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Effect of Inoculant on Yield and Yield Contributing Characters of Summer Mungbean Cultivars

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Abstract
Anexperiment was conducted at Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh to study the effect of *rhizobial* inoculant (biofertilizer) on the the yield and yield contributing characters of mungbean cultivars. Experimental treatments included two varieties of mungbean namely Binamoog5 and Binamoog7 and six inoculant treatments namely control(I_0), Bradyrhizobium Inoculant(I), Inoculant+P, NPK, Inoculant+PK+B and Inoculant+PK+CD. Inoculantion+PK+B obtained the highest grain yield of mungbean (1.49 t ha^{-1}) while Inoculantion+PK+CD showed the highest straw yield. NPK application showed significantly higher grain and straw yield over uninoculated control and parallel to inoculation but statistically inferior to I+PK+CD in respect of grain yield. Inoculantion+PK+CD or Inoculantion+PK+B may be recommended for summer mungbean production where I+PK+CD is preferable.

Key words: *Bradyrhizobium* Inoculant, Mungbean *(Vigna radiate)*

Introduction

Mungbean *(Vigna radiata L.)* is one of the important pulse crops of Bangladesh, as it is an excellent source of easily digestible protein. It complements the staple rice diet in the country. Mungbean contains 51% carbohydrate, 26% protein, 4% minerals and 3% vitamins (Kaul, 1982). The green plants are used as animal feed and the residues as manure. The crop is potentially useful in improving cropping systems as cash crop due to its rapid growth and early maturing characteristics. In Bangladesh, the daily per capita consumption of pulses is only 13.29 g (BBS, 2001) where World Health Organization has suggested 45 g per capita per day for a balanced diet (BARI, 1998). Bangladesh Institute of Nuclear Agriculture (BINA) isolated *Bradyrhizobium* strains of bacteria which is known to influence biological nitrogen fixation and improve soil health and growth and yield of pulses. Inoculation with *Bradyrhizobium* increased 57% effective nodules, 77% dry matter production, 64% grain yield and 40% hay yield over uninoculated control in mungbean cultivation. The use of *Bradyrhizobium* inoculants in crop production can play a vital role in improving soil environment and agricultural sustainability. Considering the above facts, the present study was undertaken to investigate the effect of *Bradyrhizobium* inoculant on the yield and yield contributing characters of mungbean, to study the varietal response of mungbean to inoculant and to find out a suitable combination of inoculant with other nutrient elements in sustainable mungbean production

Materials and methods

A field experiment was conducted at the field of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during March to May 2011. The soil belongs to the Old Brahmaputra Alluvial under Agro-ecological Zone (AEZ) 9. The land topography was medium high, sandy loam textured with P^H 6.7. The crops used in this study were two cultivars of Mungbean *(Vigna radiata* L.) named Binamoog-5 and Binamoog-7.

The study consists of two types to treatment as below:Factor- A. Crop variety: 2: Binamoog-5 and Binamoog-7. Factor- B. Biofertilizer and chemical fertilizers: 1.Control (I_0) 2.Inoculant (I) 3. Inoculant+Phosphorus@25 kg P ha^{-1} and Potassium@40 kg P ha^{-1} (I+PK) 4.Nitrogen(@ 30 N kg ha^{-1} +Phosphorus@25 P kg ha^{-1} +Potassium@40 kg K ha^{-1} (NPK) 5. Inoculants+ Phosphorus@25 kg P ha^{-1} and Potassium@40 kg P ha^{-1} +Boron@2 kg B ha^{-1} (I+PK+B) 6. Inoculants+ Phosphorus@25 kg P ha^{-1} and Potassium@40 kg P ha^{-1}+Cowdung@ 3ton ha^{-1} (I+PK+CD. The experiment was laid out in split plot design with three replications. Each replication had 14 unit plots in which the treatment combinations were assigned at random. The total number of subplots were 36 and size of each plot was 4 m x 3 m (12 m^2).

The *Bradyrhizobium* strains used in the present study were collected from the Soil Microbiology

Laboratory of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh and were inoculated into yeast mannitol broth medium containing 250 ml Erlenmeyer flask under laminar air flow cabinet. The amount of seed in each packet was mixed thoroughly with mentioned liquid culture. The line to line distance was 30.0 cm with continuous dropping of seeds in the line and depth of sowing was about 3 cm**.** Germination was more than 80%. Weeding, thinning and irrigation was done time to time. The crops were harvested on different dates when they attained maturity. From 1 m^2 area of each plot, plants were selected for recording data. The collected seeds were dried in the sun for reducing the moisture in the seeds to about 14 % level. Data were recorded on different parameters. The data were analyzed statistically using MSTAT and mean differences were classified by Duncan's Multiple Range Test' (Gomez and Gomez, 1984).

Results and Discussion

The remarkable effect of biofertilizer on the cultivars and their interaction effects were apparent from the data presented. The results obtained on grain yield, straw yield, 1000 grain weight, grain weight plant^{-1}, husk weight plant^{-1}, number of grain plant^{-1}, number of branch, pod number plant^{-1}, number of grain pod^{-1} and pod length have been presented in Table 1, 2 and 3 and discussed below.

Grain yield

Grain yield of mungbean was highly significant due to *bradyrhizobial* inoculants. The highest grain yield was recorded due to the application of treatment I+PK+B followed by treatment I+PK+CD. All the inoculated and nitrogen treatments recorded significantly higher grain yield of mungbean compared to uninoculated control. A similar type of results have been reported by Shukla and Dixit (1996) and Solaiman (2002), those are reported that application of inoculants increase mungbean yield .The effect of cultivars on seed yield of mungbean was not significant. The maximum seed yield was recorded by the interaction of Binamoog7 × I+PK+CD treatment.

Straw yield

Inoculated and NPK treated plots gave significantly higher straw yield compared to uninoculated control one. The highest straw yield was produced due to application of I+PK+CD treatment which was identical to I+PK+B and I+PK. Inoculation without PK or PK+B or PK+CD show significantly lower straw yield compared to PK or PK+B or PK+CD with inoculation. These results were consistent with the results of Gill *et al.* (1985) who reported that inoculation significantly increased seed and straw yield. Binamoog7 produced higher straw yield over Binamoog5. The maximum straw yield was recorded by the interaction of Binamoog7 × I+PK+CD where lowest straw yield was observed by the interaction of Binamoog7 × uninoculated control

1000-grain weight

The highest 1000-seed weight was recorded in I+PK+CD followed by I+PK+B treatment . The uninoculated control gave the lowest 1000-seed weight . Binamoog5 produced significantly higher 1000-seed weight over Binamoog7. The maximum 1000-grain weight was recorded with treatment combination Binamoog5 × I+PK and the lowest 1000-grain weight was observed by the interaction of Binamoog7 × uninoculated control(I_0).

Grain weight per plant

Treatment I+PK+B produced the highest grain weight plant^{-1} followed by I+PK+CD. All the inoculated as well as NPK treated plot showed significantly higher grain weight per plant. The lowest grain weight plant^{-1} was produced in uninoculated treatment(I_0). Binamoog7 produced higher grain weight plant^{-1} over Binamoog5. The highest grain weight plant^{-1} was recorded with interaction of Binamoog7 × I+PK+B treatments.

Husk weight per plant

All the treatment (inoculant+NPK) showed significantly higher husk yield plant^{-1} over control. The highest husk weight was produced due to application of I+PK+B treatment. The lowest husk weight was obtained in uninoculated treatment. NPK treated plots produced also lowest husk weight .Similar result was reported by Gil *et al.* (1985), who reported that application of inoculants have significant effect on husk weight. Binamoog5 produced higher husk weight over Binamoog7. The highest husk weight plant^{-1} was recorded with interaction of Binamoog5 × I+PK+B treatments.

Number of branch plant^{-}

The highest number of branch plant^{-1} was recorded in inoculated treatment. Which was statistically similar to I+PK+B and I+PK+CD. The lowest number of branch plant^{-1} was found in control treatment. The effect of cultivars on the number of branch of mungbean was not significant. The maximum number of branch plant^{-1} was recorded by the interaction of Binamoog5 x I treatment.

Table 1. Effect of biofertilizer on grain yield, straw yield, 1000 grain weight, grain weight plant^{-1}, husk weight plant^{-1} and number of branch plant^{-1} of mungbean

Inoculant	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	1000 grain weight (g)	Grain weight plant^{-1} (g)	Husk weight plant^{-1} (g)	No. of branch plant^{-1}
I_0	0.75d	5.35d	29.50c	2.63 d	3.26e	2.41c
I	1.15c	6.57c	32.50b	3.37c	4.07cd	3.16a
I+PK	1.26b	7.38ab	33.65ab	3.85b	3.89d	2.83b
NPK	1.14c	6.95bc	33.75ab	3.92b	4.11c	2.96ab
I+PK+B	1.49a	7.47ab	34.08a	4.23a	4.59a	3.13a
I+PK+CD	1.47a	7.57a	34.65a	4.19a	4.34b	3.13a
Significant level	**	**	**	**	**	**
CV(%)	4.57	6.11	2.22	4.24	4.11	5.43

Table 2. Response of cultivars on grain yield, straw yield, 1000 grain weight, grain weight plant^{-1} ,husk weight plant^{-1} and number of branch plant^{-1} of mungbean

Cultivar	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	1000 grain weight (g)	Grain weight plant^{-1} (g)	Husk weight plant^{-1} (g)	No. of branch plant^{-1}
Binamoog5	1.213	6.47b	33.83a	3.34b	4.69a	2.918
Binamoog7	1.212	7.29a	32.22b	4.06a	3.39b	2.958
Significant level	NS	**	**	**	**	NS
CV(%)	4.57	6.11	2.22	4.24	4.11	5.43

Table 3. Interaction effect of inoculant and chemical fertilizers and cultivars on grain yield, straw yield, 1000 grain weight, grain weight plant^{-1}, husk weight plant^{-1} and number of branch plant^{-1} of mungbean

Inoculant × Cultivar	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	1000 grain weight (g)	Grain weight plant^{-1}(g)	Husk weight plant^{-1} (g)	No.of Branch plant^{-1}
$V_1 \times I_0$	0.74f	5.50e	30.00e	2.30 g	3.78cd	2.33f
V_1 ×I	1.12de	6.87cd	33.00cd	2.96f	4.65b	3.66a
V_1 ×I+PK	1.3c	6.65d	35.30a	3.55d	4.55b	2.73cde
V_1 ×NPK	1.19de	6.40d	35.00a	3.41e	4.72b	2.93cd
V_1×I+PK+B	1.48ab	6.71d	34.67ab	3.75b	5.26a	2.93cd
V_1×I+PK+CD	1.42b	6.74d	35.00a	4.09c	5.20a	2.93cd
$V_2 \times I_0$	0.75f	5.20e	29.00e	2.97f	2.74f	2.50ef
V_1 ×I	1.16de	6.280d	32.00bd	3.79d	3.50de	2.66de
V_2 ×I+PK	1.21d	8.12ab	32.00cd	4.15bc	3.23e	2.93cd
V_2 ×NPK	1.10e	7.50bc	32.50bc	4.43b	3.51de	3.00c
V_2×I+PK+B	1.50ab	8.24ab	33.50ab	4.72a	3.93c	3.33b
V_2×I+PK+CD	1.53a	8.40a	34.30ab	4.30bc	3.48de	3.33b
Significant level	**	**	*	**	*	**
CV(%)	4.57	6.11	2.22	4.24	4.11	5.43

In a column same letter(s) do not differ significantly at 1 and 5% level of probability as per DMRT.
** = Significance at 1% level of probability, * = Significance at 5% level of probability

Effect of inoculant on grains plant^{-1}, pod plant^{-1}, pod lengh and grain no. pod^{-1} and their interactions are shown in Table 4, 5 and 6 and are described here

Number of grains plant^{-1}

The highest number of grain plant^{-1} was recorded by I+PK+CD treatment followed by I+PK+B, I+PK and

NPK. PK and PK+B exhibited higher grains plant^{-1} over inoculation only with PK or PK+B. The lowest number of grain plant^{-1} was recorded in control (I_0) treatment.Binamoog7 produced statistically higher number of seeds than Binamoog5. The highest number of grains plant^{-1} was observed in the interaction of Binamoog7 x I+PK+B and the lowest number of grain plant^{-1} was observed in the interaction of Binamoog5 x control.

Number of pod plant^{-1}

The highest number of pod plant^{-1} was recorded in I+PK+CD treatment followed by NPK and I+PK+B. Inoculation with phosphorus and potassium application enhanced the number of pod significantly over inoculation only. This result was in conformity with the findings of Gill *et al.* (1985) who reported that inoculation significantly increased the number of pod plant^{-1}. Binamoog5 produced higher number of pods plant^{-1} over Binamoog7. The highest number of pod plant^{-1} was observed in Binamoog5 x I+PK+CD.

Pod length

The maximum pod length was recorded with the application of I+PK+CD. Inoculated and NPK treated pods were found statistically similar pod length. Binamoog5 produced significantly higher pod length over Binamoog7. This result was similar with the findings of Thakuria and Shaharia (1990) who observed that different varieties of mungbean differed significantly in pod length. The highest length of pod was observed in the interaction of Binamoog5 × I treatment followed by Binamoog5 × I+PK+CD.

Number of grain per pod

The highest number of seed pod^{-1} was recorded in inoculated (I) treatment which was identical to I+PK, NPK and I+PK+CD. The lowest number of seed pod^{-1} was recorded in control (I_0) treatment. Banamoog5 produced significantly higher number of seed pod^{-1} ompared to Binamoog7. The highest number of seed pod^{-1} was observed in Binamoog7 x I+PK+CD.

Table 4. Effect of inoculant on number of grain plant^{-1}, number of pod plant^{-1}, pod length and number of grain pod^{-1} of mungbean

Inoculant	No. of grain plant^{-1}	No. of pod plant^{-1}	Pod length (cm)	No. of grain pod^{-1}
I_0	65.63c	16.50d	4.89b	3.88c
I	80.60b	19.39 c	5.50a	5.27a
I+PK	83.00ab	20.72 b	5.67a	4.93ab
NPK	81.48ab	22.92a	5.46a	4.90ab
I+PK+B	83.00ab	22.70a	5.50a	4.70b
I+PK+CD	84.95 a	24.01a	5.71 a	4.92ab
Significant level	**	**	**	**
CV(%)	4.09	5.10	3.73	6.48

Table 5. Response of cultivars on number of grain plant^{-1}, number of pod plant^{-1}, pod length and number of grain pod^{-1} of mungbean

Cultivar	No. of grain plant^{-1}	No. of pod plant^{-1}	Pod length (cm)	No. of grain pod^{-1}
Binamoog5	74.05b	22.69a	5.540a	4.25b
Binamoog7	85.50a	19.39b	5.375b	5.28a
Significant level	**	**	**	**
CV(%)	4.09	5.10	3.73	6.48

Table 6. Interaction effect of inoculant and cultivars on number of grain plant^{1}, number of pod plant^{-1}, pod length and number of grain pod^{-1} of mungbean

Inoculant × Cultivar	No. of grain plant^{-1}	No. of pod plant^{-1}	Pod length (cm)	No. of grain pod^{-1}
V_1 × Io	59.40f	17.60d	4.83e	3.57d
V_1 ×I	79.10cd	20.07bc	5.87a	5.11b
V_1 ×I+PK	77.00cde	22.00b	5.69abc	4.47c
V_1 ×NPK	75.56de	25.30a	5.44bcd	4.30c
V_1×I+PK+B	74.66de	24.75a	5.64abc	4.00cd
V_1×I+PK+CD	78.60cd	26.40a	5.77ab	4.09cd
V_2 × Io	71.86e	15.40e	4.96e	4.19c
V_1 ×I	82.10bc	18.70cd	5.13de	5.44ab
V_2 ×I+PK	89.00a	19.43cd	5.66abc	5.39ab
V_2 ×NPK	87.40ab	20.53bc	5.48bcd	5.50 ab
V_2×I+PK+B	91.33a	20.66bc	5.37cd	5.41ab
V_2×I+PK+CD	91.30a	21.63b	5.65abc	5.76a
Significant level	*	*	**	**
CV(%)	4.09	5.10	3.73	6.48

In a column same letter(s) do not differ significantly at 1 and 5% level of probability as per DMRT.
** = Significance at 1% level of probability * = Significance at 5% level of probability

Summary and Conclusions

From the above discussion, it may be concluded that in most cases or parameters inoculated treatments exhibited better result over uninoculated control. Inoculation along with phosphorus and potassium application further enhanced yield of mungbean. Inoculation along with PK and boron or cowdung further combindly enhanced the effectivity of biofertilizer and influenced yield and yield attributing characters of mungbean and finally recorded the highest yield of grain and straw. When the crop mungbean was inoculated with rhizobial along with recommended P, K and boron the grain yield was achieved highest but when boron replaced with cowdung the straw yield got highest. Though these two treatments are very close, as the treatment I+PK+CD gave the highest straw yield and it content also a small amount of boron also. So treatment I+PK+CD may be used for summer mungbean production.

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