1761	1334	1212
C. bijugum ILWC62	440	374	590	1031	1076	357	645
C. bijugum ILWC71	487	250	621	367	637	354	453
C. pinnatifidum ILWC213	201	280	585	477	583	472	433
C. pinnatifidum ILWC252	444	220	752	1572	1379	515	814
Carnation	0	9	22	7	6	2	8
Gran mean	538.8	297.6	526.0	748.5	1142.7	527.8	630.2
LSD at P = 0.05	772.6	274.2	472.1	456.9	1053.3	342.8	209.9
SED	386.6	137.2	236.3	228.6	527.1	171.5	127.3
Significance	*	*	*	*	*	*	*

* Significant at P ≤ 0.05.

TABLE IV - *Average number of eggs/g soil of six populations of* H. ciceri *during 1994/1995.*

Plant species and line	Nematode population						Mean
	1	2	3	4	5	6	
Chickpea	371	222	207	162	140	100	200
Lentil	87	198	146	57	54	41	97
Grass pea	137	150	163	150	99	242	157
Pea	219	203	115	106	24	478	191
Faba bean	4	8	4	5	5	8	6
Haricot bean	2	4	4	2	2	5	3
Cowpea	2	6	4	3	1	6	4
Lupin	8	13	8	6	7	9	8
Soybean	1	7	2	39	1	4	9
Vetch	1	4	1	3	2	4	3
Annual medics	0	6	5	14	3	31	10
Alfalfa	5	8	6	20	12	49	17
Spanish espercet	3	3	7	3	2	7	4
Crimson clover	3	2	3	2	1	4	3
Red clover	1	4	2	1	3	4	3
White clover	0	2	2	3	2	2	2
Cicer reticulatum	170	56	115	104	197	176	136
C. bijugum ILWC62	53	14	28	106	247	271	120
C. bijugum ILWC71	31	15	20	38	24	279	68
C. pinnatifidum ILWC252	1	5	7	5	3	23	7
C. pinnatifidum ILWC252	1	7	4	24	6	56	16
Carnation	0	6	4	6	2	9	5
Grand mean	50.2	43.0	39.1	39.2	38.2	82.2	48.6
LSD a P = 0.05	49.1	42.3	47.4	48.9	131.7	129.3	28.2
SED	24.6	21.2	23.7	24.5	65.9	64.7	17.1
Significance	*	*	*	*	*	*	*

* Significant at P ≤ 0.05.

ly for populations from Kiziltepe (3), Kirbasi (4), Kadinhani (5) and Tel Hadya (6), than on the line ILWC 71 on which population from Bismil and Kadinhani (Turkey) did not reproduce. On the lines ILWC 213 and ILWC 252 of *C. pinnatifidum*, with the exception of Population 6 from Tel Hadya (Syria) and for that from Kirbasi (4) on ILWC 252, which gave poor reproduction in a few pots only, no reproduction was observed. On the other plants only alfalfa and annual medics allowed some reproduction of Population 6 from Tel Hadya, Syria.

Tests conducted in 1995/96

The data on number of females per root system revealed significant differences among the plant species and non-significant differences among the populations for females per root system (Table V). The highest number of females per root system was observed on chickpea, followed by pea, *C. reticulatum*, lentil and grass pea. Two wild *Cicer* species, *C. bijugum* and *C. pinnatifidum*, also showed some development of females in the roots and there was no infestation on the other plant species.

The ANOVA revealed significant differences for number of juveniles per root system among plant species and nematode populations. The range in number of juveniles per root system among species was from 2-2139; chickpea exhibited the highest number and carnation the lowest (Table VI). Among the populations, the

TABLE V - *Average number of females per root system of three populations of* H. ciceri *during 1995/1996.*

Plant species and line	Nematode population			
	1	7	8	Mean
Chickpea	555	977	612	715
Lentil	212	136	92	147
Grass pea	204	114	102	140
Pea	296	342	389	342
Faba bean	0	0	0	0
Haricot bean	0	0	0	0
Cowpea	0	0	0	0
Lupin	1	0	0	0
Soybean	0	0	0	0
Vetch	0	0	0	0
Annual medics	0	0	0	0
Alfalfa	1	1	0	1
Spanish espercet	0	0	0	0
Crimson clover	0	0	0	0
Red clover	0	0	0	0
White clover	0	0	0	0
Cicer reticulatum	282	169	180	210
C. bijugum ILWC62	62	4	1	22
C. bijugum ILWC71	56	14	3	24
C. pinnatifidum ILWC213	7	21	0	10
C. pinnatifidum ILWC252	2	0	0	0
Carnation	0	0	0	0
Grand mean	76.4	80.9	62.8	73.4
LSD at P = 0.05	121.5	199.5	183.1	81.8
SED	60.8	99.8	91.6	49.5
Significance	*	*	*	*

* Significant at P ≤ 0.05.

TABLE VI - *Average number of juveniles per root system of three populations of* H. ciceri *during 1995/1996.*

Plant species and line	Nematode population			
	1	7	8	Mean
Chickpea	1900	2347	2170	2139
Lentil	3989	320	217	412
Grass pea	380	630	625	545
Pea	555	1627	645	942
Faba bean	86	242	111	147
Haricot bean	155	227	115	166
Cowpea	22	1	1	8
Lupin	32	17	22	24
Soybean	46	75	35	52
Vetch	171	740	117	343
Annual medics	41	105	82	76
Alfalfa	119	132	87	113
Spanish espercet	104	150	250	168
Crimson clover	112	257	127	166
Red clover	111	185	172	156
White clover	94	129	200	141
Cicer reticulatum	642	997	962	867
C. bijugum ILWC62	592	459	485	512
C. bijugum ILWC71	430	670	542	547
C. pinnatifidum ILWC213	860	446	447	584
C. pinnatifidum ILWC252	662	397	652	571
Carnation	5	2	0	2
Grand mean	342	475	367	395
LSD at P = 0.05	284.9	330.7	402.6	163.4
SED	142.6	165.5	201.5	98.9
Significance	*	*	*	*

* Significant at $P \leq 0.05$.

highest mean density was recorded for Population 7 followed by Population 8 and Population 1 (Table VI).

The number of eggs per gram of soil (Table VII) revealed significant differences among the plant species but not among the nematode populations. The range of eggs/g of soil in different species was between 0 and 92. Chickpea, pea, lentil, *C. reticulatum* and grass pea were the most suitable hosts with a range from 35 to 92 eggs/g of soil. The reproduction rate of the nematode on all other plant species was less than one.

Discussion and conclusions

The average number of females and juveniles in the roots and eggs per gram of soil over

different nematode populations and years (Table VIII) revealed significant differences among nematode populations and plant species and that there was a highly significant nematode population x plant species interaction. Chickpea was most susceptible to *H. ciceri*. The other plant species which should be considered good hosts include lentil, grass pea, pea and *C. reticulatum*. In general, the number of males in the roots had the same trend as that of females and is not reported.

Different plant species were grown in the plastic-house at temperatures between 18°-22°C. Such temperatures are not congenial or optimum for good growth of all of the species but they have been shown to be good for nematode invasion and reproduction. For instance, haricot bean, soybean and cowpea are summer crops and wild *Ci-*

TABLE VII - *Average number of eggs/g soil of three populations of* H. ciceri *during 1995/1996.*

Plant species and line	Nematode population			
	1	7	8	Mean
Chickpea	117	51	107	92
Lentil	34	77	20	44
Grass pea	43	36	25	35
Pea	82	62	32	59
Faba bean	1	2	9	4
Haricot bean	2	3	4	3
Cowpea	1	2	1	1
Lupin	6	7	4	6
Soybean	1	3	1	2
Vetch	1	3	1	2
Annual medics	4	3	2	3
Alfalfa	2	2	0	1
Spanish espercet	1	2	1	1
Crimson clover	2	1	0	1
Red clover	0	2	1	1
White clover	1	1	0	1
Cicer reticulatum	22	40	63	42
C. bijugum ILWC62	13	6	12	10
C. bijugum ILWC71	7	7	8	7
C. pinnatifidum ILWC213	1	6	2	3
C. pinnatifidum ILWC252	4	3	2	3
Carnation	5	3	4	4
Grand mean	16.1	14.7	13.8	14.9
LSD at P = 0.05	24.9	18.5	30.8	12.0
SED	12.5	9.3	15.4	7.3
Significance	*	*	*	*

* Significant at P ≤ 0.05.

TABLE VIII - *Analysis of variance, combined over populations of* H. ciceri, *for females and juveniles per root system and eggs/g soil during 1995 and 1996.*

Source		1995				1996		
		Mean squares				Mean squares		
	Df	Females	Juveniles	Eggs	df	Females	Juveniles	Eggs
Replicate	3	9712.4	163523.9	120.5	3	17104.9	51561.1	237.8
Population	5	373506.5**	7339105.5**	25553.6**	2	7814.0	444007.3**	124.4
Replicate x Population	15	25987.2	190838.1	1845.8	6	13958.2	51967.4	253.1
Entry (plant species)	21	1115099.9**	7756613.1**	111146.9**	21	341074.2**	2728108.2**	6990.4
Entry x Population	105	126528.5**	1475766.9**	11608.7**	42	12474.5	121900.4**	627.2**
Residual	378	21026.5	194536.7	3578.6	189	14705.9	58869.0	319.2**
LSD at P = 0.05 for Population		36.0	109.6	14.9		30.2	60.5	4.5
LSD at P = 0.05 for Entry		69.0	209.9	28.5		81.83	163.7	12.1
LSD at P = 0.05 for Population x Entry		169.1	514.3	69.8		141.7	283.6	20.9

** = Significant at P ≤ 0.01.

cer spp. under plastic-house conditions require longer period than chickpea cultigens to attain different growing stages. Therefore, at the time the observations were made, development stages of different plant species were not exactly the same. Moreover, amounts of roots (= nematode food supply) per pot greatly differed among plant species. Thus, lentil, a good host for the nematode, showed poor root development compared to most of the other plant species. All this certainly affected the development of the nematode populations and therefore, the proportion of different life stages at observation times. Therefore, the data may not reflect what would have occurred under environmental conditions ideal for each plant species. Under field conditions of summer crops nematode egg hatch and root invasion would be suppressed as soil temperature approaches 30 °C (Kaloshian *et al.*, 1986). Neverthelesds it is assumed that the data are useful to elucidate the existing differences in the host suitability for *H. ciceri* from different geographic origins.

This study revealed that there are differences in the reproduction potential of nematode populations on different plant species. Further, Population 6 (from Tel Hadya, Syria) and Population 1 (Idleb, Syria) were more virulent than others. This investigation has confirmed the host status for *H. ciceri* of all plant species (except wild *Cicer* spp.) used in a previous study (Greco *et al.*, 1986). Moreover, alfalfa and annual medics are not considered as host species of the Idleb population of *H. ciceri* which in the present studies (both in 1994/95 and 1995/96) showed some reproduction of the population from Tel Hadya on annual medics, thus confirming the earlier findings by Mamluk *et al.* (1983). Among plant species that reduced nematode soil population density (Tables II and V), vetch and clovers had their roots invaded by large numbers of nematode juveniles of which only a few or none developed to adult females. This suggests that these winter plant species can profitably be rotated with very susceptible plants since they stimulate hatching of eggs of *H. ciceri* and reduce its soil population density. This also was true for *Medicago* spp. but some populations such as Population 4 from Kirbasi (Turkey) and 6 from Tel Hadya (Syria) showed reproduction on them.

The behaviour of all tested populations of *H. ciceri* on the wild annual species of *Cicer*, possessing resistance, was similar with the exception of population from Tel Hadya to which the level or resistance was rather low. This indicated that the use of any of the resistance source in breeding programmes would, in general, provide resis-

tance to all populations of the nematode. As the accessions ILWC 62 and ILWC 71 of *C. bijugum*, and ILWC 119 of *C. reticulatum* were heterogeneous populations and not pure lines, they may result in nematode reproduction, although generally less than on chickpea, but larger than that observed in microplots for the line ILWC 119 (2.4 vs 51.7 for *C. arietinum*) (Greco *et al.*, 1993). The use of pure lines, now available (Singh *et al.*, 1996), will allow a better characterization of populations of *H. ciceri*.

The investigation has demonstrated that most of the tested plants gave the same reaction to all populations of *H. ciceri*. Therefore, in future studies on the host suitability of populations of the nematode probably the use of chickpea, bean, *Trifolium alexandrinum* or *T. repens, Medicago rigidula*, and a larger number of resistant lines is suggested.

The combined results of the 1994/95 and 1995/96 tests for the population from Idleb, Syria (Table IX) showed that the largest number of

TABLE IX - *Average number of females and juveniles per root system and number of eggs/g soil in Population 1 of* H. ciceri *during 1994/1995 and 1995/1996.*

Plant species and line	Nematode developmental stage		
	Females	Juveniles	Eggs
Chickpea	649	2957	244
Lentil	214	529	61
Grass pea	262	965	90
Pea	309	608	150
Faba bean	0	71	3
Haricot bean	24	204	2
Cowpea	0	27	1
Lupin	17	33	7
Soybean	0	99	1
Vetch	0	280	1
Annual medics	0	56	2
Alfalfa	1	153	3
Spanish espercet	0	87	2
Crimson clover	0	140	3
Red clover	0	223	1
White clover	0	99	1
Cicer reticulatum	249	1094	96
C. bijugum ILWC62	63	516	33
C. bijugum ILWC71	70	459	19
C. pinnatifidum ILWC213	6	531	1
C. pinnatifidum ILWC252	1	553	3
Carnation	0	2	3
Grand mean	84.7	440.3	33.1
CV	102.3	94.4	83.5
LSD at P = 0.05	85.8	411.2	27.4

females per root and nematode eggs/g soil occurred on the susceptible hosts chickpea, lentil, grass pea and pea. Among the wild *Cicer* spp., *H. ciceri* developed on *C. reticulatum* and to a lesser extent on *C. bijugum*. On *C. pinnatifidum*, line ILWC 252, the development was almost negligible (only 1 female per root).

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