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EFFECT OF MEDITERRANEAN CULTIVATED PLANTS ON THE REPRODUCTION OF *HETERODERA CICERI*

by
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The cyst nematode *Heterodera ciceri* Vovlas, Greco *et* Di Vito causes considerable yield losses of chickpea (*Cicer arietinum* L.) in Syria (Greco *et al.*, 1984; Vovlas *et al.*, 1985). Damage due to a cyst nematode (probably the same species) in lentil (*Lens culinaris* Medic.), which is another important pulse in Syria, and other leguminous crops has also been reported in the same area (Bellar and Kebabeh, 1983; Mamluk *et al.*, 1983). Because of the low economic returns of the crops mentioned and a lack of cultivars resistant to the nematode, the only suitable way to satisfactorily control *H. ciceri* would be by crop rotation. There was little information on the host range of the chickpea cyst nematode and on its population density as affected by various plant species. Therefore, an investigation was undertaken in 1984 to ascertain the host status for plant species, of importance in the mediterranean region, to the nematode and their effect on the population density of the parasite.

Materials and Methods

A preliminary investigation was conducted in February-May 1984. Plastic pots, containing 5.5 dm^3 of soil infested with 75 cysts of the

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nematode/200g, were sown with a variable number of seeds, according to the plant species, and kept in a glasshouse maintained at 20-25°C. There were two pots for each of the 40 plant species. After two months 10g of roots per pot were comminuted in a blender and the female nematodes were counted.

A second investigation was undertaken from October 1984 to January 1985. Clay pots containing 750 cm^3 of a sandy loam soil were inoculated with 20 eggs of *H. ciceri*/cm^3 soil and either sown or planted with 54 plant species, belonging to 14 botanical families, including the species tested in the preliminary experiment. Some of the plant species in this test were used to differentiate the host range of *H. ciceri* from those of closely related *Heterodera* species. Pots were arranged on benches in a glasshouse at 18-23°C with ten pots sown with each plant species. Fortyfive days after germination, when the nematode specimens on the roots were mostly adults, plant in five pots were uprooted, the roots washed free of adhering soil and comminuted, and nematodes extracted according to Coolen's method (1979). The nematodes were counted and classified according to their developmental stages. Plants in the remaining pots were cut down to soil level 20 days later, when most of the specimens in the roots reached the cyst stage. Ten days later the soil from each pot was thoroughly mixed, air dried and sub-samples of 200g each were processed by the Fenwick can and Seinhorst's method (1974). Since many of the cysts in the soil were new, magnesium sulphate solution (1.25 sp. g.) was used instead of the alcohol, to increase the recovery of cysts from soil debris. Cysts were then crushed according to Bijloo's modified method (Seinhorst and Den Ouden, 1966) and the egg content estimated.

Results and Discussion

The results of the two investigations were substantially similar, and therefore only data from the second experiment are reported (Table I). Chickpea, lentil and pea were heavily infested indicating that they are very good hosts of *H. ciceri*. Grasspea was rated as good host. Among other leguminous species, bean, lupin, and alfalfa proved to be poor hosts, and crimson clover, faba bean, annual medics, red clover, and vetch were very poor hosts. Cowpea, previously reported as a host (Vovlas *et al.*, 1985), soybean, spanish espercet and white clover, among the leguminous species, were non hosts of *H. ciceri*. However, on the soybean cultivar of the first test, a few females of the nematode were produced. High numbers (79-246)

Table I - *Plant species tested as host of* Heterodera ciceri

Plant species			Nematode specimens/5g roots				P_f/P_i	Host[1] status
Common name	Botanical name	Cultivar, hybrid or line	J2	J3+J4	♀	♂J4		
Leguminosae								
Bean	*Phaseolus vulgaris* L.	La Victoire	161	69	50	31	0.67	p
Chickpea	*Cicer arietinum* L.	ILC 482	0	141	691	161	4.72	gg
Cowpea	*Vigna unguiculata* Walp.	Azuki	246	0	0	2	0.84	nh
Crimsom clover	*Trifolium incarnatum* L.	Local Italian	261	9	3	3	0.82	pp
Faba bean	*Vicia faba* L.	Local Syrian	12	17	2	19	0.75	pp
Grasspea	*Lathyrus sativus* L.	Acc. 347	21	114	363	93	4.08	g
Lentil	*Lens culinaris* Medic.	ILL 4400	0	337	1653	385	34.82	gg
Lupin	*Lupinus albus* L.	Local Italian	1	4	28	5	0.81	p
Annual medics	*Medicago rigidula* Desr.	Sel. 716 Acc. 811	564	72	8	0	1.02	pp
Alfalfa	*Medicago sativa* L.	Bresaola	512	131	33	0	0.72	p
Pea	*Pisum sativum* L.	Progress 9	0	704	5193	1210	5.00	gg
Red clover	*Trifolium pratense* L.	9789	16	7	1	1	0.92	pp
Soybean	*Glycine hispida* Moench.	Kent	240	7	0	0	1.1	nh
Vetch	*Vicia sativa* L.	Acc. 2541	11	27	7	15	3.14	pp
Spanish espercet	*Hedysarum coronarium* L.	Local Italian	79	0	0	0	0.61	nh
White clover	*Trifolium repens* L.	Nano Huia	181	0	0	0	0.57	nh
Polygonaceae								
Curled dock	*Rumex crispus* L.		386	17	0	42	0.57	nh
Caryophyllaceae								
Carnation	*Dianthus caryophyllus* L.	Astor	0	2	7	1	1.08	pp
Chenopodiaceae								
Sugarbeet	*Beta vulgaris* L.	Buramo	0	0	0	0	0.63	nh
Spinach	*Spinacia oleracea* L.	Riccio d'America	0	0	0	0	0.67	nh

Table I - (continued)

Plant species			Nematode specimens/5g roots				P_f/P_i	Host [1] status
Common name	Botanical name	Cultivar, hybrid or line	J2	J3+J4	♀	♂J4		
Cucurbitaceae								
Cucumber	*Cucumis sativus* L.	Mezzo lungo verde	47	0	0	0	0.65	nh
Gourd	*Cucurbita ficifolia* L.	Local Syrian	0	0	0	0	0.79	nh
Melon	*Cucumis melo* L.	Cantalupo di Charentais	0	0	0	0	1.02	nh
Watermelon	*Citrullus vulgaris* Schrad.	Sugar baby	50	0	0	0	0.61	nh
Zucchini	*Cucurbita pepo* L.	Ambassador hybrid	0	0	0	0	0.88	nh
Solanaceae								
Egg plant	*Solanum melongena* L.	Bellezza nera	0	0	0	0	0.52	nh
Pepper	*Capsicum annuum* L.	Yolo Wonder	0	0	0	0	0.83	nh
Potato	*Solanum tuberosum* L.	Elvira	0	0	0	0	0.72	nh
Tomato	*Lycopersicon esculentum* Mill.	Ventura	0	0	0	0	0.85	nh
Cruciferae								
Cabbage	*Brassica oleracea* L.	Cuore di bue	0	0	0	0	0.93	nh
Cauliflower	*Brassica oleracea* var. *botrytis* L.	Gigante di Napoli	0	0	0	0	0.73	nh
Rashad	*Nasturtium fontanum* Asch.	Local Syrian	0	0	0	0	0.61	nh
Turnip	*Brassica rapa* L.	Precoce Natalino	0	0	0	0	0.51	nh
Umbelliferae								
Carrot	*Daucus carota* L.	Sel. 92	0	0	0	0	0.78	nh
Celery	*Apium graveolens* L.	Tall Utah	0	0	0	0	0.67	nh
Coriander	*Coriandrum sativum* L.	Local Syrian	0	0	0	0	0.86	nh
Fennel	*Foeniculum vulgare* Mill.	Grosso romanesco	0	0	0	0	0.75	nh
Parsley	*Petroselinum hortense* L.	Local Italian	0	0	0	0	0.95	nh
Liliaceae								
Garlic	*Allium sativum* L.	Local Italian	0	0	0	0	0.62	nh
Onion	*Allium cepa* L.	Bianca di Giugno	0	0	0	0	0.48	nh

Table I - (continued)

Plant species			Nematode specimens/5g roots				P_f/P_i	Host[1] status
Common name	Botanical name	Cultivar, hybrid or line	J2	J3+J4	♀	♂J4		
Compositae								
Artichoke	*Cynara scolymus* L.	Romanesco	0	0	0	0	0.74	nh
Lettuce	*Lactuga sativa* L.	Verde degli Ortolani	0	0	0	0	1.03	nh
Sunflower	*Helianthus annuus* L.	Sole d'oro	0	0	0	0	1.21	nh
Malvaceae								
Cotton	*Gossypium herbaceum* L.	Local Syrian	0	0	0	0	0.77	nh
Okra	*Hibiscus esculentus* L.	Local Syrian	0	0	0	0	1.02	nh
Rosaceae								
Strawberry	*Fragaria* x *ananassa* Duch.	Tioga	0	0	0	0	0.89	nh
Linaceae								
Flax	*Linum usitatissimum* L.	Local Syrian	0	0	0	0	1.03	nh
Graminaceae								
Barley	*Hordeum vulgare* L.	Aramis	0	0	0	0	0.75	nh
Bread Wheat	*Triticum vulgare* Vill.	Fortunato	0	0	0	0	0.95	nh
Durum Wheat	*Triticum durum* Desf.	Creso	0	0	0	0	0.66	nh
Maize	*Zea mais* L.	Lorena hybrid	0	0	0	0	0.91	nh
Oat	*Avena sativa* L.	Rogar 8	0	0	0	0	0.67	nh
Sorghum	*Sorghum vulgare* Pers.	N-K 180	0	0	0	0	0.51	nh
Triticale	*Triticasecale* Withmack	Driva outcross 7 Syria	0	0	0	0	0.58	nh
LSD: P=0.05			85	101	481	113	1.42	
P=0.01			112	134	635	149	1.87	

[1] No female = nh (non host); 1-20 females = pp (very poor host); 21-100 females = p (poor host); 101-500 females = g (good-host); > 500 females = gg (very good host).

of second stage juveniles were found in the roots of the third group of plant species, and only a very few males in the roots of cowpea.

Generally, many more juvenile stages were osberved within the roots of those leguminous species on which the nematode either did not reproduce or reproduced poorly. Among non leguminous species, only a few females were observed in two out of five plants of carnation, reported as host for some populations of *H. trifolii* Goffart (Marinari, 1960; Ritter, 1960; Cuany and Dalmasso, 1975). On curled dock, the type host for *H. rosii* Duggan *et* Brennan (1966), no females were produced, but many second stage juveniles invaded the roots and among which only a few developed to fourth stage females and males.

On *Chenopodiaceae* and *Cruciferae*, which can be infested with some European populations of *H. trifolii* (Maas and Heijbroek, 1982), neither females nor juveniles were observed. Among non leguminous non host species, a few second stage juveniles penetrated the roots of cucumber and watermelon of the *Cucurbitaceae*, but no further development occurred in these plants.

It is noteworthy that the tested *Trifolium* spp., reported as host for *H. trifolii* (Mulvey and Anderson, 1974) and *H. daverti* (Wouts and Sturhan, 1978) were practically non hosts for *H. ciceri*, as only second stage juveniles invaded the roots of white clover and very few females developed on crimson and red clover.

The reproduction rate of *H. ciceri* (P_f/P_i = Final population/Initial population) (Table I) was well above 1 in the pots planted with chickpea, grasspea, pea, vetch, and lentil which gave the highest value (34.8). However, the reproduction of the nematode on chickpea and pea was not as high as would be expected from the number of females found on the roots of these species. Most probably the cultivars of chickpea and pea tested were very susceptible and their root systems did not develop sufficiently to feed the numbers of females per pot, and therefore a rather low reproduction rate was achieved. In all other pots planted with non-host or poor host plant species, the population density of *H. ciceri* remained at sowing level or declined markedly. The slight population increase apparently obtained in pots with some non host plants may be attributed to experimental error.

The results indicate that *H. ciceri* has a rather different host range compared with other closely related *Heterodera* species. Nevertheless, among good hosts it shares pea and grasspea with *H. goettingiana* Liebscher (Jones, 1950; Di Vito *et al.*, 1980).

The host range of *H. ciceri* is clearly confined to leguminous species. Therefore, in infested areas the use of crop rotations, with non leguminous crops, should provide effective control of the nematode.

SUMMARY

Fiftyfour plant species, belonging to fourteen botanical families, were tested under glasshouse conditions for their effect on the reproduction of *Heterodera ciceri*. Chickpea, lentil, grasspea, and pea were good hosts of the nematode. Among other legumes, bean and alfalfa were poor hosts, crimsom clover, red clover, faba bean, annual medics, soybean, and vetch were very poor hosts, and cowpea, spanish espercet, and white clover were non-hosts for the nematode. Among non leguminous crops, very few females of the nematode developed on carnation and only juveniles and males were found on curled dock. The population of the nematode increased markedly in pots containing the good host plants and generally declined in those planted with plants which were poor hosts or non-hosts.

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