Nematol. medit. (1980), *8*: 171-175.

Plant Protection Department, College of Agriculture, Riyadh University, Riyadh, Saudi Arabia

RESPONSE OF SOYBEAN CULTIVARS TO INFECTION BY *MELOIDOGYNE INCOGNITA* AND *RHIZOBIUM JAPONICUM* ALONE AND IN COMBINATION

by

I. Y. TRABULSI, M. A. ALI and M. E. ABD-ELSAMEA

Several plant parasitic nematodes have been reported in association with soybean, *Glycine max* L. (Rebois and Golden, 1978). Root-knot nematodes, *Meloidogyne* spp., are regarded as a major pest wherever the crop is grown.

Nitrogen-fixing bacteria are important in relation to the growth and yield of soybean (Longeri and Herrera, 1972; Saxena and Tilak, 1975). Bacterial root nodulation can be suppressed by the invasion of plant parasitic nematodes. Studies involving *Meloidogyne* and *Heterodera* spp. have shown that their invasion of the roots of leguminous hosts can completely prevent nodulation with subsequent reduction in plant growth (Robinson, 1960; Malek and Jenkins, 1964; Taha and Raski, 1969; Barker and Huisingh, 1970; Wescott and Barker, 1976). The response of three soybean cultivars to the root-knot nematode, *Meloidogyne incognita* (Kofoid *et* White) Chitwood and the influence of nematode invasion on nodulation by *Rhizobium japonicum* were investigated in the experiments described here.

Materials and Methods

Seeds of soybean cvs Cobb, 1AC-2 and Jupiter were sown in steam-sterilized sandy soil in 21 cm diameter plastic pots. Three weeks

after germination the plants were thinned to two per pot. Four treatments were applied to each cultivar, with five replicates of each treatment and the experiment was repeated twice. In the first, each pot was inoculated with 2,000 second-stage *M. incognita* larvae; in the second, each pot was inoculated with 10 ml suspension of *Rhizobium japonicum*, strain CC709; the third treatment was simultaneous inoculated with nematodes and bacteria; and the fourth was the untreated control. The experiment was carried out in a temperature controlled greenhouse (31°C + 1°C). The pots were watered with Hoagland's nutrient solution minus N or tap water as needed.

After 60 days, measurements were made of top length and weight, root length and weight, and number and dry weight of nodules. The extent of nematode root galling was estimated on the basis of a 0-75 index; nematodes were extracted from the soil by an elutriation and sieving method (Barker *et al.*, 1975) and the numbers of those in the roots were estimated by dissecting 2 g of root tissue per treatment replicate. The nitrogen content of the plant tops was determined by the micro-Kjeldahl method as modified by Piper (1950).

Table I - *The development of* Meloidogyne incognita *on three soybean cultivars.*

Nematode development	Cultivars		
	Cobb	Jupiter	IAC-2
Developmental stages in root	721	354	507
Egglaying in root	407	154	354
Nematodes in soil	28719	9937	14863
Population increase	14.9 "	4.2	7.9
Root gall index	3.2 "	1.3	2.7

* estimated by rating the percent of galls/root as following: O = Uninfected root; 1 = 1-20%; 2 = 21-40%; 3 = 41-60%; 4 = 61-80%; 5 = 81-100%.
" significant at 5% level of probability.

Results and Discussion

The three soybean cultivars tested significantly influenced the development of *M. incognita* (Tab. I) the highest population being recorded on cv. Cobb and the lowest on cv. Jupiter. The root gall

Table II - *Response of soybean cultivars to infestation of* M. incognita.

Cvs.		Cobb	Jupiter	IAC-2
Root lenght (cm)	Infested	17.1 ± 1.7[a]	19.8 ± 1.6[b]	20.8 ± 3.4[ab]
	Non-infested	25.8 ± 1.5 A	22.6 ± 2.8[b]	25.6 ± 1.9[ab]
% Reduction		33.6 ± 6.1[a]	11.6 ± 8.4[b]	19.4 ± 8.8[ab]
Shoot length (cm)	Infested	24.4 ± 1.9[a]	26.7 ± 1.1[b]	22.6 ± 7.1[ab]
	Non-infested	31.5 ± 2.3[a]	30.9 ± 1.0[b]	32.1 ± 3.8[ab]
% Reduction		22.6 ± 5.6[a]	13.8 ± 1.0[b]	21.3 ± 5.4[ab]
Root Fresh weight (g)	Infested	3.3 ± 0.7[a]	3.0 ± 0.9[b]	1.6 ± 0.4[ab]
	Non-infested	6.3 ± 2.2[a]	3.3 ± 1.1[b]	2.5 ± 0.5[ab]
% Reduction		41.2 ± 3.8[a]	7.5 ± 4.6[b]	33.6 ± 8.1[ab]
Shoot fresh weight (g)	Infested	3.6 ± 0.3[a]	2.6 ± 0.4[b]	2.9 ± 0.2[ab]
	Non-infested	4.7 ± 0.7[a]	3.0 ± 0.4[b]	4.2 ± 0.8[ab]
% Reduction		22.8 ± 5.4[a]	13.3 ± 8.0[b]	28.8 ± 5.1[ab]

a, b and c represent significant levels at 0.05 according to Duncan's multiple range test.

Table III - *Response of soybean to inoculation of* M. incognita *and* R. japonicum *alone and in combination.*

Cultivars	Treatments	Nodules plant		Dry weight of plant shoot (mg)	Nitrogen fixation	
		Number	Dry weight (mg)		per plant (mg)	per g dry tissue*
Cobb	Control	—	—	1.03	20.5	19.9
	Nematode	—	—	0.83	14.0	16.7
	Rhizobia	11.5	51.0	1.41	30.7	21.8
	Rhizobia + Nemas	5.0	15.5	0.86	11.8	13.7
IAC-2	Control	—	—	0.86	13.8	16.0
	Nematode	—	—	0.82	10.7	13.0
	Rhizobia	31.0	1890	1.61	49.9	31.0
	Rhizobia + Nemas	3.0	7.5	0.89	3.1	3.4
Jupiter	Control	—	—	0.60	9.1	15.2
	Nematode	—	—	0.53	7.5	14.2
	Rhizobia	23.3	98.5	1.02	28.7	28.1
	Rhizobia + Nemas	10.6	35.0	0.80	15.9	19.8

* Averages of five replicates.

indices accorded with the soil populations and with the nematode development in the roots.

Root-knot infestations significantly affected the growth of the plants and nitrogen fixation compared with the uninfested control (Tab. II and III). The results reflect the extent of susceptibility to the nematode and consequently cv. Jupiter was least affected.

In plants inoculated with *Rhizobia* but without nematodes, cv. 1AC-2 developed the largest number of nodules and fixed the most nitrogen (Tab. III). Root-knot nematode infestation resulted in a considerable decrease in the number of nodules and nitrogen fixation, the least effect with cv. Jupiter. Nodules on nematode-infested roots were swollen and brown in colour, compared with the normal whitish to light pink colour on uninfested plants.

The results demonstrate that the growth of soybean is markedly improved by the presence of *Rhizobium japonicum* and the root knot nematodes adversely affect growth, nodule development and nitrogen fixation.

SUMMARY

The response of three cultivars of soybean (*Glycine max* L.) to infection by *Meloidogyne incognita* and to *Rhizobium japonicum*, alone and in combination, was investigated in a glasshouse experiment. Cv. Jupiter appeared to be moderately resistant to root-knot nematodes, while cvs. Cobb and 1AC-2 were susceptible. Nematode infection adversely affected root nodule production and nitrogen fixation in all cultivars with a consequent effect on plant growth.

RIASSUNTO

Risposta di cultivar di soia alle infestazioni di Meloidogyne incognita *e* Rhizobium japonicum *da soli ed in combinazione.*

È stata saggiata in serra la risposta di tre cultivars di soia (*Glycine max* L.) nei confronti delle infestazioni di *Meloidogyne incognita* e *Rhizobium japonicum* da soli ed in combinazione. La cultivar Jupiter è apparsa essere moderatamente resistente al nematode galligeno, mentre le cultivars Cobb e 1AC-2 sono risultate suscettibili. L'infestazione del nematode ha influenzato negativamente la formazione dei noduli e la fissazione d'azoto in tutte le cultivars con conseguente effetto sulla crescita delle piante.

LITERATURE CITED

BARKER K. R. and HUISING D., 1970 - Histological investigations of the antagonistic interaction between *Heterodera glycines* and *Rhizobium japonicum* on Soybean. *Phytopathology, 60*: 1282-1283.

BARKER K. R., BYRD D. W. Jr., GRIFFIN W. E., STONE C. A. and NUSBAUM G. J., 1975 - A semi automatic elutriator for extracting nematodes. *J. Nematol., 7*: 320 (Abstr.).

LONGERI S. L. and HERRER O. A., 1972 - Inoculation of soybean (*Glycine max*), inoculation effect of yield, protein and oil content of the grain. *Agric. Tec., 32*: 132-137.

MALEK R. B. and JENKINS W. R., 1964 - Aspects of the host parasite relationships of nematodes and hairy vetch. *New Jersey Agr. Sta. Bull., 813*: 32 pp.

PIPER C. S., 1950 - Soil and plant analysis. The University of Adelaide, Australia, p. 274-275.

REBOIS R. V. and GOLDEN A. M., 1978 - Nematode occurrence in soybean fields in Mississippi and Louisiana. *Plant Dis. Reptr., 62*: 433-437.

ROBINSON P. E., 1961 - Root-knot nematodes and legume nodules. *Nature, 189*: 506-507.

SAXENA M. C. and TILAK K. V. B. R., 1975 - Response to nodulation in soybean and its residual effect on wheat. *Ind. J. Agron., 20*: 369-370.

TAHA A. H. Y. and RASKI D. J., 1969 - Interrelationships between root-nodule bacteria, plant parasitic nematodes and their leguminous hosts. *J. Nematol., 1*: 201-211.

WESTCOTT S. W. and BARKER K. R., 1976 - Interaction of *Acrobeloides buetschlii* and *Rhizobium leguminosarum* on Wando pea.

Accepted for publication on 19 May, 1980.