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RESPONSE OF FORAGE VETCHES AND FORAGE PEAS TO ROOT-KNOT NEMATODE (MELOIDOGYNE ARTIELLIA) AND CYST NEMATODE (HETERODERA CICERI)

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Summary. One hundred genotypes (lines) of forage peas (*Pisum sativum* L.) and eighty-one of vetches (*Vicia* spp.) were examined for their response to cyst nematode (*Heterodera ciceri*) and root-knot nematode (*Meloidogyne artiellia*) in 1985/86 and 1986/87 seasons in a heavily infested field with both nematodes at ICARDA's research station in Northern-Syria. Forage peas genotypes were severely attacked by *H. ciceri* and vetches were severely attacked by *M. artiellia*. Only six genotypes of common vetch were attacked by both nematodes. Genotypes possessing resistance or tolerance under field conditions were tested in the glasshouse using artificial infection. Glasshouse tests indicated that woolly-pod vetch (*Vicia villosa spp. dasycarpa* sel. 683) was highly resistant to root-knot nematode, repeating its performance under field conditions. Field and glasshouse screening did not yield highly resistant common vetch genotypes to *M. artiellia* or highly resistant forage peas genotypes to *H. ciceri*, but some genotypes were tolerant.

Annual forage legume crops such as vetches (*Vicia* spp.) and peas (*Pisum sativum* L.) are one of the alternatives being studied to replace fallow in the traditional cereal-based rotations in the dry areas of West-Asia and North Africa region. Such cool season legume species are of considerable value to the expanding livestock population in this region (Abd El Moneim *et al.*, 1988; 1990). However, they are susceptible to root-knot nematode (*Meloidogyne artiellia* Franklin) and cyst nematode (*Heterodera ciceri* Vovlas Greco *et* Di Vito), which nematodes are a major limiting factor in introducing these legumes in West Asia and North Africa (ICARDA, 1985).

Seventeen species of *Vicia* have been reported to be susceptible to root-knot nematodes (Bessey, 1911; Malloch, 1923 and Buhrer *et al.*, 1923). Also, the root-knot nematode (*Meloidogyne incognita acrita*) parasitizes *Vicia villosa* (Martive and Birchfield, 1955). Common vetch cv. Warrior, developed by Auburn University Agricultural Experimental Station is reported to be resistant to three of five important root-knot nematode species and acts as trap crops (Minton *et al.*, 1965). *Vicia calcarata*, *V. serratifolia*, and 17 F_7 and F_8 hybrids from the *V. sativa* x *V. cordata* cross have been reported as resistant to *Meloidogyne incognita*, *M. incognita acrita* and *M. javanica* but susceptible to *M. arenaria* and *M. hapla*. *Vicia angustifolia* was susceptible to all five nematode species (Minton *et al.*, 1966; Minton and Donnelly, 1967).

The root-knot nematode was identified as *Meloidogyne artiellia* Franklin (Mamlouk *et al.*, 1983). This nematode has been reported in the Mediterranean basin only. The cyst nematode was tentatively identified as *Heterodera rosii* Duggan *et* Brenan, 1966. There were no records of this nematode in the region (Lamberti, 1981). This nematode was found on chickpea (*Cicer arietinum* L.), vetches (*Vicia* spp.), peas (*Pisum sativum* L.), annual medics (*Medicago* spp.) and chicklings (*Lathyrus* spp.). But light and scanning electron microscopy studies and the host range of the cyst nematode infesting chickpea in Syria have shown that the nematode is a new species *Heterodera ciceri* (Volvas *et al.*, 1985). In Northern Syria *M. artiellia* and *H. ciceri* cause considerable damage to forage vetches and peas. Losses of grain yield varied from 47 to 76% in *V. narbonensis L.* (narbon vetch) and 2 to 12% in *V. villosa* spp. *dasycarpa Ten* (woolly-pod vetch) ICARDA, 1988. *H. ciceri* causes also damage to other grain legume crops (Greco *et al.*, 1984; ICARDA, 1985; Saxena *et al.*, 1987). Developing resistant cultivars of these forage legume species has been hampered by the lack of suitable sources of resistance and also lack of rapid reliable screening procedures. Species carrying resistance to these nematodes could be of much greater value in areas of adaptation and heavily infestation.

The high incidence of root-knot nematode (*M. artiellia*) and cyst nematode (*H. ciceri*) during the last decade led to initiation of a program of screening forage legumes for resistance. The objectives of the breeding program were (i) to screen a large number of genotypes (selections) of forage vetches and peas for resistance to both *H.*

ciceri and *M. artiellia*, under natural field conditions in highly infested soil occurring naturally, (ii) to select some genotypes as sources of resistance and to use them in another cycle of screening under artificially infested soil (controlled) conditions and (iii) to identify highly resistant genotypes to be used as a basic materials for breeding program by national research programs in West Asia and North Africa (ICARDA region).

Materials and methods

One hundred genotypes (lines) of forage peas (*Pisum sativum L.*) and eighty-one of forage vetches including 79 common vetch (*V. sativa L.*) one each of narbon vetch (*V. narbonesis L.*) and woolly-pod vetch (*V. villosa* ssp. *dasycarpa Ten*) were screened for resistance to root-knot nematode (*M. artiellia*) and cyst nematode (*H. ciceri*) at ICARDA's research station at Tel Hadya in North Syria. Tel Hadya has estimated annual rainfall of 342 mm (Dennet *et al.*, 1983), and growing period of 5 to 6 months. The climate is Mediterranean with rainfall from October until May. The soils are well structured reddishbrown clay, classified as Vertical Luvisols with PH 8.0-8.5.

Screening was done in a soil naturally and heavily infested with both nematodes. Nematodes population was monitored by taking soil samples before planting and during crop growth (Table I). The screening was carried out during the 1985/86 and 1986/87, growing seasons. Each of the forage vetches and peas was sown in a separate trial in a triple lattice design with three replicates. Plot size was 5x5.8 m^2. The experiments were sown with an Oyjord experimetnal drill 10 days after the first autumn rains in each season. Seeding rate was 100 kg/ha and all plots received a basal dressign of 40 kg P_2O_5/ha.

To monitor nematode population soil samples were taken during the growth period of the plants at approximately 4 week interval. Five samples of soil from each replicate were taken. Each sample was compiled by taking a zig-zag course through a replicate and collecting ten 1-kg lots of soil, which were then thoroughly mixed and a 1-kg aliquot removed for extraction. Nematodes were extracted and counted by Jenkins rapid centrifugal floating technique (Jenkins, 1961).

At the beginning of the flowering stage (about 10-12 weeks after germination), 10 guarded plants from each plot of each genotype were harvested, the roots were washed free of soil and rated for severity of galling for *M. artiellia* based on the following scale of scoring: 1 = no-galling (resistant); 2 = light galling (tolerance); 3 = moderate galling (moderately tolerance); 4 = heavy galling (susceptible); and 5 = very heavy galling (highly susceptible). For *H. ciceri*, genotypes were rated by using 1-5 rating scale based on number of female nematode where, 1 = free of infestation (resistant); 2 = 1-5 females (tolerant); 3 = 6-20 females (moderately tolerant); 4 = 21-50 females (susceptible); and 5 >50 females (highly susceptible).

Genotypes with an average rating of 1 and 2 for each kind of nematode were selected and tested under artificial conditions in a glasshouse in 1987/88. Seeds were surface sterilized with 1% mercuric chloride and then thoroughly washed with sterilized water. Seeds of each genotype were sown in 20 cm diameter pots (at 4 seeds/pot) filled with sterilized soil (20% sand, 33% silt, 46% clay and 0.8% organic matter). Nematodes were extracted from infested soil by using a device larger but similar to that used by Caswell *et al.*, 1985. Infection with cyst nematoe was done before planting by adding appropriate amounts of soil-cyst mixture to the sterilized potting mixture to give 20 eggs and juveniles/cm^3 soil. Two weeks after sowing seedlings were thinned to two plants per pot. Root-knot infection was assessed according to Minton *et al.*, 1966. Pots were arranged on benches in a glasshouse maintained at 16-27C°, in a randomized block design with four replicates. The pots were irrigated as required. Two trials were conducted, one for *H. ciceri* and the other for *M. artiellia*. The levels of nematode infestation were determined 12 weeks after sowing as described before under field conditions using the same scale of scoring.

TABLE I - *Mean numbers of* Heterodera ciceri *and* Meloidogyne artiellia *per 500 cm^3 soil present in the experimental field at different dates.*

	Season-date	*H. ciceri* [1]	*M. artiellia* [2]
1985/86			
	20.10.1985	85	675
	30.11.1985	79	730
	22.12.1985	70	1125
	31.01.1986	73	1530
	3.03.1986	98	1400
	1.04.1986	101	2100
	26.04.1986	120	2410
1986/87			
	26.10.1986	95	804
	12.12.1986	104	1010
	13.01.1987	80	1140
	15.02.1987	84	1700
	14.03.1987	105	1350
	14.04.1987	118	2010
	14.05.1987		

[1] Juveniles + males; [2] Juveniles.

Results and discussion

Population of *M. artiellia* and *H. ciceri* substantially increased during growing period of the plants (Table I). Mature root-knot females were observed in mid March, while white cysts appeared in mid April.

In the field vetches were severely attacked by *M. artiellia* and peas were severely attacked by *H. ciceri.* Only six entries by common vetch (*V. sativa L.*) were attacked by both cyst and root-knot nematodes. Three vetches (common vetch sel. 2095, 1934 and woolly-pod vetch sel. 683) were resistant to root-knot nematode (Table II). Twenty-two entries were tolerant, 30 moderately tolerant and 16 were susceptible. The local common vetch acc. 2541 was susceptible to root-knot nematode.

In forage peas only one entry (sel. 61) showed resistance, 17 tolerance and the remaining 83 entries were moderately tolerant and susceptible to cyst nematode (Table III).

Plants screened in the glasshouse confirmed the results obtained in the field viz. that the woolly-pod vetch is resistant to root-knot nematode. Narbon vetch acc. 67 and 8 common vetch entries showed tolerance, but the other 15 entries of common vetch did not show the tolerance that was observed in the previous two seasons in the field.

The glasshouse screening of the 18 entries of peas mostly failed to demonstrate the resistane and tolerance to *H. ciceri* which was evident in the previous two years in the field. Selection 61 did not repeat its resistant performance. However, there were five entries showing good tolerance and this group included selection 61 (Table IV).

The results cofirm those of others (Greco *et al.*, 1984; ICARDA, 1985; Saxena *et al.*, 1987) and contribute additional information about the reaction of *Vicia* spp. and *P. sativum* to *M. artiellia* and *H. ciceri.* The low root-knot indices obtained for woolly-pod vetch selection 683 in the field and in the glasshouse confirmed its resistance. High level of resistance possibly exists in other genotypes, hence the desirability of examining additional genetic materials. Additional vetches and forage peas from other resources should also be tested. The high level of resistance to *M. artiellia* in woolly-pod vetch selection 683 is of a great value in soils where this nematode is a serious problem. In addition it can act as a trap crop.

For annual forage legume species such as *Vicia* spp. and *P. sativum*, the only practical and economic means of controlling these nematodes is the use of genetically resistant genotypes. Screening for sources of resistance is the most important step in establishing any breeding programme for nematode resistance.

TABLE II - *Mean root-knot indices of* Vicia spp. *under field conditions during 1985/86 and 1986/87* (M. artiellia).

	Rating scale [1]				
	1	2	3	4	5
No. of entries	3	22	30	13	13
% of total	3.7	27	37	16	16
Resistance class	R	T	MT	S	HS

[1] Root-knot indices based on 1 = no galling (R); 2 = light galling (T); 3 = moderate galling (MT); 4 = heavy galling (S); 5 = very heavy galling (HS).

TABLE III - *Means cyst nematode indices of forage peas under field conditions during 1986/87 and 1987/88* (H. ciceri).

	Rating scale [1]				
	1	2	3	4	5
No. of entries	1	17	45	38	–
% of total	1	17	45	38	–
Resistance class	R	T	MT	S	HS

[1] Cyst indices based on 1 = free (R); 2 = 1-5 females (T); 3 = 6-20 females (MT); 4 = 21-50 females (5); 5 >50 females (HS).

TABLE IV - *Forage vetches and peas promising genotypes (lines) for their response to* M. artiellia *and* H. ciceri.

Vetches entries	Rating for M. artiellia	Peas entries	Rating for H. ciceri
Sel. 683 [a]	1	61	2
Sel. 2095	2	496	2
Sel. 1934	2	166	2
Acc. 67 [b]	2	175	2
Sel. 1448	2	330	2
Sel. 1437	2		
Sel. 2020	2		
Sel. 1136	2		
Sel. 715	2		
Sel. 2019	2		

[a] Woolly-pod vetch (*V. villosa ssp. dasycarpa*); [b] Narbon vetch (*V. narbonensis.*

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