Comparative performance of urea and biofertilizer on growth of blackgram

M.R.A. Mondol, M.M.H. Chowdhury[1], H. Mahmud[2], A. Akter[3] and M.A. Khaleque[4]
International Rice Research Institute (IRRI), [1]Seed Pathology Centre, [3]Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, [2]DAE, Khamarbari, Dhaka, [4]BADC, Dhaka

Abstract: The experiment was conducted at the field Laboratory of the Department of Crop Botany, BAU, Mymensingh during the period from August to November, 2003 to evaluate the comparative performance of urea and biofertilizer on growth of backgram. Most of the growth and physiological characters such as plant height, root length, number of branches plant^{-1}, number of total nodules plant^{-1}, main root nodules plant^{-1}, lateral root nodules plant^{-1}, nodules dry weight plant^{-1}, number of leaf plant^{-1}, leaf area plant^{-1} LAL, TDM, CGR pod plant, pod length, seed yield plot and straw yield plot^{-1} increased significantly due to application of biofertilizer (Rhixobium inoculant) and urea over control. BARI mash-3 performed better than BARI mash-2 and BINA mash-1in respect of plant height, root length, branches plant, nodules plant nodules weight plant, leaf plant, leaf area, LAL, TDM harvest index pod plant, seed yield plot and straw yield plot. The maximum seed yield was found in BARI mash-3 (85.09 g plot) with Rhizobium inoculation with minimum seed yield in BINA mash-1 (69.07 g plot) in control.
Key wards: Variety, urea, biofertilizer, growth and yield.

Introduction

Malnutrition is a serious problem that has been a great threat to cripple the whole nation in Bangladesh. Pulse, a protein rich agricultural crop, plays an important role in human nutrition. It is the cheapest source of protein for the poor and is called the poor man's meat (Mian, 1976). Pulses contain a remarkable amount of proteins, minerals, vitamins and carbohydrates. Among the various pulses, blackgram is important one which contains approximately 25-28% protein, 4.5-5.5% ash, 0.5-1.5% oil, 3.5-4.5% fiber and 62.65% carbohydrate on dry weight (Kaul, 1982). Bangladesh needs more than 2800 thousand tons of pulses to meet the demand of a population of 140 millions at present situation (FAO, 2003, BBS, 2004). Annual import of pulses in Bangladesh is about 50 thousand tons (BARI, 2004) for which we have to spend a large amount of foreign currency every year. However, the country produced only 517 thousand tons which was only 25% of the total demand. In 2001-2002, the country produced only 20,000 tons of blackgram which was less than 59.18% by the immediate previous your (BBS, 2004). Blackgram (*Vigna mungo* L) is an important pulse ranking the fourth both in acreage and production among the pulses. In Bangladesh it can be grown both in summer and winter seasons. Excessive growth with less number of pods and seeds occurs when the crop is grown in summer. To overcome this problem, Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have developed three short duration blackgram varieties (BARI mash-3, BARI mash-2 and BINA mash-1) maturing within 70-75 and 80-85 days, respectively, which can be well fitted in Rabi seasons. Legumes have been used in building and conserving soil fertility since the beginning of agriculture. Blackgram, is one of the legumes pulse crop in Bangladesh for both human consumption and animal fodder. The proper Rhizobia are provided for effective nodulation, leguminous plants can utilize the vast reservoir of free nitrogen in the atmosphere through them. When effective Rhizobia do not occur naturally in the soil they can be provided be seed inoculation. The successful growing of blackgram is dependent on the Rhizobia in the soil. But not all effective Rhizobia strains are present in all soils of Bangladesh. However, inoculation can meet the challenge of providing superior strains in the soil so that the most effective nodulation and nitrogen fixation are obtained. Keeping the above views in mind, the present research work was conducted to investigate the effect of Rhizobium on growth, nodulation and varietal performance of yield on blackgram.

Materials and Methods

The experiment was conducted at the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University Mymensingh during the period from August, 2003 to November, 2003. The topography of the experimental field was medium high land belonging to the sonatola soil series of grey flood plain soil type under Agro-ecological zone-9 (AEZ-9) named Old Brahmaputra floodplain (FAO, 1988). Three blackgram varieties (BINA mash-1, BARI mash-2 and BARI mash-3) were used in the present study. The size of each unit plot was (1m ×1m) and the plots were spaded one day before planting and the basal dose of fertilizers was incorporated thoroughly before sowing. Urea, Triple super phosphate (TSP) and Muriate of potash (MP), Biofertilizer were used as sources of nitrogen, phosphorus, potassium and Rhizobium, respectively. Total amount of TSP and MP was applied as basal dose during the land preparation. Urea and Rhizobium inoculum were applied in the selective plots during land preparation and seed sowing. The design was two factors experiment laid out in Randomized complete block design (RCBD) with 3 replications taking variety as the factor A and the inoculants (Un inoculanted, Urea and Biofertilozer) were considered as the factor B.

The Rhiobium inoculants was collected from the Biofertilizer Department, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. Three gram of seed was required for each plot based on the recommended seed rate ha seeds were weighted and packet in 27 separate polythene bag. The seed were soaked with molasses and then 1.35 g of peat based inoculant of Rhizobium were taken for this experiment. Inoculant was taken for each of these individuals packets and mixed with the seeds thoroughly and thick black past materials were made. The number of Rhizobial population was about 10^6 cells seeds^{-1}. Care was taken to avoid any contamination of the inoculants. The inoculum coated seeds were placed in a cool dry place for drying and sown in the field at afternoon. The line to line distance was 25 cm and seed to

seed distance maintained 15 cm. Intercultural operation was done when it necessary.

Plant samples were collected from the field after 30 DAS. From each plot 3 randomly selected plants were carefully uprooted. The roots were carefully washed in water and the nodules from the main root and branch root of each plant were separately collected and counted. The shoot, root and nodule materials were first air-dried and then oven dried at 72±2^{0}C. The oven dry weights of shoot, root and nodules were recorded. Second and third plant samples were collected at 50 and 70 DAS and do same. Plants of each pots was harvested and the dry matter weight of the plant tops was noted. Total leaf area of individual sample was measure by an electronic leaf area meter at central laboratory, Bangladesh Agricultural University Mymensingh. Growth parameters like leaf area index (LAI) crop growth rate (CGR) and total dry matter (TDM) were computed from the above data using the following formula (Hunt, 1978). The data collected on different parameters under the experiment were analyzed to obtained the level of significance using the MSTAT computer package programme. The difference between pairs of means were compared by Duncans Multiple Range Test (DMRT).

Results and Discussion

Plant height: Plant height was recorded from 30DAS to 70 DAS as 20 days intervals. Genotypes (BINA mash-1, BARI mash-2 and BARI mash-3) significantly influenced the plant height at 30, 50 and 70 DAS. The plant height was gradually increased with advancement of DAS V_3 produced the highest plant height (47.18) followed by V_2 (46.25) and V_1 (33.06) at 70 DAS (Table 1). The data revealed that the variety V_3 (BAEI mash-3) gave the tallest plant 25.82 cm, 45.29 cm and 47.18 cm per plant at 30, 50 and 70 DAS, respectively whereas V_1(BINA mash-1)showed lowest plant heights 20.49 cm, 29.85 cm and 33.06 cm per plant at the same sampling dates. Among the urea and biofertilizer treatments, biofertilizer showed the highest plant height 25.96 cm, 42.74 cm and 44.73 cm at 30.50 and 70 DAS, respectively compared to other treatments. Urea produced the second highest plant heights in all stages of growth and the control produced the lowest. Interaction effects of variety and treatments showed non significant variation in producing taller plants at 30 and 50 DAS but produced significant variations at 70 DAS (Table 2). The highest plant height (50.217) was attained by V_3T_2 followed by V_2T_2 (49.217 cm) and V_3T_1 (48.107 cm), V_1T_0, V_1T_1 and V_1T_2 gave the lowest plant heights. Sultan (1993) found increased plant height over uninoculated control in soybean.

Table 1. Effect of plant genotypes, urea and biofertilizer on plant height, root length and number of branches of black gram at different stages of growth

Number of genotypes	Plant height (cm)			root length (cm)			Number of branches plant^{-1}		
	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS
BINA mash-1 (V_1)	20.49b	29.85c	33.06c	7.47b	10.48b	12.14c	0.587	1.847b	2.106b
BARI mash-2 V_2)	25.12a	44.55b	46.25b	7.99b	10.62ab	13.00b	0.550	2.032b	2.513a
BARI mash-3 (V_3)	25.82a	45.29a	47.18a	8.55a	10.84a	13.52a	0.550	2.366a	2.736a
level of significance	**	**	**	*	*	**	NS	**	**
Inoculant treatments									
Control (T_0)	22.05c	36.80c	38.77c	6.38c	8.40c	11.63c	0.403b	1.477c	1.85c
Urea (T_1)	23.42b	40.14b	42.99b	8.12b	10.40b	13.14b	0.623	2.032b	2.43b
Biofertilizer (T_2)	25.96a	42.74a	44.73a	9.31a	13.14a	13.89a	0.660a	2.736a	3.06
Level of significance	**	**	**	**	**	**	**	**	**
CV%	3.22	1.37	1.64	8.09	5.26	3.10	19.15	10.43	6.80

Table 2. Interaction effect of plant genotypes, urea and biofertilizer on plant height, root length and number of branches of black gram at different stages of growth.

Genotypes × inoculant interaction	Plant height (cm)			root length (cm)			Number of branches plant^{-1}		
	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS
V_1× T_0	18.773	27.217	30.217e	6.083	8.217	10.220e	0.440	1.440	1.550
V_1× T_1	20.053	29.993	34.217e	7.783	10.663	12.550d	0.660	1.550	2.107
V_1× T_2	22.653	32.340	34.773e	8.553	12.550	13.673ab	0.660	2.550	2.660
V_2× T_0	23.050	40.993	42.883d	6.550	8.217	12.007d	0.440	1.440	1.660
V_2× T_1	24.610	44.883	46.663c	8.210	10.217	13.377bc	0.550	2.107	1.883
V_2× T_2	27.703	47.773	49.217ab	9.220	13.440	13.673ab	0.660	2.550	2.550
V_3× T_0	24.327	42.217	43.217d	6.527	8.774	12.673cd	0.330	1.550	3.107
V_3× T_1	25.607	45.550	48.107b	8.370	10.336	13.550b	0.660	2.440	2.660
V_3× T_2	27.550	48.107	50.217a	10.173	13.440	14.340a	0.660	3.107	3.440
Level of significant	NS	NS	*	NS	NS	**	NS	NS	NS
CV%	3.22	1.37	1.64	8.09	5.26	3.10	19.25	10.43	6.80

Root length: Root length was recorded from 30DAS to 70 DAS at 20 days intervals (Table-1). V_3 produced the highest root length in all stages of growth followed by V_2. V_1 yielded significantly lowest root length (12.14 cm) at 70 DAS. The data revealed that the V_3 (BARI mash-3) showed the tallest root length 8.35 cm, 10.84 cm and 13.52 cm per plant at 30, 50 and 70 DAS, respectively whereas V_1 (BINA mash-1) showed lowest root length

7.47 cm, 10.48 cm and 12.14 cm at same sampling dates. Among the treatments bio-fertilizer produced tallest root length 9.31 cm, 13.14 cm and 13.89 cm per plant at 30, 50 and 70 DAS, respectively, whereas urea showed 8.12 cm, 10.40 cm and 13.14 cm at the same sampling dated (Table 2). The treatments had statistically higher root length over control through out the all growth period. However, bio-fertilizer was found superior to urea in producing taller root length per plant. The interaction effects between plant genotypes and treatments showed non-significant variations in the root length per plant at 30 and 50 DAS but were significant in 70 DAS. The highest interaction values were 14.340 cm and the lowest 10.220 cm at 70 DAS. Sriramachandrasekharan and Vaiyapuri (2003) reported that the inoculation significantly increased root length.

Number of branches: Number of branches per plant was recorded from 30 to 70 DAS at 20 days intervals. The genotypes (BINA mash-1, BARI mash-2 and BARI mash-3) did not produced significant number of branches per plant at 30 DAS but they gave significant result at 50 and 70 DAS V_3 (BARI mash-3) produced the maximum number of branches per plant 0.550, 2.366 and 2.736 at 30, 50 and 70 DAS, respectively whereas, V_2 (BARI mash-2) showed 0.550, 2.032 and 2.513 branches per plant at the same sampling dates. The tested three varieties performed in the order of $V_3 > V_2 > V_1$. The treatment effects were found significant in all three stages of growth. Mean effect of biofertilizer produced highest number of branches per plant 0.660, 2.736 and 3.060 at 30, 50 and 70 DAS, respectively whereas urea produced the second highest 0.623, 2.032 and 2.439 at the same sampling dates. The data revealed that the treatment bio-fertilizer was superior of urea and the control in producing the number of branches per plant (Table 1). The interaction effects between plant genotypes and treatments (biofertilizer, urea) on the number of branches per plant were not significant at all growth stages (Table 2). The results were similar to findings of Gill *et al.* (1985) who reported that inoculum significantly increased the number of branches plant^{-1}.

Table 3. Effect of plant genotypes, urea and biofertilizer on number of total nodules, number of main root modules, lateral root nodules and nodules dry weight of black gram at different stages of growth.

Name of genotypes	No. of total nodules plant^{-1}		No. of main root nodules plant^{-1}		Lateral root nodules plant^{-1}		Nodules dry weight plant^{-1} (g)	
	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS
BINA mash-1 (V_1)	11.916c	14.952b	5.477c	6.994	6.439c	8.180c	0.013b	0.027b
BARI mash-2 V_2)	13.06b	16.063a	5.999b	7.513	6.994b	8.513b	0.021b	0.030ab
BARI mash-3 (V_3)	14.398a	16.396a	6.958a	7.366	7.440a	8.888a	0.024a	0.038a
level of significance	**	**	**	NS	**	**	**	**
Inoculant treatments								
Control (T_0)	10.916c	14.714c	5.036c	6.439c	5.847c	7.736c	0.014b	0.022b
Urea (T_1)	12.323b	15.767b	5.699b	7.254b	6.624b	8.364b	0.017b	0.031
Biofertilizer (T_2)	16.138a	17.470a	7.699a	8.180a	8.402a	9.481a	0.028a	0.041a
Level of significance	**	**	**	**	**	**	**	**
CV%	2.49	2.65	5.83	3.44	3.49	3.17	22.99	11.64

Number of nodules per plant: Number of nodules per plant was recorded at 30 and 50 DAS. A significant variation in number of nodules per plant was observed by the plant genotypes at different stages (Table 3). Variety V_3 (BARI mash-3) induced highest number of nodules per plant compared to V_2 (BARI mash-2) and V1 (BINA mash-1). The highest maximum number of total nodules per plant 14.398 and 16.396 were produced by V_3 at 30 and 50 DAS, respectively whereas V_2 (BARI mash-2) produced 13.063 and 16.063 at the same sampling dates and the lowest number of total nodules 11.916 and 14.952 were produced by V_1 (BINA mash-1) at 30 and 50 DAS, respectively (Table 3). Among the treatments a significant variation on total number of nodules per plant was observed at different growth stages (Table 3). The mean effect of bio-fertilizer produced the maximum number of total nodules per plant 16.138 and 17.470 at 30 and 50 DAS, respectively followed by urea 12.323 and 15.567 at the same sampling dates. Control gave the lowest number of total nodule 10.916 and 14.714 at 30 and 50 DAS, respectively. The above findings are in agreement with Sarker *et al.* (1989) who reported that blackgram seed inoculated increased number of nodule plant^{-1}. Bhuiya *et al*. (1981) inoculated 6 strains of Rhizobium in blackgram and found increased nodule number by every strain over control and strain BAU 502 gave 256%more nodules compared to control. Hoque *et al.* (1980) reported that application of inoculum. GI-13 produced 22.1 nodule per plant compared to only 6.6 per plant in un inoculated control.

Nodules dry weight per plant: Nodules dry weight per plant was recorded at 30 and 50 DAS. A significant variation of nodules dry weight per plant was observed by the plant genotypes at different growth stages (Table 3). At 30 DAS V_3 (BARI mash-30) produced the highest dry weight per plant 0.024 g and lowest 0.013 g per plant was produced by V_1 (BINA mash-1), which was statistically similar to V_1. At 50 DAS, V_3 (BARI mash-3) produced the maximum dry weight per plant 0.038 g and lowest 0.027 g was produced by V_1 (BINA mash-1). V_2 (BARI mash-2) produced the second highest nodules dry weight (0.030) which was statistically identical to V_3. Treatment effects showed the significant variations in nodules dry weight per plant. The highest nodules dry weight plant^{-1} was produced by bioferfilizer 0.028 and 0.041 g at 30 and 50 DAS, respectively. Urea gave the second highest (0.017 and 0.031) and the control produced the lowest nodules dry weight 0.014 and 0.022 at 30 and 50 DAS,

respectively. From these results it was revealed that the mean effect of biofertilizer was superior to urea and the control in producing the nodules dry weight per plant. Interaction effects of both the plant genotypes and the treatments were non significant in producing nodules dry weight per plant (Table 4). Hoque *et al*. (1980) carried out two field trials on Bragg soybean with *Bradyrhizobium japonicum* strain in both peat and soil based inoculants and obtained 83% higher nodulation, 15%higher dry shoot weight and 40% higher nodule weight over un inoculated control.

Table 4. Interaction effect of plant genotypes, urea and biofertilizer on number of total nodules, number of main root modules, lateral root nodules and nodules dry weight of black gram at different stages of growth.

Genotypes × inoculant interaction	No. of total nodules plant^{-1}		No. of main root nodules plant^{-1}		No lateral root nodules plant^{-1}		Nodules dry weight plant^{-1} (g)	
	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS	30 DAS	50 DAS
V_1× T_0	9.769	14.100	4.217	6.550	5.550	7.550d	0.010	0.020
V_1× T_1	10.880	14.767	4.997	6.883	5.883	7.883d	0.010	0.027
V_1× T_2	15.100	15.990	7.217	7.550	7.883	9.107b	0.020	0.033
V_2× T_0	10.657	14.100	5.007	6.550	5.550	7.550d	0.013	0.030
V_2× T_1	12.433	16.323	5.550	7.440	6.883	8.660c	0.020	0.030
V_2× T_2	16.100	17.767	7.440	8.550	8.554	9.330b	0.030	0.040
V_3× T_0	12.323	14.323	5.550	6.217	6.440	8.107c	0.020	0.017
V_3× T_1	13.657	16.210	6.550	7.440	7.107	8.550bc	0.020	0.037
V_3× T_2	17.213	18.653	8.440	8.440	8.773	10.007a	0.033	0.050
Level of significance	NS	NS	NS	NS	NS	*	NS	NS
CV%	2.49	2.65	5.83	3.44	3.47	3.17	22.99	11.64

Number of pods per plant: Number of pods per plant was recorded at final harvest. The analysis of variance showed that plant genotypes had highly significant effect on the number of pods per plant (Table 5). BARI mash-3 produced the maximum number of pods per plant 21.107 followed by BARI mash-2 (18.446). BINA mash-1 produced the lowest number of pod 16.292 per plant.

The effect of treatment on the number of pods per plant was found highly significant (Table 5). Biofertilizer showed the maximum number of pods per plant 21.884 and the urea showed the second highest number of pods 18.773 per plant. Control produced the lowest number of pods (16.081) per plant. The interaction effects between plant genotypes and treatments showed a highly significant variation on the number pods per plant at final harvest (Table 6). The highest number of pods 22.550 was produced by V_3T_3 followed by V_3T_1 (21.550) pods per plant. Gill *et al.* (1985) reported that inoculation significantly increased number of branches plant^{-1}, pods plant^{-1} straw and grain yield and harvest index. Bhuiyan *et al.* (1984) recorded increased yields of grain and straw of grass per by 20% respectively, through inoculation with Rhizobium strain BAU 539 over uninoculated control.

Pod length: The pod length was recorded at final harvest. The mean effect of plant genotypes on pod length was significant.V_3 (BARI mash-3) produced the highest pod length of 3.737 cm followed by V_2 (3.33 cm) V_1 produced the lowest pod length (3.144). There was a highly significant variation on the effect of different mean treatments of plant in producing pod length (Table 5). Biofertilizer showed the highest pod length (04.07 cm) followed by urea (3.367 cm) and the lowest by the control (2.774 cm). The interaction effect of plant genotypes and treatments (biofertilizer and urea) did not vary significantly in producing pod length (Table 6).

Seed yield per plot: Plant genotypes showed significant variation in seed yield per plots (Table 5). The data revealed that the highest seed yield per plot 77.310 g was obtained with mean effect of V_3 (BARI mash-3) followed by V_1 (74.916 g) per plot and V_2 (75.194 g) per plot.

Among the treatments, biofertilizer showed the highest seed yield 82.941 g per plot and the urea produced the second highest 74.304 g per plot and control produced the lowest seed yield (70.174 g) per plot (Table 5). The interaction effect of plant genotypes and treatments showed significant variation in producing seed yield per plot (Table 6). The highest seed yield 85.090 g per plot was recorded by the combination V_3T_2 and the lowest seed yield 69.067 g by V_1T_0. All the genotypes and treatment combination had higher seed yield per plot over the control.

Straw yield per plot: Plant genotypes showed significant variation in straw yield per plot (Table 5). The data revealed that the highest straw yield per plot 193.949 was obtained with the mean effect of V_3 (BARI mash-3) and lowest 170.560 g per plot was produced by V_1 (BINA mash-1). V_2 (BARI mash-2) produced the second highest straw yield (9181.031 g) per plot. Among the treatments, biofertilizer showed maximum straw yield 198.598 g per plot followed by area 181.560 g per plot (Table 5). Control gave the lowest straw yield (165.382 g) per plant. The interaction effect of plant genotypes and treatments showed non significant variation in producing straw yield per plot (Table 6). The highest straw yield 209.627 g per plot was recorded by the combination V_3T_2 and the lowest straw yield 176.093 g per plot was recorded with the combination V_1T_1, whereas biofertilizer showed better than urea combination. All the genotypes and treatments combination had higher straw yield per plot over the control except V_3T_0 combination. V_3T_0 combination produced 180.903 g per plot straw yield which was more than V_1T_1 and V_2T_1 combination. It may hampered because of varietal effect. Haque and Hashem (1992) observed that inoculation of soybean seeds with Bradyrhizobium inoculum gave the highest nodule weight, shoot dry weight and stover yield.

Table 5. Effect of plant genotypes, urea and biofertilizer on TDM, CGR and harvest index of black gram at different stages of growth.

Genotypes	No. of pods plant^{-1}	Pod length (cm)	Seed yield plot^{-1} (g)	Straw yield plot^{-1} (g)	Harvest index (%)
BINA mash-1 (V_1)	16.292b	3.114c	74.916b	170.560c	30.840
BARI mash-2 (V_2)	18.446b	3.331b	75.194b	181.031b	29.329
BARI mash-3 (V_3)	21.107a	3.737a	77.310a	193.949a	28.594
Level of sign.	**	**	**	*	NS
Inoculant treatments					
Control (T_0)	15.181c	2.774c	70.174c	165.382c	30.121
Urea (T_1)	18.773b	3.367b	74.304b	181.560b	29.056
Biofertilizer (T_2)	21.884a	4.071a	82.941a	198.598a	29.585
Level of sign.	**	**	**	**	NS
CV%	1.93	4.32	1.01	6.32	6.48

Table 6. Interaction effect of plant genotypes, urea and biofertilizer on number of pods, pod length, seed yield and straw yield of black gram at different stages of growth.

Genotypes × inoculant interaction	No. of pods plant^{-1}	Pod length (cm)	Seed yield plot^{-1} (g)	Straw yield plot^{-1} (g)	Harvest index (%)
V_1× T_0	15.107c	2.440	69.0671	143.932	33.038
V_1× T_1	16.550d	3.200	74.353cd	176.093	29.687
V_1× T_2	17.220c	3.773	81.327b	191.643	29.794
V_2× T_0	17.217e	2.773	70.083ef	171.300	19.034
V_2× T_1	18.220d	3.220	73.093d	177.270	29.194
V_2× T_2	19.883b	4.000	82.407	194.523	29.757
V_3× T_0	19.220e	3.110	71.373e	180.903	28.291
V_3× T_1	21.550bc	3.660	75.467c	191.317	28.287
V_3× T_2	22.55a	4.440	85.090a	209.627	29.207
Level of significance	**	NS	*	NS	NS
CV%	1.93	4.32	1.01	6.32	6.48

Harvest index: The varieties showed non significant differences on harvest index (Table 5). The highest harvest index was recorded in BINA mash-1 (30.840%) and the lowest harvest index in BARI mash-3 (28.594). There was no significant difference in harvest index due to the mean effect of urea and biofertilizer. The highest index was observed 30.121% with uninoculated control and the lowest was observed 29.056% with urea (Table 5). The interaction effect among variety, urea and biofertilizer was not significant incase of harvest index (Table 6). Highest harvest index (33.038%) were observed in BINA mash-1 with uninoculated control and lowest (28.287%) in BARI mash-3 with urea. Overall result of the field experiment showed that biofertilizer appears to be an effective method of successful blackgram production which may also improved the soil health, saving of costly synthetic chemical fertilizer such as urea and keeps soil and environment free from pollution.

References

BBS (Bangladesh Bureau of Statistics). 2004. Monthly Statistical Bulletin of Bangladesh, December, 2004. Statistics Division. Ministry of Planning Government of People's Republic of Bangladesh, Dhaka, P.133.

Bhuiyan, Z.H. , Hoque, M.S. and Mian, M.H. 1984. Field trial at BAU farm on the effect of Rhizobium inoculation on mungbean. First annual report on BNF irrigated and rainfed condition. P. 11-14.

BRRI. 2004. Krishi Projokti Hatbhoi. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. pp.86-89.

Bhuiya, Z.H., Hoque, M.S. Shajahan, M. and Khanam, D. 1981. Nitrogen fixation work on pulses at BAU Proc. National Workshop on pulses, Aug. 18-19, BARI. p. 230-238.

FAO (Food and Agricultural Organization). 1988. Land Resources Ppraisal of Bangladesh for Agricultural Development, Rep.2. Agro-ecological regions of Bangladesh, UNDP, FAO, Rome.P.116.

FAO (Food and Agricultural Organization). 2003. Mungbean, A Guide Book on production of pulse in Bangladesh. Food and Agriculture Organization. Project Mannual, Khamarbari, Farmgate, Dhaka.p.27.

Gill, M.A., Naimal, A., and Nayyer, M.M. 1985. Relative effect of phosphorus combined with potash and Rhizobium phaseoli on the yield of Vigna radiata (mung). J.Agric. Reapectively., Pakistan. 23:279-282.

Haque, M.S. and Hashem, M.A. 1992. Performance of some promising strains of soybean and groundnut under field condition. Proc. Bangladesh Agricultural University. Mymensingh. Res. Prog. 6:112-119.

Hunt, R. 1978. Plant growth analysis studies in biology. No. 96. Edward Arnold Ltd. London. p.67.

Hoque, M.S. Ali, M. and Mannan, M.S. 1980. Response of Braggsoybean to inoculation with different strains of Rhizobium japanicum I, Nodulation and dry matter production. Thai. J. Agric. Sci. 16:303-3014.

Kaul, A.K. 1982. Pulses in Bangladesh. Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka. P.27.

Mian, A.I. 1976. Grow more pulse to keep your pulse well, an essay of Bangladesh pulses, Department of Agron., BAU, Mymensingh.PP.11-15.

Sarkar, B.B., Bhattacharjee, N.B. and Roy, S. 1989. Rhizobium culture helps increase the yields of blackgram. Indian Farming 38(2): 13-14.

Sriramachandrasekharan, M.V. and Vaiyapuri, V. 2003. Influence of granular insecticide carbofuran in association with

Rhizobium on nodulation, growth and yield of blackgram. J. Ecology, 15(2):107-111.

Sultan, M.M. 1993. Influence of Rhizobium inoculant and urea nitrogen on the yield and yield contribuying characters of lentil (Lens culinaris Medik). M.Sc. Ag. Thesis, Dept. of Soil Science, Faculty of Agriculture, Bangladesh Agricultural University Mymensingh.