J. Bangladesh Agril. Univ. 7(1): 7–13, 2009 **ISSN 1810-3030**

Effect of *Bradyrhizobium* and *Azotobacter* on growth and yield of mungbean varieties

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Abstract

A field experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh during the period from January to April 2004 to study the effects of *Bradyrhizobium* and *Azotobacter* inoculation on growth and yield of mungbean varieties. There were ten treatment combinations taking two varieties of mungbean viz. BARI mung-3 and BARI mung-4, and five bacterial and chemical fertilizers viz.control, *Bradyrhizobium*, *Azotobacter*, *Bradyrhizobium* plus *Azotobacter* and 20 kg N ha^{-1}. The experiment was laid out in a split plot design with three replications assigning varities in main plots and bacterial and chemical fertilizers in subplots. The unit plot size was 4 m x 3 m. After 35 days of sowing, 10 plants were randomly uprooted from each plot to study nodulation. At maturity yield and yield contributing characters were recorded. Variety BARI mung-3 recorded significantly higher nodule number and weight, and shoot weight compared to BARI mung-4. On the other hand, BARI mung-4 produced significantly higher seed and stover yields than BARI mung-3 did. Application of *Bradyrhizobium* or *Azotobacter* or their combination significantly increased nodulation, and root and shoot weights at 35 days after sowing. Similarly, the number of seeds pod^{-1} and seed yield were significantly influenced by the bacterial biofertilizer. These results indicate that use of both *Bradyrhizobium* and *Azotobacter* inoculants appears to be an effective method for successful mungbean production at BAU farm.

Keywords: Growth, Yield, Mungbean, *Bradyrhizobium* and *Azotobacter*

Introduction

Mungbean (*Vigna radiata*), also popularly as green gram, is an ancient and well known legume crop in Asia, particularly in the Indian subcontinent. It is one of the important pulse crops of Bangladesh, as it is an excellent source of easily-digestible protein of low flatulence, which complements the staple rice diet in the country. Since it is a short duration legume (maturing in 55 to 70 days), it fits well into many cropping systems, including rice and sugarcane under both rainfed and irrigated conditions. It increases small farmers income and improves soil conditions. It holds the 1st position in price, 3rd in protein content and 4th both in acreage and production in Bangladesh (Anon., 1999). On an average in Bangladeshi diet only 8 to 10% of the protein intake originates from animal sources, the rest can be met from plant sources by increasing the consumption of pulses. Hence from the point of nutritional value, mungbean is perhaps the best of all other pulses. However, the average yield of mungbean in the country is about 625 kg/ha, which is much lower than that of India and some other countries of the world. This poor yield may be attributed due to climatic condition, adaptation of varieties, disease and insect problems, poor crop management practices and judicious application of fertilizer especially nitrogenous fertilizers/biofertilizers as nitrogen is the most important element for crop.

In Bangladesh, most of the soils are deficient in organic matter and nitrogen. To fulfill the demand of nitrogen, usually urea is being used. The price of this fertilizer is very high. As a result the poor and marginal farmers cannot afford to apply fertilizer. The root nodule bacteria, *Bradyrhizobium*, can fix atmospheric nitrogen by symbiotic process with the root system of legume crops and make available to the plants. Estimates of 50-100 kg N ha^{-1} yr^{-1}represent the average N_2 fixed for an average legume crops. Available literature shows that *Bradyrhizobium* inoculation increased mungbean seed yield from 4.3% to 162% (Vaishya *et al.*, 1983). In Bangladesh, inoculation with *Bradyrhizobium* increased 57% effective nodules, 77% dry matter production and 64% seed yield over uninoculated control in mungbean cultivation (Chanda *et al.,* 1991). Thus the ability of mungbean to fix atmospheric nitrogen (N_2), in association with bacteria of the genus *Bradyrhizobium* sp. is of extreme importance.

Azotobacter is a free living nitrogen fixer, besides it can synthesize and secrete considerable amounts of biologically active substances like B vitamins, nicotinic acid, pentothenic acid, biotin, heteroauxins, gibberellins etc. which enhance root growth of plants. Seed inoculation with *Azotobacter chroococcum* also significantly increased the growth parameters of mungbean (Khan and Kounsar, 2000).

In order to meet the increasing need of pulses for ever growing population over a limited land, production level of this pulse crops should be increased. In view of poor soil fertility by crops and poor economic condition and malnutrition problem of the common people, the biofertilizers technology seems to have great prospect in the country. The acute energy crisis and environment considerations further justify the increased use of biological sources of nitrogen instead of chemical sources that costs more and not sustainable. Hence, dual inoculation of *Azotobacter* and *Bradyrhizobium* appears to be very important for legume cultivation and sustainable agriculture.

Under the above circumstances, present study was undertaken to investigate the effects of *Bradyrhizobium* and *Azotobacter* on growth and yield of mungbean.

Materials and Methods

A field experiment was conducted at the Soil Science field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh during the period from January to April 2004 to study the effects of *Bradyrhizobium* and *Azotobacter* inoculation on growth and yield of mungbean varieties. Growth characters were: number of effective nodules plant^{-1}, nodule weight, root weight and shoot weight; and yield contribution characters were: pod length, number of pods plant^{-1}, seeds pod$^{-1,}$ 1000-seed weight and stover yield. There were ten treatment combinations taking two varieties of mungbean viz BARI mung-3 and BARI mung-4, and five bacterial and chemical fertilizers viz. control, *Bradyrhizobium*, *Azotobacter*, *Bradyrhizobium* plus *Azotobacter* and urea @ 20 kg N ha^{-1}. The experiment was laid out in a split plot design with three replications assigning varieties in the main plots and bacterial and chemical fertilizers in the subplots. The unit plot size was 4 m X 3 m. After 35 days of sowing, 10 plants were uprooted from each plot to study nodulation. At maturity yield and yield contributing characters were recorded. The data were analyzed statistically using Analysis of Variance technique and differences among treatment means were adjudged by Duncan's Multiple Range Test.

Results and Discussion

Growth characters

Number of effective nodules plant^{-1}: It is an important parameter under study, since nodule is the main criterion of biological nitrogen fixation by *Bradyrhizobium* and *Azotobacter* inoculants on legumes. BARI mung - 3 produced significantly higher number of effective nodules compared to that of BARI mung - 4 (Table 1). The highest number of effective nodules per plant (34.9) was recorded in combined application of *Bradyrhizobium* and *Azotobacter* inoculants and the lowest (23.1) was found in uninoculated control. The use of' *Bradyrhizobium* inoculants alone gave the second highest number of nodule plant^{-1} in F_2 (31.2 plant^{-1}) followed by *Azotobacter* inoculants (29.8 plant-1) and application of 20kg N ha^{-1} (25.1 plant^{-1}).

Nodule weight plant^{-1}: The results showed that the varietal response and bacterial fertilizers showed significant effect on weight of nodules (Table 1). BARI mung - 3 produced significantly higher nodule weight (33.7 mg plant^{-1}) compared to that of BARI mung - 4 (29.0 mg plant^{-1}). The highest weight of nodules (42.3 mg plant^{-1}) was found due to the application of *Bradyrhizobium* + *Azotobacter* and the lowest was in control (23.1 plant^{-1}) Results un nodules weight obtained in *Azotobacter alone* (30.0mg plant^{-1}) and *Bradyrhizobium* alone (32.8) were statistically identical.

Root weight plant^{-1}: There was no significant variation on root weight of the two mungbean varieties but the effect of different bacterial fertilizers was statistically significant (Table1). The highest root weight (1.45 g plant^{-l}) was obtained with the F_2, *(Bradyrhizobium* alone) which was statistically identical with the combined use of *Bradyrhizobium* and *Azotobacter.* The lowest root weight was found in control (1.17 g plant^{-1}).

Shoot weight: There was significant variation in the shoot weight of two varieties of mungbean recorded at 35 DAS (Table 1). BARI mung-3 produced significantly higher (5.4 g plant^{-1}) shoot weight compared to that of BARI mung-4 (5.0 g plant^{-1}). The effect of different bacterial fertilizers were significant on shoot weight of mungbean (Table 1). The highest shoot weight (6.4 g plant^{-1}) was noted due to combined application of *Bradyrhizobium* and *Azotobacter.* The shoot weights recorded due to *Bradyrhizobium* inoculants (F_2) and 20 kg N ha^{-1}(F_5) were statistically identical and superior to control.

Table 1. Effect of variety and bacterial fertilizers on total number of effective nodules, nodule weight, root weight and shoot weight of Mungbean crop at 35 Days after sowing (DAS)

Treatment	Effective nodules plant^{-1}	Nodule weight (mg plant^{-1})	Root weight (g plant^{-1})	Shoot weight (g plant^{-1})
Variety				
V_1: BARI mung - 3	30.4^{a}	33.7^{a}	1.30	5.4^{a}
V_2: BARI mung - 4	27.2^{b}	29.0^{b}	1.34	5.0^{b}
$S\bar{x}$	0.151	0.45	NS	0.078
Bacterial fertilizers				
F_1: Control	23.1^{e}	23.1^{d}	1.17^{c}	4.6^{cd}
F_2: *Bradyrhizobium*	31.2^{b}	32.8^{b}	1.45^{a}	5.2^{b}
F_3: *Azotobacter*	29.8^{c}	30.0^{bc}	1.29^{b}	4.6^{d}
F_4: *Bradyrhizobium* + *Azotobacter*	34.9^{a}	42.3^{a}	1.37^{ab}	6.4^{a}
F_5: 20kg N ha-1	25.1^{d}	28.6^{c}	1.30^{b}	5.1b^{c}
$S\bar{x}$	0.239	0.72	0.026	0.124
CV (%)	2.03	5.62	4.96	5.81

NS = Not Significant, $S\bar{x}$ = Standard Deviation and CV = Coefficient of variation
abcde Means with different superscript in the same column differ significantly.

Yield contributing characters

Pod length: The two varieties did not vary significantly with respect to pod length (Table 2). Pod length of mungbean increased significantly due to use of bacterial fertilizers. The longest pod (34.1cm) was found in F_4 (*Bradyrhizobium +Azotobacter)*. The pod length found due to *Azotobacter* (F_3) inoculant was comparable to those found in F_2 (*Bradyrhizobium*), F_5 (20 kg N ha^{-1}) and F_1 (control).

Number of pods plant^{-1}: The number of pods plant^{-1} was significantly affected by the varieties and different bacterial fertilizers (Table 2). BARI mung-4. The different bacterial fertilizers exerted significant effect on the formation of pods plant^{-1}. The highest number of pods plant^{-1} (20.5) was found in F_4 *(Bradyrhizobium + Azotobacter).* The use of *Bradyrhizobium,* or *Azotobacter* inoculants alone also recorded higher number of pods plant^{-1}over control and 20 kg N ha^{-1}.

Seeds pod^{-1}: The number of seeds pod^{-1} was significantly affected by two varieties. BARI mung - 3 produced higher seeds pod^{-1} than BARI mung- 4. The different bacterial fertilizers exerted significant effect on the number of seeds pod^{-1} (Table 2). The highest number of seeds pod^{-1} was produced in F4 (*Bradyrhizobium+Azotobacter*). The use of *Bradyrhizobium* (F_2) or *Azotobacter* (F_3) alone or 20 kg Nha^{-1} (F_5) and control (F_1) recorded statistically identical number of seeds plant^{-1}.

1000-Seed weight: The two varieties of mungbean did not vary significantly in case of 1000-seed weight (Table 2). The different bacterial fertilizers exerted significant on 1000-seed weight of Mungbean. The highest 1000 seed weight (34.1 g) was produced in F_4 (*Bradyrhizobium* + *Azotobacter*) followed by F_2 (33.1 g) and F_3 (30.8 g), F_5 (30.0 g) and the lowest 1000 seed weight (29.4g) was found in control (F_1).

Seed yield: There was statistical difference between the two varieties of mugbean in seed yield (Table 2). The variety BARI mung - 4 produced significantly higher seed yield (1007 kg ha^{-1}) compared to that of BARI mung - 3 (947 kg ha^{-1}). The different bacterial fertilizers exerted significant effect on the seed yield of mungbean. The use of *Bradyrhizobium* inoculants (F_2) or *Azotobacter* inoculants (F_3) produced significant increase over uninoculated control (F_1) and 20 kg N ha^{-1} (F_5) application (Table 2). The highest seed yield of 1165 kg ha^{-1} was noted when both *Bradyrhizobium* and *Azotobacter* inoculants (F_4) were used together.

Stover yield: There were significant differences the two varieties of mungbean in terms of stover yield (Table 2). Higher stover yield (3183 kg ha^{-1}) was produced by the variety BARI mung - 4 than variety BARI mung - 3 (3022 kg ha^{-1}). The highest (3754 kg ha^{-1}) and the lowest stover yield (2644 k ha^{-1}) was found in F_4 (*Bradyrhizobium*+*Azotobacter*) and in control (F_4), respectively.

Table 2. Effect of variety and bacterial fertilizers on pod length, pods plant^{-1}, seed plant^{-1}, 1000-seed weight, seed yield (kg ha^{-1}) and stover yield of mungbean

Treatment	Pod length (cm)	Pod plant^{-1}	Seeds pod^{-1}	1000- Seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Variety						
V_1: BARI mung-3	6.64	16.66^a	10.86^a	31.4	947^b	3022^b
V_2: BARI mung-4	6.50	15.80^b	10.24^b	31.5	1007^a	3183^a
$S\bar{x}$	NS	0.236	0.180	NS	16.44	8.59
Bacterial fertilizers						
F_1 Control	6.11^c	13.50^d	9.5^b	29.4^c	846^c	2644^e
F_2: *Bradyrhizobium*	6.68^b	18.33^b	10.6^b	33.1^b	998^b	3031^c
F_3: *Azotobacter*	6.45^{bc}	15.33^c	9.8^b	30.8^c	998^b	2888^d
F_4: *Bradyrhizobium*+ *Azotobacter*	7.21^a	20.50^a	12.4^a	34.1^a	1165^a	3754^a
F_5: 20 kg N ha^{-1}	6.40^{bc}	13.50^d	10.3^b	30.0^b	878^c	3195^b
$S\bar{x}$	0.098	0.374	0.285	0.107	25.1	13.58
CV (%)	3.66	5.65	6.63	2.3	6.51	5.07

NS- Not Significant, $S\bar{x}$ - Standard Deviation and CV-Coefficient of Variation
abcde Means with different superscript in the same column differ significantly.

The variety BARI mung-3 recorded significantly higher nodule number and weight and shoot weight compared to that of BARI mung- 4. All the plant parameters were significantly affected by the use of bacterial fertilizers. The use of *Bradyrhizobium* or *Azotobacter* significantly increased the nodulation, weight of nodules, and weights of root and shoot. Combined application of *Bradyrhizobium* and Azotoacter showed better performance compared to those when they were used singly. There was significant interaction between the varieties of mungbean and bacterial fertilizers on nodulation and dry weight of nodule, and weights of root and shoot. Booth the varities of mungbean the highest values were observed due to combined use of *Bradyrhizobium* and *Azotobacter*. There were significant differences between the two varieties of mungbean on seeds pod^{-1}, seed yield, and stover yield but not on 1000-seed weight. The variety BARI mung-4 recorded significantly seed yield, and stover yield compared to that of BARI mung-3. All the yield contributing characters were affected by the use of bacterial fertilizers. The use of *Bradyrhizobium* or *Azotobacter* singly significantly increased seeds pod^{-1}, seed yield and stover yield. Combined application of *Bradyrhizobium* and *Azotobacter* showed better performance compared to those when they were used singly. There was significant interaction between the varieties of mungbean and bacterial fertilizers on yield contributing characters on 1000-seed weight and stover yield but not on seeds pod-1 seed yield. Both the varieties of mungbean produced the highest values due to combined use of *Bradyrhizobium* and *Azotobacter.*

The Interaction Effect: Result presented in Table 3 revealed that there was significant interaction between the mungbean varieties and bacterial fertilizers to produce effective nodules plant^{-1} at 35 DAS. The highest number of nodules (36.5 plant^{-1}) was observed by the treatments V_1F_4 (BARI mung - 3 and *Bradyrhizobium*+*Azotobacter*) which was statistically dissimilar to V_2F_4 (BARI mung - 4 and Bradyrhizobium + *Azotobacter*) and significantly superior to other treatments. All the treatment gave higher effective nodules than control in both the varieties of mungbean. The findings are in agreement with the investigations of other Islam *et al.* (1999), Uslu (1997), Patra and Bhattacharyya, (1997), Haque and Barrow (1993), Sarkea *et al.* (1993), Sanghakara and Marambe (1989).

The interaction effect of variety and bacterial fertilizers was also significant in recording nodule weight of mungbean varieties. In BARI mung-3, the nodule weight ranged from 24.0 mg in control to 45.3 mg due to dual application *Bradyrhizobium* and *Azotobacter*. The use of *Bradyrhizobium* inoculants significantly increased the nodule weight compared to that of uninoculated control. The use of *Azotobacter* also recorded increase nodule weight compared to that found in control, In case of BARI mung-4, the nodule weight ranged from 22.3 mg plant^{-1} in control to 39.3mg plant due to dual inoculation with *Bradyrhizobium* and *Azotobacter*. The nodule weight obtained due to single inoculation With *Bradyrhizobium* or *Azotobacter* also recorded significantly higher nodule weight compared to that found in control. Similar results were observed by Perveen *et al.* (2002) Haque and Barrow (1993), Sarker *et al.* (1993) Bhuiyan *et al.*(1992) Bhuiyan *et al.* (1984) and Patra and Bhattacharyya (1997).

Table 3. Interaction effect of variety and bacterial fertilizers on effective nodules plant^{-1}, nodule weight (mg plant^{-1}), root weight (g plant^{-1}), shoot weight(g plant^{-1}), pods length, pod plant^{-1}, seed pod^{-1}, 1000-Seed weight (g), seed yield (kgha^{-1}) and stover yield (kg ha^{-1}) of mungbean

Variety × Bacterial fertilizers		Effective nodules plant^{-1}	Nodule weight (mg plant^{-1})	Root weight (g plant^{-1})	Shoot weight (g plant^{-1})	Pod length (cm)	Pod plant^{-1}	Seed Pod^{-1}	1000-Seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
V_1: BARI mung - 3	F_1: Control	23.0^{g}	24.0^{e}	1.19^{d}	4.54^{e}	6.03^{d}	13.66^{d}	9.6	29.4^{g}	847	2658^{h}
	F_2: *Bradyrhizobium*	35.8^{a}	38.3^{b}	1.41^{bc}	5.82^{bc}	6.66^{bc}	20.33^{ab}	11.3	31.9^{d}	954	2927^{f}
	F_3: *Azotobacter*	31.8^{c}	32.3^{b}	1.12^{d}	5.42^{cd}	6.43^{bcd}	16.66^{c}	9.6	30.3^{f}	922	2784^{g}
	F_4: *Bradyrhizobium+ Azotobacter*	36.5^{a}	45.3^{a}	1.58^{a}	6.57^{a}	7.60^{a}	19.33^{b}	13.0	35.6^{a}	1132	3612^{b}
	F_5: 20 kg N ha^{-1}	24.8^{f}	28.6^{d}	1.20^{d}	4.64^{e}	6.46^{bcd}	13.33^{d}	10.6	29.7^{g}	880	3127^{d}
V_2: BARI mung - 4	F_1: Control	23.1^{g}	22.3^{e}	1.16^{d}	4.82^{e}	6.20^{d}	13.33^{d}	9.3	29.4^{g}	846	2630^{h}
	F_2: *Bradyrhizobium*	27.6^{g}	27.6^{d}	1.39^{bc}	5.05^{de}	6.70^{bc}	16.33^{c}	10.0	34.3^{b}	1042	3135^{d}
	F_3: *Azotobacter*	26.6^{e}	27.3^{d}	1.34^{c}	4.60^{e}	6.46^{bcd}	14.00^{d}	10.0	31.3^{e}	1075	2992^{e}
	F_4: *Bradyrhizobium +Azotobacter*	33.2^{b}	39.3^{b}	1.48^{ab}	6.26^{ab}	6.83^{b}	21.66^{a}	11.8	32.5^{c}	1197	3895^{a}
	F_5: 20 kg N ha^{-1}	25.4^{f}	28.6^{d}	1.32^{c}	4.54^{e}	6.33^{cd}	13.66^{d}	10.0	30.3^{f}	876	3264^{c}
	$S\bar{x}$	0.338	1.018	0.037	0.175	0.138	0.529	NS	0.151	NS	19.21
	CV (%)	2.03	5.62	4.96	5.81	3.66	5.65	6.63	2.3	6.51	5.07

$S\bar{x}$ - Standard Deviation and CV-Coefficient of Variation

abcdefgh Means with different superscript in the same column differ significantly.

The interaction effect of varieties and bacterial fertilizers was statistically significant at 1% level of probability (Table 3). The highest root weight was obtained in V_1 F_4 (BARI mung-4 and *Bradyrhizobium* + *Azotobacter*) and similar result was found in V_2F_4 variety (1.48 g plant^{-1}). It was revealed that inoculated treatments gave higher root weight than control. Srinivas and Shaik (2002), Sarker *et al.* (2002), Chowdhury *et al.* (2000), Barakah and Heggo (1998), Bhuiyan and Obaidullah (1992) observed that seed inoculation increased root weight as well as plant growth.

The interaction effect of varieties and bacterial fertilizers was statistically significant at 1% level of probability (Table 3). The highest shoot weight in V_1 F_4 (BARI mung-3 and *Bradyrhizobium*+ *Azotobacter*) was statistically similar with V_2F_4 (BARI mung - 4 and *Bradyrhizobium* + *Azotobacter*). It was observed that *Bradyrhizobium* + *Azotobacter* inoculated treatments gave higher shoot weight than control. Vasilas and Fuhrmann (1993) observed that seed inoculation with *Bradyrhizobium*, *Azotobacter* or in combination increased shoot weight as well as plant growth.

The interaction effect of variety and bacterial fertilizers was also significant (Table 3). The highest pod length (7.60cm) found in V_1F_4 (BARI mung-3 and *Bradyrhizobium* + *Azotobacter*) which was superior to all other treatments. The lowest pod length in both varieties was found without any bacterial fertilizers (F_1). It appeared that dual inoculation of *Bradyrhizobium* and *Azotobacter* or single inoculation was equally for larger pod compared to V_2 (BARI mung - 4). Similar results were also found by Sarker *et al.* (1993), Perveen *et al.* (2002) and Sharma (2001) for mungbean.

The interaction effect of' mungbean varieties and bacterial fertilizers was statistically significant. In both the varieties, the higher number of pods plant^{-1} was found when both *Bradyrhizobium* and *Azotobacter* inoculants were used and the lowest was found without any bacterial fertilizers. Malik *et al.* (2002), EI-Kramany (2001), Siddqui *et al.* (2001), Perveen *et al.* (2002) and Kumar *et al.* (2001) observed that seed inoculation with *Bradyrhizobium, Azotobacter* alone or in combination increased pods plant^{-1}.

The interaction effect of mungbean varieties and bacterial fertilizers was statistically non significant. In both the varieties the highest number of seeds pod^{-1} was found due to dual application of *Bradyrhizobium* and *Azotobcrcter* inoculants and the lowest seeds pod^{-1} was found without any bacterial fertilizers. Srinivas and Shaik (2002), Perveen *et al.* (2002), Malik *et al.* (2002), EI-Kramany (2001), Siddiqui *et al.* (2001) and Kumar *et al.* (2001) observed that seed inoculation with *Bradyrhizobium, Azotobacter* alone or in combination increased seeds pod^{-1}.

The interaction effect of varieties and bacterial fertilizers on 1000-seed weight statistically significant (Table 3). In this study inoculation with *Bradyrhizobium Azotohacter* singly or combined of *Bradyrhizobium plus Azotobacter* has significant positive effect on seed weight. Prevent *et al.* (2002), EI-Kramany (2001), Siddiqui *et al.* (2001), Srivastava *et al.* (2000), Khan and Kounsar (2000) and Kumar *et al.* (2001) observed that seed inoculation with *Bradyrhizobium* + *Azotobacter* and *Bradyrhizobium*, *Azotobacter* single increased 1000-seed weight.

The interaction effect of varieties and different bacterial fertilizers was not significant in producing seed yield of mungbean. In both the varieties, the lowest yield was obtained in control while the highest yield was obtained by the dual application of *Bradyrhizobium* and *Azotobacter* inoculants (F_4). Reason behind the highest performance of dual inoculation may be N fixation by the both microbes *Bradyrhizobium* and *Azotobacter* symbiotically, asymbiotically and other plant growth promoting and alelopathic effects of *Azotobacter*. Perveen *et al.* (2002), E1-Kramany (200l), Siddiqui *et al.* (2001) and Kumar *et al.* (2001) observed that seed inoculation with *Bradyrhizobium* + *Azotobacter* and *Bradyrhizobium* + *Azotobacter* single increased seed yield.

The interaction effect of varieties and bacterial fertilizers was statistically significant at 1% level of probability. The highest stover yield was obtained of 3895 kg ha^{-1} in V_2F_4 (BARI mung-4 with *Bradyrhizobium* + *Azotobacter)* and the lowest yield of 2630 kg ha $^{-1}$ was recorded in V_1F_1 (BARI mung-3 and control).

Preveen *et al.* (2002), EI-Kramany (2001), Siddiqui *et al.* (2001) Srivastava *et al.* (2000), Khan and Kounsar (2000), Kumar *et al.* (2001). Sharma and Khurana (1997) and Sattar and Ahmed (1995) observed that seed inoculation with *Rhizobium* +*Azotobacter* and *Bradyrhizobium, Azotobacter* single inoculation increased stover yield.

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