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Department of Microbiology and Plant Pathology, Punjab Agricultural University, Ludhiana, India

EFFECT OF IRON INTERACTION WITH *RHIZOBIUM* SP. AND *MELOIDOGYNE INCOGNITA* IN RELATION TO UPTAKE OF NITROGEN, IRON AND ZINC IN MUNGBEAN

by

P. P. K. CHAHAL, V. P. S. CHAHAL, N. P. KAUR[1] and C. L. ARORA[1]

Summary. The effect of *Rhizobium* sp. and *Meloidogyne incognita* on nodulation, nitrogen fixation and translocation of Fe and Zn in the shoot of mungbean (*Vigna radiata*) cv. SML-32 was investigated in plants grown in the presence of different concentrations of Fe. Application of Fe at 20 ppm produced the maximum number of nodules per plant, nitrogenase activity of nodules, dry weight of shoots per plant and N content of shoot. However, 30 ppm Fe had an adverse effect on all these characters and reduced the translocation of Fe and Zn in the shoot.

Meloidogyne incognita reduces nitrogen fixation in legumes (Chahal and Chahal, 1987) and affects the absorption and translocation of nutrients (Meon *et al.*, 1978). Fe and Zn play an important role in the nodulation of legumes. No information is available on requirements of Fe for legume growth, nodule functioning as well as its absorption and translocation in nodulated and non-nodulated legumes infected by *M. incognita*. In the present investigation, interaction of Fe with *Rhizobium* sp. and *M. incognita* (Kofoid *et* White) Chitw. was studied in relation to nitrogen fixation and the translocation of Fe and Zn in mungbean (*Vigna radiata* L.) plants.

Materials and methods

Seeds of mungbean cv. SML-32 were surface sterilized by immersion in acidified 0.1% $HgCl_2$ solution for 5 minutes followed by 95% ethanol for 30 seconds. The seeds were separately washed with sterile-distilled water to remove the surface sterilizing agent. Some of the seeds (5 g) were then inoculated with 1 ml broth of *Rhizobium* sp. strain R-1 containing approximately 10^8 cells and dried in the shade for 30 minutes before sowing.

Inoculated and uninoculated seeds were sown in plastic pots (15 cm diam.) containing 500 g washed steam-sterilized river sand. After three days the seedlings were thinned to one per pot. Fe in the form of $FeCl_3 \bullet 7H_20$ was applied at 0. 5, 10, 20 or 30 ppm of soil at the time of sowing. Trace elements containing 0.005% Zn were added at 1 ml/1000 ml of the nutrient solution which was applied twice a week. Treatments consisted of uninoculated control, *Rhizobium* sp., *M. incognita* and *Rhizobium* sp. and *M. incognita*, each replicated ten times. The experiment was in the form of a randomized block.

[1] Department of Soils, Punjab Agricultural University, Ludhiana, India.

For nematode inoculation, 10 ml suspension of 2000 freshly hatched juveniles of *M. incognita* was poured over the exposed roots of the seedling in each pot which were then covered with sand. Fifty days after sowing, the number of nodules, nitrogenase activity of nodules (Hardy *et al.*, 1973), nitrogen content of the shoots (Piper, 1950) and the number of galls on the root system were recorded. Translocation of Fe and Zn in the shoot was determined by atomic absorption spectrophotometry after wet digestion with diacid.

Results and discussion

Mungbean plants raised from seeds inoculated with *Rhizobium* sp. showed an increasing number of nodules/plant up to 20 ppm Fe and then a significant decrease at 30 ppm (Table I). Nitrogen fixation was also influenced by concentrations of Fe; there was a linear increase in the nitrogenase activity of nodules up to 20 ppm Fe followed by a decline at 30 ppm. *Meloidogyne incognita* infection significantly reduced the number of nodules and their nitrogenase activity at all Fe concentrations compared with non-infested nodulated plants. This may be due to interference in the formation and functioning of nodules by the nematodes (Chahal and Chahal, 1987). The adverse effect of Fe at 30 ppm concentration indicates that Fe being a constituent of nitrogenase (Klucas *et al.*, 1968) and leghaemoglobin in the nodules (Bergersen and Turner, 1975) is required only at an optimum concentration for efficient symbiotic nitrogen fixation. Higher concentrations of Fe had a detrimental effect. A deficiency of Fe may also restrict nitrogen fixation by limiting the growth of legumes (Andrew, 1962). Nodulated plants had slightly more galls per plant than non-nodulated plants. This may be attributed to better root development of *Rhizobium* inoculated plants. The maximum number of galls per plant occurred at 20 ppm Fe and decreased at 30 ppm.

Dry weight of shoots and the N content of nodulated plants increased significantly up to 20 ppm Fe followed by a significant reduction at 30 ppm (Table II). *M. incognita* infection caused significant reduction in the dry weight of shoots and N content of nodulated and non-nodulated plants at all concentrations of Fe.

There was a linear increase in the translocation of Fe and Zn in the shoot of nodulated plants up to 20 ppm Fe and thereafter a decline at 30 ppm (Table III). With the increase in concentration of Fe, there was an increase in the amount of Fe and Zn translocated in the shoots of control plants as

TABLE I - *Effect of different concentrations of Fe on nodulation and gall formation in mungbean attacked by* Meloidogyne incognita.

Fe added (ppm)	No. of nodules/plant		Nitrogenase activity m C_2H_4/h/g nodules		No. of galls/plant	
	Rhizobium	Rhizobium+ Meloidogyne	Rhizobium	Rhizobium+ Meloidogyne	Rhizobium	Rhizobium+ Meloidogyne
0	24	20 NS	62.2	57.3 *	7.4	7.5 NS
5	25	22 NS	68.7	60.6 *	8.0	8.4 NS
10	27	23 NS	68.8	63.6 *	12.4	12.7 NS
20	28	25 NS	70.0	68.6 NS	16.9	17.8 NS
30	22	21 NS	57.2	51.2 *	14.3	14.7 NS
Paired 't' value =	4.88		4.046		2.27	

TABLE II - *Effect of different concentrations of Fe on dry weight of shoot and its N content in mungbean attacked by* M. incognita.

Fe added (ppm)	Dry weight of shoot/plant (g)				N content of shoot (%)			
	Control	Rhizobium	Meloidogyne	Rhizobium+ Meloidogyne	Control	Rhizobium	Meloidogyne	Rhizobium+ Meloidogyne
0	0.09	0.21	0.09	0.16	0.67	1.81	0.31	1.27
5	0.12	0.23	0.10	0.18	0.71	2.12	0.42	1.72
10	0.14	0.26	0.11	0.11	0.76	2.91	0.53	2.36
20	0.18	0.29	0.13	0.24	0.77	2.98	0.54	2.38
30	0.21	0.24	0.12	0.20	0.52	2.21	0.43	1.85
C.D. at 5% level of significante		1) Conc. of Fe	= 0.0234			0.0911		
		2) Treatments	= 0.0204			0.0794		
		3) Conc. of Fe X Treatments	= 0.0916			0.3563		

TABLE III - *Uptake of Fe and Zn in the shoot of mungbean plants attacked by* M. incognita *as influenced by different concentrations of Fe.*

Fe added (ppm)	Fe translocated (mg/kg dry wt.)				Zn translocated (mg/kg dry wt.)			
	Control	Rhizobium	Meloidogyne	Rhizobium+ Meloidogyne	Control	Rhizobium	Meloidogyne	Rhizobium+ Meloidogyne
0	0.114	0.182	0.085	0.132	12	30	5	21
5	0.221	0.236	0.121	0.189	15	46	6	39
10	0.265	0.284	0.185	0.196	19	76	8	71
20	0.467	0.487	0.218	0.247	26	102	14	89
30	0.481	0.482	0.259	0.292	27	42	3	36
C.D. at 5% level of significante		1) Conc. of Fe	= 0.0178			4.56		
		2) Treatments	= 0.0165			3.97		
		3) Conc. of Fe X Treatments	= 0.074			17.83		

well as *M. incognita* infected non-nodulated and nodulated plants. Although nodulated and non-nodulated plants infected with *M. incognita* accumulated Fe and Zn in the foliage, this was significantly less than that accumulated in the foliage of control plants and plants nodulated by *Rhizobium*. This contradicts an earlier report that there was no alteration in the level of Fe and other nutrients such as N, P, K, Ca and Mg in the foliage of *M. incognita* infected plants (Hunter, 1958). The results

obtained with mungbean support the idea that Fe and Zn may accumulate in the roots and that limited amounts are translocated to the shoots of infected plants.

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