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INTERACTION BETWEEN *HETERODERA CAJANI* AND *RHIZOBIUM* ON MUNG BEAN AND CLUSTER BEAN

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Summary. The interaction between *Heterodera cajani* and *Rhizobium* in different combinations revealed that prior addition of *Rhizobium* (by two weeks) enhanced nodulation but reduced nematode reproduction on mung bean. With cluster bean, addition of *Rhizobium* prior to or simultaneously with the nematode reduced plant growth although nodulation was enhanced when *Rhizobium* was added two weeks before nematode inoculation. Prior addition of *Rhizobium* also enhanced reproduction of the nematode on cluster bean.

Mung bean [*Vigna radiata* (Linn.) Wilczek] and cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] are important leguminous crops that are highly susceptible to *Heterodera cajani* Koshy (Koshy and Swarup, 1972; Bhatti and Gupta, 1973). Cyst nematodes generally cause reduced nodulation in leguminous crops (Taha and Raski, 1969). Nodules are the centres of symbiotic nitrogen fixation but little is known about the nature and extent of damage to this process caused by nematode infestation. The purpose of the present investigation was to determine the effect of *Heterodera cajani* on plant growth, rhizobial activity and nitrogen fixation in mung bean and cluster bean.

Materials and methods

Surface sterilized seeds of mung bean and cluster bean were sown in 15 cm earthen pots each containing 1 kg steam sterilized sandy soil and sieved farm yard manure mixture in the ratio of 3:1. One week after germination the plants were reduced to one per pot.

Cultures of *H. cajani* were raised from single surface-sterilized cysts recovered from either pigeonpea or cluster bean plants and multiplied on the same hosts grown in sterilized soil.

Rhizobia specific for mung bean (S-14) and cluster bean (CT-2014) were obtained from the Department of Microbiology, Haryana Agricultural University, Hisar. A 72 hour old culture of *Rhizobium* broth was inoculated by pipetting 1 ml broth held in 10 ml suspension of sterilized distilled water around and on exposed roots of the plants which were covered with soil immediately after inoculation and the plants then watered lightly. One thousand freshly hatched second-stage juveniles of *H. cajani* per pot were used as nematode inoculum.

Each treatment (Table I) was replicted four times. The plants were watered as required. Sixty days and 105 days after first inoculation, the plants were taken from the pots and observations recorded on various plant growth parameters.

The relative nitrogen fixing efficiency of rhizobial nodules was measured by the acetylene reduction method (Hardy *et al.*, 1968).

TABLE I - *Interaction between* Heterodera cajani *and* Rhizobium *on mung bean.*

Treatment	Root weight (g)	No. of cysts in soil	No. of females on roots	Acetylene reduction activity (n mols/hr/ g nodule wt)
Rhizobium (R) alone	3.3	0 (1)	0 (1)	628
Nema + R (Simultaneously)	1.7	240 (15.4)	146 (12.0)	624
Nema + R (7 days later)	1.2	214 (14.2)	212 (14.4)	432
Nema + R (14 days later)	1.6	182 (13.0)	247 (15.4)	240
Nema only	1.8	107 (10.3)	243 (15.3)	136
R + Nema (7 days later)	2.5	245 (15.4)	240 (15.4)	1142
R + Nema (14 days later)	2.6	73 (8.4)	113 (10.7)	518
C.D. at 5%	1.1	(4.82)	(5.74)	–

Figures in parentheses are $\sqrt{n+1}$ values.

Results and discussion

The data pertaining to the interaction between *Heterodera cajani* and *Rhizobium* on mung bean are given in Table I. Differences in shoot and root length, shoot weight, number and weight of nodules were not significant between the treatments. However, root weight was significantly less in the treatment where the nematode was inoculated earlier than *Rhizobium* or where they were inoculated simultaneously.

Minimum numbers of cysts in the soil (73) and in the roots (113) were recorded when *Rhizobium* was inoculated two weeks earlier than the nematode.

The reduction in nematode numbers may be attributed to incompatibility between bacterium and nematodes. It is also generally observed that in mung bean, the nodules appear earlier than in other leguminous crops, thereby reducing the sites of nematode penetration. Moreover, nodules may also be penetrated by juveniles although they are not suitable sites for subsequent development. This will lead to maleness and ultimately to reduction of the nematode population. Barker *et al.* (1972) have also reported an adverse effect of *Rhizobium* on the cyst formation of *H. glycines* on soybean. Nodules as a site of juveniles penetration have also been reported by several workers (Taha and Raski, 1969; Sharma and Sethi, 1976).

The nitrogen fixing capability of the nodules was adversely affected by the nematodes, more so when *Rhizobium* was absent or when nematodes were inoculated prior to *Rhizobia.* It was not adversely affected when *Rhizobium* was added one week before the nematodes. Perhaps at this time nodule formation is not completed. However, when *Rhizobium* preceded nematode inoculation by two weeks, there was a greater reduction in nitrogen fixation. Possibly after two weeks nodules are completely formed and these provide favourable sites for nematode penetration, leading to earlier destruction of nodules and thereby also reducing the nematode population (Table I). Several workers have reported the reduction in nitrogen fixing capability of nodules due to the presence of nematodes (Taha and Raski, 1969; Lehman *et al.*, 1971; Baldwin *et al.*, 1974; Hussey and Barker, 1974).

There was a significant reduction in shoot length when nematodes were added with or after the *Rhizobium.* Significant reduction in shoot weight compared with the uninoculated control occurred in all the nematode and bacterium combinations, but was least in simultane-

ous inoculation. The number of nodules was reduced significantly in all the nematode inoculated treatments except that in which *Rhizobium* was added two weeks prior to the nematodes. Nodule weight, however, was not adversely affected when *Rhizobium* was inoculated prior to nematodes (Table II). Root length and weight were not affected by treatments.

Maximum numbers of cysts per plant were formed when *Rhizobium* was added two weeks before the nematodes and minimum numbers when nematodes were inoculated two weeks before the bacterium (Table II).

The relative nitrogen fixing efficiency of nodules was reduced by the pigeonpea cyst nematode, and more so when added simultaneously with *Rhizobium* (Table II). It was not advsersely affected when *Rhizobium* was added one week earlier than the nematodes as in the case of mung bean.

TABLE II - *Interaction between* H. cajani *and* Rhizobium *on cluster bean.*

Treatment	Shoot length (cm)	Shoot weight (g)	No. of nodules	Weight of nodules (g)	No. of cysts in soil	No. of females on roots	Acetylene reduction activity (n mols/hr/ g nodule wt.)
Rhizobium (R) alone	42.5	11.0	45.0	2.2	0 (1)	0 (1)	2114
Nema + R (Simultaneously)	35.1	4.9	16.5	1.1	34.2 (5.9)	7.5 (2.8)	991
Nema + R (7 days later)	40.0	7.1	36.5	1.5	21.5 (4.8)	22.7 (4.8)	1178
Nema + R (14 days later)	39.5	7.1	31.7	1.5	10.5 (3.5)	10.7 (3.3)	1029
Nema only	37.5	8.5	16.0	0.4	13.0 (3.7)	15.0 (4.0)	1007
R + Nema (7 days later)	32.4	5.9	31.0	1.7	26.0 (5.2)	13.5 (3.8)	2386
R + Nema (14 days later)	32.7	6.6	37.0	2.0	35.0 (5.9)	15.7 (4.1)	1267
C.D. at 5%	5.15	2.88	9.65	0.59	(0.79)	(0.67)	–

Figures in parentheses are $\sqrt{n+1}$ values.

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