

## Response of cowpea rhizobia on nodulation and yield of mungbean (*Vigna radiata* L. Willczek)

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The effect of *Rhizobium* on mungbean (*Vigna radiata*) in unsterilized soil *in vitro* revealed that the plants inoculated with *Rhizobium* at seed showed better plant growth characteristics i.e., root and shoot length and fresh and dry weights compared to uninoculated control plant. The rate of increase in case of dry weight over uninoculated control was 64.28% and 45.00% at 45 and 60 DAS respectively. Maximum mean nodule number, and nodule dry weight were recorded by the application of *Rhizobium*. The field trial revealed that the plants inoculated with *Rhizobium* at seed along with urea @ 25 kg/ ha showed significantly higher yield compared to control. The rate of increase was 31.53% and 37.52% in the first and second year respectively.

**Key words :** *Rhizobium*, mungbean, urea

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### INTRODUCTION

Pulses are important world food crops because they provide an inexpensive source of vegetable dietary protein. In many densely populated areas of the world, the economy does not support large-scale production and utilization of animal protein. In those areas, the protein in people's diets may be augmented by supplementation with the protein-rich pulse grains. In addition to being less expensive than animal protein, pulse grains provide a source of rich protein for those people who prefer vegetable to animal protein in their diet for cultural or religious reasons. Pulse grain proteins nutritionally complement the proteins in cereal grains; when eaten together a diet nutritionally balanced in protein may be enjoyed. The mungbean, also called mung, moong, and greengram in India and mungo in the Philippines, is prized among the pulse species, for its seeds are high in protein and easily digested when consumed as food. In a symbiotic relationship with specific soil rhizobia of the genus *Bradyrhizobium*, root nodules develop on mungbean in which atmospheric nitrogen is converted to available forms to the mungbean plant.

### MATERIALS AND METHODS

The experiment was conducted in unsterilized soil in earthen pots of 10 cm diameter to study the effect of *Rhizobium* (Strain M-10 of cowpea group) on host plant mungbean (*Vigna radiata*). Three days old Yeast mannitol broth (containing mannitol 10.09 g, dipotassium monohydrogen phosphate 0.59g, magnesium sulphate 0.29 g, sodium chloride 0.1 g, yeast extract 1.09 g, calcium carbonate 0.5g., distilled water

1.0 L) culture of the symbiont was used for inoculation of the host plant. Seeds of variety B-1 of mungbean plant were inoculated with M-10 strains of cowpea *Rhizobium* and were sown in unsterilized soil. Two sets of experiment were conducted in two consecutive year. The strength of *Rhizobium* as obtained in first set was  $71.00 \times 10^6$  cells/ml and in second set it was  $74.00 \times 10^6$  cells/ml. Other treatments namely *Rhizobium* at seedling stage and *Rhizobium* at 15 DAS were taken. Necessary replicates and uninoculated control were maintained. Observations were made on 45 and 60 days after sowing in order to study the (i) effect on growth characteristics of the host plants and (ii) the nodule development of the host plants.

The field trial was also conducted on mungbean, variety B-1 in the University Farm in two consecutive *kharif* season. Four treatments consisting of combinations of *Rhizobium* and urea and symbiont inoculation and uninoculated control were replicated four times in a randomized block design in field with 6 sq.m (3m x 2m) net plot size.

The plants were inoculated with the corresponding symbiont namely M-10 strain of cowpea group by seed inoculation and seed inoculation along with urea @ 25 kg/ha with *Rhizobium* suspension at  $30.33 \times 10^6$  cells/ml and  $32.00 \times 10^6$  cells/ml by mixing with seed. The soil was treated with urea @ 25 kg/ha before sowing. Observations were made on 45 days after sowing in terms of nodulation and were made on sample plants @ 5% of the plant population for estimation of nodulation. Yield of mungbean was estimated by harvesting and weighing of the grain obtained per plot and represented as q/ha.

## RESULTS AND DISCUSSION

### *Effect on plant growth characteristics*

Results of two sets in average presented in the Table 1 revealed that the root and shoot length of the plant inoculated with *Rhizobium* at seed was higher compared to uninoculated control in both the trials. This trend continued upto 60 DAS.

The plants treated with *Rhizobium* at seedling stage recorded higher root and shoot length compared to control but recorded lower compared to plants inoculated with *Rhizobium* at seed. This trend also continued upto 60 DAS.

The plants treated with *Rhizobium* at 15 DAS showed higher root and shoot length compared to uninoculated control but recorded lower compared to plants treated with *Rhizobium* at seed and *Rhizobium* at seedling. This trend continued upto 60 DAS.

The fresh and dry weight of plants inoculated with the *Rhizobium* at seed showed increased fresh and dry weight compare to uninoculated control. This trend continued upto 60 DAS.

The plants treated with *Rhizobium* at seedling recorded the higher fresh and dry weight compare to uninoculated control and also higher over plants treated with

*Rhizobium* at 15 DAS but recorded lower compared to plants treated with *Rhizobium* at seed on both 45 and 60 DAS respectively.

The plants treated with *Rhizobium* at 15 DAS showed increased plant fresh and dry weight compare to uninoculated control although the rate of increase was lower as compare to plants treated with *Rhizobium* at seedling and plants treated with *Rhizobium* at seed.

Highest plant dry weight was recorded in the plants treated with *Rhizobium* at seed. The rate of increase was 64.28% at 45 DAS and 45.00% at 60 DAS over uninoculated control plants.

#### *Effect on nodule development.*

Results presented in the Table 1 revealed that the nodulation (i.e. the number and weight of nodules) of the plant inoculated with the symbiont at seed were recorded to be higher compare to uninoculated control plants.

The plants treated with *Rhizobium* at seedling also showed increased nodulation compare to uninoculated control plants and the plants treated with *Rhizobium* at 15 DAS but showed decreased rate of nodulation compare to plants treated with *Rhizobium* at seed. This trend continued upto 60 DAS.

The plants treated with *Rhizobium* at 15 DAS showed decreased rate of nodulation compare to plants inoculated with *Rhizobium* at seedling stage and also the plants inoculated with *Rhizobium* at seed but showed increased rate of nodulation compare to uninoculated control plants. Although this rate of increase was not so higher. This trend continued upto 60 DAS.

#### *Effect on nodulation in field*

Results presented in the Table 2, revealed that the plants inoculated with *Rhizobium* at seed along with urea @ 25 kg/ha showed increased rate of nodulation compared to uninoculated control plants.

Plants treated with *Rhizobium* at seed also showed increased rate of nodulation which was higher compared to uninoculated control plants but lower compared to plants treated with *Rhizobium* at seed along with urea @ 25 kg/ha whereas, plants treated only with fertilizer (urea @ 25 kg/ha) before sowing showed increased rate of nodulation compared to uninoculated control plants but the rate of increase was not significant.

Range of nodulation varied from 14.75 - 16.60 and 9.78-12.30 in the plants treated with *Rhizobium* at seed along with urea @ 25 kg/ha in the first and second year respectively.

Percent increases on nodulation over control were observed to be significantly higher in the plants treated with *Rhizobium* at seed along with urea. The rate of increase was 72.35% in the first year and 77.21% in the second year. This treatment showed

**Table 1.** Mean of different characters of mungbean (*Vigna radiata*) in unsterilized soil at 45 (A) and 60 (B) days after sowing under different treatments

Treatments	Shoot length (cm)		Root length (cm)		Nodule no./plant		Nodule fresh wt.(g)/plant		Plant fresh wt. (g) (shoot + root)		Plant dry wt. (g) (shoot + root)	
	A	B	A	B	A	B	A	B	A	B	A	B
Control	8.84	10.13	14.23	16.10	10.71	9.87	0.02	0.02	1.81	3.48	0.28	0.40
<i>Rhizobium</i> at seed	15.37	16.80	20.78	22.73	16.39	15.48	0.06	0.04	2.30	4.53	0.46	0.58
<i>Rhizobium</i> at seedling	13.07	14.57	16.74	18.25	13.69	12.33	0.04	0.03	2.05	4.19	0.35	0.49
<i>Rhizobium</i> at 15 DAS	12.30	13.64	14.27	16.38	12.61	10.97	0.04	0.02	1.95	3.57	0.31	0.42
SE	0.69	0.49	2.65	0.85	1.31	0.72	0.000077	0.004	0.058	0.44	0.005	0.008
CD at 5%	1.21	1.02	2.37	1.35	1.66	1.24	1.01	0.09	0.35	0.94	0.10	0.13

A = 45 DAS; B = 60 DAS

DAS = Days after sowing

All the data represent the average of two sets of experiments

Table 2. Number of nodules and yield of moongbean in field condition under different treatments

Treatments	Number of nodules/plant				Yield (q/ha)							
	Range		Mean		Increase or decrease (%) over control		Range		Mean		Increase or decrease (%) over control	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
Control	7.62 -11.00	5.75 -6.75	9.15	6.23	-	-	9.50 -11.25	10.34	10.34	10.34	-	-
<i>Rhizobium</i> at seed + urea	14.75 -16.60	9.78 -12.30	15.77	11.04	72.35	77.21	12.90 -14.00	13.60	14.22	14.22	31.53	37.52
<i>Rhizobium</i> at seed	14.50 -16.30	9.75 -11.90	15.32	10.68	67.43	71.43	11.16 -12.75	11.97	12.29	12.29	15.76	18.86
Urea before sowing	10.25 -12.25	8.75 -11.25	11.00	9.86	20.22	58.27	11.90 -14.60	13.25	13.37	13.37	28.14	29.30
SE			0.606	0.707				0.647	0.531			
C.D. at 5%			1.370	3.611				1.462	1.200			

X = First Year

Y = Second Year

better performance regarding nodulation compared to other three treatments.

#### *Effect on grain yield*

Results presented in the Table 2 showed that the plants treated with *Rhizobium* at seed along with urea @ 25 kg/ha perform increased grain yield compared to uninoculated plants. Plants treated with *Rhizobium* at seed showed higher grain yield compared to uninoculated control plants but lower compared to plants treated with *Rhizobium* at seed along with urea and the plants treated with only urea before sowing.

Range of grain yield was observed to be 12.90 to 14.00 q/ha and 13.50 to 14.90 q/ha in the plants treated with *Rhizobium* at seed along with urea in the first and second year of field experiments respectively, followed by the plants treated with urea before sowing where the range of grain yield was recorded as 11.90 to 14.60 q/ha and 12.90 to 14.00 q/ha in two consecutive years.

The rate of increase over control was recorded to be significantly higher in the plants treated with *Rhizobium* at seed along with urea, which was 31.53% and 37.52% respectively.

In unsterilized soil *Rhizobium* at seed was better for all the characters. The treatment, i.e. *Rhizobium* at seedlings was good for shoot length and plant dry weight and *Rhizobium* at 15 DAS for shoot length and *Rhizobium* at seed for shoot and root length, number and weight of nodules.

It was interesting to note that the application of *Rhizobium* was best in combination with seed rather than with seedling of after 15 DAS. Bhargave *et al.* (1974) reported that there was better nodulation and higher bacteroid and leghemoglobin content in the nodules in case of plants where *Rhizobium* inoculated at seed. This has been confirmed with the present work. Murugesan *et al.* (1991) reported that under pot culture condition maximum mean nodule number, and nodule dry weight were recorded by the application of *Rhizobium*. This was confirmed here. Plant treatment with *Rhizobium* at seed also showed increased dry weight over control. The increase was 64.28% at 45 DAS and 45.00% at 60 DAS (Wange *et al.*, 1990).

In field trial similar results were actually achieved like the pot trial. The plant grown from the seeds inoculated with *Rhizobium* produced higher yield. However, this increase in yield was lower compared to plants inoculated with *Rhizobium* at seed and urea @ 25 kg/ha in the field before sowing (Subba Rao and Tilak, 1984). It thus pointed out that *Rhizobium* at seed with urea could create an ideal soil health that facilitated *Rhizobium* growth, ultimately resulting higher yield followed by urea alone, which was partly used by the microbes present in the soil giving intermediate yield. Raju and Verma (1984) have suggested inoculation + 15 kg N/ha was most effective treatment for *Vigna radiata*.

Seed inoculation with *Rhizobium* perform better yield compare to control have been reported by Gaur (1975), Subba Rao and Tilak (1977), Mandhare *et al.* (1990) and Bhattacharyya and Mukherjee (1990). This was confirmed here.

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