

EFFECT OF PHOSPHORUS AND *RHIZOBIUM* INOCULANTS ON THE GROWTH AND YIELD OF MUNGBEAN

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Abstract

The experiment was conducted at the research field of Patuakhali Science and Technology University (PSTU), Patuakhali during the period from December 2014 to March 2015 to evaluate the effect of phosphorus (P) and Rhizobium inoculation on growth and yield of mungbean. The variety BARI Mung-6 was used in this experiment as the test crop. The experiment was laid out in Randomized Block Design (RCBD) with three replications. There were nine treatments, such as T₁ (Control), T₂: P₀+30g Rhizobium inoculants kg⁻¹ seed, T₃: P₀ +50g Rhizobium inoculants kg⁻¹ seed, T₄: 40 kg P ha⁻¹ + R₀, T₅: P 40 kg/ha + 30g Rhizobium inoculants kg⁻¹ seed, T₆: 40 kg P ha⁻¹ + 50g Rhizobium inoculants kg⁻¹ seed, T₇: 60 kg P ha⁻¹ + R₀, T₈: 60 kg P ha⁻¹ +30g Rhizobium inoculants kg⁻¹ seed and T₉: 60 kg P ha⁻¹ + 50g Rhizobium inoculants kg⁻¹ seed. Basal doses of Urea @ 10 kg, MoP @ 40 kg, and gypsum @ 10 kg ha⁻¹, respectively, were applied at the time of final land preparation. Treatment effects were examined on plant height, leaves plant⁻¹, branches plant⁻¹, root length plant⁻¹, leaf area plant⁻¹, shoot dry weight plant⁻¹, root dry weight plant⁻¹ and yield and yield contributing characters, such as number of pods plant⁻¹, pod length, number of seeds pod⁻¹, 1000-seed weight, and seed yield ha⁻¹. There was a significant positive effect of the treatments on yield and yield components of mungbean. Treatment T₆ (40 kg P ha⁻¹ + 50g Rhizobium inoculants kg⁻¹ seed) produced significantly higher crop yield over other treatment combinations. Combined application of Rhizobium inoculants with 40 kg P ha⁻¹ was considered to be the balanced and suitable combination of fertilizer nutrients for achieving the maximum output through cultivation of mungbean.

Key words: Mungbean, *Rhizobium* inoculation, Yield, Phosphorus

Introduction

Mungbean (*Vigna radiata*) is one of the most important conventional pulses grown in Bangladesh. In Bangladesh, among pulses, mungbean ranks fourth in acreage and production and first in market price (BBS, 2012). It is one of the major protein rich pulse crops grown mainly for both human and animal. It can supplement the cereal-based diet to improve the nutritional value of food and has a special importance in intensive crop production system of the country for its short growing period (Ahmed *et al.*, 1978). In Bangladesh, mungbean gives the highest yield under summer planting (Satter and Ahmed, 1995). Mungbean seed inoculation with effective *Rhizobium* strains will produce better nodulation, nitrogen (N) fixation, growth, and higher yield. Nitrogen is the most important nutrient element among the major essential elements. For legume, nitrogen is more useful because it is the main

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component of amino acid as well as protein. Adequate supply of nitrogenous fertilizer is essential for normal growth and yield of a crop. The use of biological nitrogen fixation (BNF) technology in the form of *Rhizobium* inoculants in grain legumes can be an alternative of nitrogenous fertilizer, particularly for improving the production of food legumes in the country. Yield increases in mungbean by 10 to 37 % following *Rhizobium* inoculation as reported by many researchers (Rao, 1980; Satter and Ahmed, 1992). The nitrogen fixation process is influenced by many factors and P is one of them. *Rhizobial* activities and nitrogen fixation is depressed without proper application of P. It promotes early root formation and the formation of lateral, fibrous, and healthy roots, which is very important for nodule formation and to fix atmospheric N. It was reported that application of P along with *Rhizobium* inoculant influenced nodulation and N fixation of legume crops (Solaiman and Habibullah, 1990). So, it is necessary to examine the effects of different levels of those nutrients and assess their best combination in terms of enhanced N fixation and productivity of mungbean. Therefore, this study was undertaken to determine the effect of P and *Rhizobium* inoculants on growth and yield of mungbean to know the optimum dose of those nutrients.

Materials and Methods

The research was carried out on an experimental research farm of Patuakhali Science and Technology University, Patuakhali during the period from December 2014 to March 2015 to study the effect of phosphorous and *Rhizobium* inoculants on the yield of mungbean. The experimental location was situated geographically at 22°37' N latitude and 89°10' E longitudes. The area is covered by Gangetic Tidal Floodplains and falls under Agro-ecological Zone i. e., AEZ- 13. The area lies at 0.9 to 2.1 meter above mean sea level (Iftekhar and Islam, 2004). BARI Mung-6 variety was used in this experiment as the test crop. The experimental treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications. The experimental unit was divided into three blocks and unit plot of 12 m² (4 m x 3.0 m) size. Nine treatments of the study include T₁ (Control), T₂: P₀+30g *Rhizobium* inoculants kg⁻¹ seed, T₃: P₀+50g *Rhizobium* inoculants kg⁻¹ seed, T₄: 40 kg P ha⁻¹ + R₀, T₅: P 40 kg/ha + 30g *Rhizobium* inoculants kg⁻¹ seed, T₆: 40 kg P ha⁻¹ + 50g *Rhizobium* inoculants kg⁻¹ seed, T₇: 60 kg P ha⁻¹ + R₀, T₈: 60 kg P ha⁻¹ +30g *Rhizobium* inoculants kg⁻¹ seed and T₉: 60 kg P ha⁻¹ + 50g *Rhizobium* inoculants kg⁻¹ seed. Basal doses of Urea @ 10 kg, MoP @ 40 kg and gypsum @ 10 kg ha⁻¹ were applied at the time of final land preparation. The quantity of seed required for each plot was weighed and was kept in polythene packets. Molasses were mixed with seeds at a rate of 20 g kg⁻¹ so that seed coat became sticky. Then *Rhizobium* was mixed with seeds (@ 30 g inoculums/kg seed and (@ 50 g inoculums/kg seed. The inoculums coated seeds were placed in a cool dry place for sometimes and then sown in the field. Data on plant characters were recorded at different stages (30, 45, 60, and 75 DAS). plant height, leaves plant⁻¹, branches plant⁻¹, root length plant⁻¹, leaf area plant⁻¹, shoot dry weight plant⁻¹, root dry weight plant⁻¹, yield, and yield contributing characters, such as number of pods plant⁻¹, pod length, number of seeds pod⁻¹, 1000-seed weight and seed yield ha⁻¹ were recorded. The data obtained from experiment on various parameters were statistically analyzed in MSTAT-C computer program (Russel, 1986). The mean values for all the parameters were

calculate and the analysis of variance for the characters was accomplished by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Plant height

The effects of phosphorus and *Rhizobium* inoculant on the plant height of mungbean were found to be positive and statistically significant (Table 1). The plant height influenced by different treatments was recorded at 30, 45, 60, and 75 DAS. At all the growth stages, the maximum plant height was recorded in treatment in 40 kg P ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed (T₆) and lowest result was found in T₁ (control). Similar results were also reported by Bhuiyan *et al.* (2008) who found the highest plant height (44.95 cm) with 40 kg P plus 1.0 kg Mo/ha and *Rhizobium* inoculants.

Number of leaves per plant

Number of leaves plant⁻¹ increased significantly through the application of phosphorus and *Rhizobium* inoculants on mungbean at all the stages of growth (Table 1). The maximum number of leaves plant⁻¹ (7.5, 19.5, 24.4 and 27.7) was found through the application of phosphorus 40 kg ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed (T₆). The lowest number of leaves plant⁻¹ (4.5, 9.7, 11.5 and 14.7) was found in control treatment (T₁).

Table 1. Effect of different phosphorous and *Rhizobium* inoculants on plant height and number of leaves plant⁻¹ at different days after sowing

Treatment	Plant height (cm) at different DAS				No. of leaves plant ⁻¹ at different DAS			
	30	45	60	75	30	45	60	75
P ₀ R ₀	10.3 e	13.5 e	31.3 d	35.6 e	4.5 e	9.7 d	11.5 d	14.7 e
P ₀ R ₃₀	14.5 c	17.0 d	36.8 c	44.4 d	5.5 cd	14.9 c	20.5 c	23.7 d
P ₀ R ₅₀	14.8 bc	20.0 bc	40.0 b	49.8 bc	6.5 b	17.9 b	22.3 b	25.7 bc
P ₄₀ R ₀	13.8 bc	19.0 bc	39.0 b	48.2 c	6.5 b	17.9 b	22.2b	25.7 bc
P ₄₀ R ₃₀	14.9 bc	20.2 bc	40.1 b	50.2 b	6.5 b	17.9 b	22.3 b	25.7 bc
P ₄₀ R ₅₀	16.5 a	23.4 a	43.6 a	53.5 a	7.5 a	19.5 a	24.4 a	27.7 a
P ₆₀ R ₀	14.2 c	16.4 d	35.8 c	42.0 d	5.4 cd	14.3 c	19.9 c	23.2 d
P ₆₀ R ₃₀	14.8 b	18.6 c	39.5 b	47.2 c	6.0 bc	16.9 b	21.7 b	25.3 c
P ₆₀ R ₅₀	15.3 b	20.7 b	41.1 b	51.6 b	6.5 b	18.1 b	22.5 b	25.9 b
CV (%)	4.56	5.60	3.12	3.56	5.71	4.32	3.22	2.31
Sig. level	*	**	**	*	**	**	**	**

P₄₀: 40 kg P ha⁻¹ and P₆₀: 60 kg P ha⁻¹, R₃₀: 30g *Rhizobium* inoculants kg⁻¹ seed, R₅₀: 50g *Rhizobium* inoculants kg⁻¹ seed.

**= significant at 1% level of probability and *= significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Number of branches plant⁻¹

The number of branches plant⁻¹ was significantly influenced by combined application of P and *Rhizobium* inoculants (Table 2). The highest number of branches plant⁻¹ (4.06, 6.36, 7.90 and 9.17) were found in treatment T₆ (40 kg P ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed). The lowest number of branches (2.39, 3.01, 4.53 and 4.63) was obtained in control. It was observed that the higher number of branches was produced by inoculated plants compared to un-inoculated control (Table 2). Similar results were also reported by Bhuiyan *et al.* (2008). Muhammad *et al.* (2004) found that the number of branches per plant was significantly influenced with both inoculum and P application.

Root length (cm)

A significant variations were found on the root length of phosphorus and *Rhizobium* inoculants application (Table 2). The maximum root length of mungbean (7.38 cm, 11.30 cm, 16.87 cm, and 19.7 cm at 30 DAS, 45 DAS, 60 DAS, and 75 DAS) were recorded in phosphorus @ 40 kg ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed (T₆), which was significantly different from and superior to all other treatments and the minimum root length (3.48 cm, 5.37 cm, 6.42 cm, and 6.66 cm at 30 DAS, 45 DAS, 60 DAS, and 75 DAS, respectively) was found in control treatment (T₁). Similar results were also reported by Bhuiyan *et al.* (2008) and Solaiman (1999).

Table 2. Effect of phosphorous and *Rhizobium* inoculants on branch plant⁻¹ and root length at different days after sowing (DAS)

Treatment	Branch plant ⁻¹ at different DAS				Root length (cm) at different DAS			
	30	45	60	75	30	45	60	75
T ₁ : P ₀ R ₀	2.39 d	3.01d	4.53e	4.63e	3.48d	5.37c	6.42e	6.66d
T ₂ : P ₀ R ₃₀	3.58bc	5.80 c	6.37cd	6.77 bc	6.15bc	8.73b	13.70d	15.5c
T ₃ : P ₀ R ₅₀	3.09ab	6.43ab	7.59bc	7.78 b	6.65 b	10.06b	16.00b	17.6 b
T ₄ : P ₄₀ R ₀	3.08ab	6.33ab	7.49bc	7.71 b	6.60 b	9.58b	16.02b	17.8 b
T ₅ : P ₄₀ R ₃₀	3.19ab	6.53ab	7.69bc	7.72b	6.20bc	9.32b	15.20 c	16.9b
T ₆ : P ₄₀ R ₅₀	4.06 a	6.36a	7.90a	9.71a	7.38 a	11.30 a	16.87a	19.7a
T ₇ : P ₆₀ R ₀	3.37bcd	6.63c	6.99 d	6.80 c	5.65c	9.16 b	13.62d	15.9c
T ₈ : P ₆₀ R ₃₀	3.93ab	6.14 b	7.67 bc	7.15 bc	5.650c	9.167b	13.72d	15.7c
T ₉ : P ₆₀ R ₅₀	4.11ab	6.54ab	7.09 b	8.00 b	6.70b	10.10b	16.00b	17.8 b
CV(%)	3.21	5.32	3.22	6.31	5.81	7.52	3.65	5.31
Sig. level	**	*	*	*	**	*	*	*

P₄₀: 40 kg P ha⁻¹ and P₆₀: 60 kg P ha⁻¹. R₃₀: 30g *Rhizobium* inoculants kg⁻¹ seed, R₅₀: 50g *Rhizobium* inoculants kg⁻¹ seed.) **= significant at 1% level of probability and *= significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Number of Nodules per plant

Inoculation had a significant positive effect on the formation of nodules. Seed inoculation with *Rhizobium* markedly increased nodule number as compared to that of the non-inoculated plants of mungbean (Table 3). These results are in agreement with Bhuiyan *et al.* (2008). They reported that P at the rate of 40 kg/ha produced highest number of nodules and with increasing P rate nodule number plant⁻¹ was decreased significantly. The maximum number of nodules at different growth stages were 8.50, 15.80, 17.90, and 7.25 per plant were recorded in phosphorus @ 40 kg ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed (T₆). Sharma *et al.* (1995) reported that seed inoculation with *Rhizobium* and application of 40 kg P₂O₅/ha in chickpea (*Cicer arietinum*) either alone or in combination enhanced nodulation over un-inoculated control.

Table 3. Effect of phosphorous and *Rhizobium* inoculants on number of nodule plant⁻¹ and leaf area at different days after sowing (DAS)

Treatment	Nodules plant ⁻¹ at different DAS				Leaf area plant ⁻¹ (cm ²) at different DAS			
	30	45	60	75	30	45	60	75
T ₁ : P ₀ R ₀	4.3 e	6.5 e	7.1 d	3.6 e	9.1 d	14.65 e	18.3 e	19.8 e
T ₂ : P ₀ R ₃₀	5.5 cde	11.3 d	13.3 c	4.4 cd	16.3 c	24.7 c	26.0 c	33.9 cd
T ₃ : P ₀ R ₅₀	7.2 ab	14.9 b	16.1 b	5.08 b	19.6 b	27.7 b	34.2 b	36.1 b
T ₄ : P ₄₀ R ₀	7.1 abc	14.7 b	16.0 b	5.0 b	19.2 b	27.2 b	34.0 b	36.0 b
T ₅ : P ₄₀ R ₃₀	6.7 bcd	13.7 c	15.3 b c	4.76 bc	19.7 b	27.6 b	34.1 b	36.0 b
T ₆ : P ₄₀ R ₅₀	8.5 a	15.8 a	17.9 a	7.25 a	21.2 a	29.1 a	35.5 a	37.9 a
T ₇ : P ₆₀ R ₀	5.3 de	11.6 d	12.6 c	4.1 de	15.4 c	23.3 d	25.1 d	33.3 d
T ₈ : P ₆₀ R ₃₀	6.6 bcd	13.8 c	15.4 bc	4.8 bc	16.8 b	27.3 b	33.6 b	34.9 bc
T ₉ : P ₆₀ R ₅₀	7.2 abc	14.8 b	16.09 b	6.0 b	19.5 b	27.6 b	24.0 b	35.9 b
CV (%)	3.71	5.32	3.22	6.31	5.56	6.66	5.35	7.67
Sig. level	**	*	*	*	**	*	*	*

P₄₀: 40 kg P ha⁻¹ and P₆₀: 60 kg P ha⁻¹; R₃₀: 30g *Rhizobium* inoculants kg⁻¹ seed, R₅₀: 50g *Rhizobium* inoculants kg⁻¹ seed.) **= significant at 1% level of probability and *= significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Leaf area per plant (cm²)

Leaf area of plant as influenced by combined application of phosphorous and *Rhizobium* inoculants recorded in different stages of growth (Table 3). The maximum leaf area of plant (21.2 cm², 29.1 cm², 35.5 cm² and 37.9 cm²) at 30, 45, 60 and 75 DAS, respectively, were recorded in phosphorus @ 40 kg ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed (T₆) and the lowest leaf area of plant (9.1 cm², 14.65 cm², 18.3 cm² and 19.8 cm² at 30 DAS, 45 DAS, 60 DAS, and 75 DAS) was found in control treatment (T₁).

Dry weight of root per plant (g)

The effect of P and *Rhizobium* inoculant significantly increased dry weight of root plant⁻¹ compared to that of control (Table 4). *Rhizobium* inoculant and phosphorus fertilizers produced significantly higher dry weight of root plant⁻¹ over control. *Rhizobium* inoculant (50g *Rhizobium* inoculants kg⁻¹ seed) and phosphorus 40 kg/ha produced higher dry weight of root plant⁻¹. Bhuiyan *et al.*, (2008) reported similar result who reported that addition of Mo up to 1.0 kg/ha along with *Rhizobium* inoculants and phosphorus up to 40 kg/ha produced higher dry weight of root and then reduced gradually.

Dry weight of shoot per plant (g)

There was a significant effect of P and *Rhizobium* inoculants on dry weight of shoots plant⁻¹ (g) (Table 4). *Rhizobium* inoculation and phosphorus increased dry weight of shoot significantly over control. The highest dry weight of shoots plant⁻¹ (g) were recorded in 40 kg P ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed (T₆) in all the data recording stages and the lowest dry weight of shoots plant⁻¹ (g) were found in control treatment (T₁). Result reported by Bhuiyan *et al.* (2008) are more or less similar to these findings.

Table 4. Effect of phosphorous and *Rhizobium* inoculants on root and shoot dry weight at different days after sowing (DAS)

Treatment	Dry weight of root plant ⁻¹ (g) at different DAS				Shoot dry weight (g) at different DAS			
	30	45	60	75	30	45	60	75
T ₁ : P ₀ R ₀	0.143 d	0.337 c	0.422 c	0.513 d	2.21 f	3.05 d	4.03 f	4.65 d
T ₂ : P ₀ R ₃₀	0.275 b	0.448 b	0.612 b	0.758 b	2.52 d	4.17c	5.58 d	6.57 c
T ₃ : P ₀ R ₅₀	0.273 b	0.450 b	0.625 b	0.643 c	2.74 b	4.62 b	5.70 bc	6.85 b
T ₄ : P ₄₀ R ₀	0.272 b	0.452 b	0.623 b	0.641 c	2.46 e	4.25 c	5.47 e	6.49 c
T ₅ : P ₄₀ R ₃₀	0.276 b	0.446 b	0.601 b	0.742 b	2.74 b	4.65 b	5.70 bc	6.85 b
T ₆ : P ₄₀ R ₅₀	0.345 a	0.595 a	0.747 a	0.877 a	3.0 a	4.98 a	6.00 a	7.21 a
T ₇ : P ₆₀ R ₀	0.199 c	0.343 c	0.431 c	0.520 d	2.75 b	4.58 b	5.78 b	6.89 b
T ₈ : P ₆₀ R ₃₀	0.285 b	0.499 b	0.634 b	0.761 b	2.78 c	4.48 bc	5.62 cd	6.71 bc
T ₉ : P ₆₀ R ₅₀	0.265 b	0.447 b	0.622 b	0.634 c	2.81 b	4.60 b	5.70 bc	6.85 b
CV (%)	4.23	3.65	4.65	3.45	4.71	6.32	4.22	5.31
Sig. level	**	*	*	*	**	*	**	*

P₄₀: 40 kg P ha⁻¹ and P₆₀: 60 kg P ha⁻¹. R₃₀: 30g *Rhizobium* inoculants kg⁻¹ seed, R₅₀: 50g *Rhizobium* inoculants kg⁻¹ seed.) **= significant at 1% level of probability and *= significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Number of pods per plant

There was a significant effect of different levels of phosphorus and *Rhizobium* inoculants in the number of pods plant⁻¹ (Table 5). Among the treatments, phosphorus @ 40 kg ha⁻¹ + 50g *Rhizobium* inoculants kg⁻¹ seed (T₆) recorded the maximum number of pods plant⁻¹ (24.65) which was statistically different from other treatments. On the other hand, control recorded the minimum number of pods plant⁻¹ (13.20). Similar results were also reported by Bhuiyan *et al* (2008) and Landge *et al.* (2002).

Pod Length

The length of pod recorded under different treatments is presented in Table 5. The data reveals that the length of the pods was significantly influenced by levels of phosphorus and *Rhizobium* inoculants. Maximum length of the pods (8.32 cm) was recorded with 40 kg P ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed (T₆) and the lowest pod length 6.09 cm was found with control (T₁).

Number of seeds pod⁻¹

The data show that there was a significant effect of phosphorus and *Rhizobium* inoculant on the number of seeds pod⁻¹ (Table 5). The phosphorus application @ 40 kg ha⁻¹ +50g *Rhizobium* inoculants kg⁻¹ seed produced the maximum number of seeds pod⁻¹ (8.49) and treatment T₁ (control) recorded the minimum number of seeds pod⁻¹ (6.38). Similar results were also reported by Landge *et al.* (2002).

Seed weight

Thousand-seed weight (g) was found statistically significant due to the application of different phosphorus and *Rhizobium* inoculants (Table 5). The highest 1000- seed weight (39.15 g) was recorded with the treatment T₆ which was statistically at par with treatment T₉ and control treatment recorded the lowest weight of 1000–seed (29.85 g). Similar findings were found by Bhuiyan *et al.* (2008). Malik *et al.* (2002) reported that seed inoculation with *Rhizobium* significantly increased 100-grain weight (42.27 g) of mungbean. Similar results were observed by Podder *et al.* (1999) and Chowdhury *et al.* (1998).

Seed yield

Seed yield of mungbean was significantly influenced by phosphorus and *Rhizobium* inoculants (Table 5). The highest seed yield (2.19 t ha⁻¹) was found with 40 kg P/ha +50g *Rhizobium* inoculants kg⁻¹ seed, which was statistically at par with treatment T₉. The lowest seed yield was recorded in control (1.32 t ha⁻¹). Bhuiyan *et al.* (2008), Yadav and Jakhar (2001) also found similar result on mungbean.

Table5. Effect of phosphorous and *Rhizobium* inoculants on yield contributing characteristics and yield of mungbean

Treatment	Pod length (cm)	No. of pods plant ⁻¹	No. of seed pod ⁻¹	1000-seed wt (g)	Seed yield (t ha ⁻¹)
T ₁ : P ₀ R ₀	6.09e	13.20 d	6.38f	29.85 e	1.34 d
T ₂ : P ₀ R ₃₀	7.11 d	20.35 c	6.89 e	34.67 d	1.87 c
T ₃ : P ₀ R ₅₀	7.59 c	22.55 b	7.61 c	36.58 b	1.96 c
T ₄ : P ₄₀ R ₀	7.30 d	22.68 b	7.34 d	36.80 b	1.98 bc
T ₅ : P ₄₀ R ₃₀	7.65 b	22.77 b	7.59 c	36.66 b	2.06 b
T ₆ : P ₄₀ R ₅₀	8.32 a	24.65 a	8.49 a	39.15 a	2.19 a
T ₇ : P ₆₀ R ₀	7.19 d	20.55 c	7.24 d	35.06 c	1.917 c
T ₈ : P ₆₀ R ₃₀	7.56 c	22.17 b	7.65 c	36.76 b	2.03 bc
T ₉ : P ₆₀ R ₅₀	7.83 b	23.52 ab	8.0 b	36.95 ab	2.10 ab
CV%	3.35	4.30	5.35	6.34	4.33
Sig. level	**	*	**	*	**

P₄₀: 40 kg P ha⁻¹ and P₆₀: 60 kg P ha⁻¹; R₃₀: 30g *Rhizobium* inoculants kg⁻¹ seed, R₅₀: 50g *Rhizobium* inoculants kg⁻¹ seed.) **= significant at 1% level of probability and *= significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Conclusions

In view of the findings and the results presented above, it may be concluded that among the treatments, phosphorous levels 40 kg P ha⁻¹+50g *Rhizobium* inoculants kg⁻¹ seed significantly dominated over others. There is enough scope to explore and exploit the production of mungbean in Bangladesh by using *Rhizobium* technology along with phosphorus.

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