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ADVERSE EFFECT OF *MELOIDOGYNE INCOGNITA* ON THE FUNCTIONING OF NODULES OF MUNGBEAN (*VIGNA RADIATA*)

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Root-knot nematodes, *Meloidogyne* spp., can interfere with the process of symbiotic nitrogen fixation between legume host and *Rhizobium* (Sharma and Sethi, 1976; Chahal *et al.*, 1985). This was examined in an experiment with mungbean (*Vigna radiata* L.) and *Meloidogyne incognita* (Kofoid *et* White) Chitw.

Materials and Methods

Surface sterilized seeds of mungbean cv. G-65 were inoculated with a culture of *Rhizobium* strain R-7 at 1 M (approx. 10^8 cells)/5 g seed. Five seeds were sown in clay pots (15 cm diam) containing 750 g steam-sterilized sandy loam soil and after ten days the seedlings were thinned to one per pot and the pots inoculated with 250, 500, 1000 or 2000 freshly hatched second stage juveniles of *M. incognita*. Each treatment was replicated 20 times including the untreated (rhizobia only) control; the pots were kept in a glasshouse throughout the experiment. Forty days after nematode inoculation the experiment was ended and measurements were made of shoot length, dry weights of shoots and roots, number of nodules and galls, and root and soil populations of nematodes were recorded. Chlorophyll content of leaves (Witham *et al.*, 1971), leghaemoglobin content of nodules (Wilson and Reisenauer, 1963), nitrogenase activity of nodules (Hardy *et al.*, 1973), bacteroid content of nodules (Bergersen, 1961) and total nitrogen uptake by the plants (Piper, 1950) were measured.

Results and Discussion

Shoot length and dry weight of shoots progressively decreased with increase in the initial inoculum levels of nematodes but the dry weight of roots increased with increase in nematode inoculum up to 500 juveniles/pot but then further increase in the number of nematodes, i.e., 1000 and 2000 juveniles/pot, caused significant reduction (Table I). Increasing numbers of nematodes caused a significant reduction in the chlorophyll content 'a' and 'b' of leaves (Table I) which ultimately led to the reduced production and supply of carbohydrates to the nodules for carrying out nitrogen fixation (Minchin and Pate, 1973; Chahal *et al.*, 1983).

Rhizobium inoculated plants without nematodes had conspicuously large and pink-coloured nodules whereas nodules on nematode infested plants were brownish in colour. The numbers of nodules/plant and their dry weight were significantly reduced by nematode infection (Table II) which agrees with earlier reports (Hussaini and Seshadri, 1975; Sharma and Sethi, 1976; Chahal *et al.*, 1985). Root-knot nematode juveniles directly interfere with the establishment of rhizobia (Hussaini and Seshadri, 1975) and the secretion of hydrolytic and oxidative enzymes or growth regulators produced by nematodes may play a determinative role in nodule development (Barker *et al.*, 1972; Ali *et al.*, 1981) and the competitive phenomenon (Malek and Jenkins, 1964).

Nitrogenase activity, leghaemoglobin and bacteroid contents of nodules were significantly reduced by nematode infection (Table II). Inoculum levels of 1000 and 2000 juveniles/pot caused more reduction than those of lower levels. Total nitrogen uptake by the shoots also decreased with increase in the initial inoculum levels of nematodes. Invading nematodes are considered to disturb the functioning of nodules by altering host nutrition (Doney *et al.*, 1970) and by reducing the leghaemoglobin (Sharma and Sethi, 1975; Chahal and Singh, 1984) and bacteroids (Barker *et al.*, 1972; Ali *et al.*, 1981) content of nodules. As leghaemoglobin regulates the supply of oxygen and bacteroids contain nitrogenase enzyme required for the reduction of atmospheric nitrogen to ammonia, then a decrease in these due to nematode infection would lead to a decrease in fixation of nitrogen.

The minimum number of nematodes used as initial inoculum formed the maximum number of galls and with further increase in the number of nematodes there was a decrease in the number of galls/plant (Table III). Similar results have also been reported with tomato (Jones and Nirula, 1963), cowpea (Sharma and Sethi, 1975) and peas (Chahal and Singh, 1984). Maximum multiplication of nematodes occurred with an initial inoculum

Table I - *Effect of different leaves of* Meloidogyne incognita *on growth characters of mungbean cv. G-65 inoculated with* Rhizobium *strain R-7 (Data represent average of 3 replications).*

Levels of nematodes per pot	Shoot length (cm)	Dry weight of shoot (g)	Dry weight of root (mg)	Chlorophyll contents of leaves (mg/0.5 g leaves)	
				'a'	'b'
0	90.0	7.4	827	2.79	2.16
250	87.4	6.8	908	1.86	1.42
500	82.2	5.9	1085	1.52	1.25
1000	54.1	3.8	780	1.12	1.08
2000	45.0	3.0	602	0.97	0.90
Level of significance at 5%	17.998	1.211	0.942	0.1042	0.101

Table II - *Effect of different levels of* Meloidogyne incognita *on nitrogen fixation and symbiotic characters of mungbean cv. G-65 inoculated with* Rhizobium *strain R-7 (Data represent average values of 3 replications).*

Levels of nematodes per pot	No Nodules/ plant	Dry weight of nodules/ plant (mg)	Nitrogenase activity (μm C_2H_4/h/g dry weight nodules)	Leghaemoglobin /g fresh nodules	Bacteroids (X 10^3/g fresh nodules)	Nitrogen of shoots (%)
0	127	83	137	5.85	9.98	3.81
250	72	42	114	4.25	7.65	3.28
500	37	34	62	3.87	3.57	3.05
1000	12	12	42	2.05	2.11	2.06
2000	10	11	39	1.95	1.98	1.92
Level of significance at 5%	11.527	10.685	20.085	0.985	0.216	0.209

Table III - *Multiplication of* Meloidogyne *in the soil and roots of mungbean cv. G-65 inoculated with* Rhizobium *strain R-7 (Data represent average values of 3 replications).*

Nematode inoculum per pot	No Galls/plant	Number of nematodes		Multiplication
		Soil	Roots	
0	—	—	—	—
250	2127	675	4741	22
500	1498	1927	65495	135
1000	1075	9937	42594	53
2000	740	7291	34232	21
Level of significance at 5%	649	1793	N.S.	—

of 500 juveniles/pot which was significantly greater than at higher inocula. This might be due to the inability of the host to provide sufficient nutrients for large numbers of nematodes (Sharma and Sethi, 1976).

From the results of the experiment, it may be concluded that *M. incognita* affects symbiotic nitrogen fixation not only by reducing the number of nodules but also by disturbing the functioning of nodules due to decrease in the photosynthate supply, and bacteroid and leghaemoglobin content of nodules.

SUMMARY

Meloidogyne incognita caused reduction in the number of nodules, dry weight of nodules, dry weight of shoot, total nitrogen uptake and chlorophyll contents of leaves of mungbean (*Vigna radiata* L.) cv. G-65. The functioning of nodules was adversely affected by nematode infection which could be attributed to reduction in the bacteroids, leghaemoglobin contents of nodules and reduced supply of photosynthate to the nodules.

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