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Effect of biofertilizer and urea on growth and yield of mungbean

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Abstract: An experiment was conducted at the Field Laboratory, Bangladesh Institute of Nuclear Agriculture, Mymensingh during February to May 2010 to investigate the effect of biofertilizer and urea on growth, yield attributes and yield of two mungbean varieties. The experiment comprised of four fertilizer combinations *viz.*, (i) control (No biofertilizer and urea, F_0), (ii) Biofertilizer with no urea (F_1), (iii) Biofertilizer with 1/3rd urea (13 kg urea ha^{-1}) of recommended dose (F_2), (iv) Recommended dose of urea (40 kg urea ha^{-1}) with no biofertilizer (F_3) and two varieties *viz.*, BINAmung-5 and BINAmung-6. The recommended doses of TSP, MoP and gypsum were applied in each plot. The experiment was laid out in two factors randomized complete block design with three replications. Results showed that combined application of urea and biofertilizer was more effective in plant growth and yield attributes than single application of biofertilizer or urea. Among the fertilizer combinations, biofertilizer with recommended TSP, MP, gypsum and 1/3rd urea showed superiority in plant height, number of branches plant^{-1}, leaf area plant^{-1}, number of nodules plant^{-1}, chlorophyll content in leaves, total dry mass plant^{-1}, absolute growth rate, number of pods plant^{-1} and harvest index compared to other fertilizer treatments which resulted the highest seed yield both per plant and per hectare. In contrast, the lowest above parameters was recorded in F_0 where biofertilizer and urea was not applied. The genotypic variation existed in morphological, growth, yield attributes and yield with BINAmung-5 was superior to BINAmung-6. The combined effects of variety and fertilizer combination on yield attributes and yield were superior in F_2 (biofertilizer with 1/3rd urea of recommended dose) of both the genotypes with magnitude was higher in BINAmung-5 than in BINAmung-6. Therefore, biofertilizer with 13 kg urea ha^{-1} may be recommended for increased seed yield of mungbean after few more field trials under different AEZ of Bangladesh.

Key words: Mungbean, biofertilizer, urea, yield.

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is one of the major pulse crops grown in Bangladesh. It is considered as the quality pulse in the country but the production per unit area is very low (763 kg ha^{-1}) (BBS, 2009). The reasons for low yield are manifold: some are varietal and some are agronomic management especially improper fertilizer application. Among the fertilizer elements, nitrogen plays a key role in mungbean production. It affects the vegetative growth, development and yield. The important role of nitrogenous fertilizer in increasing mungbean yield has been widely recognized (Asad *et al.*, 2004). Mungbean yield may be increased by 20 to 45% by proper utilization of nitrogen fertilizer (Hayat *et al.,* 2004). Costly and environmentally risky chemical fertilizers cause continuous problem for increasing mungbean production in developing countries including Bangladesh. These problems are likely to become serious in future. Biological nitrogen fixation (BNF) resulting from symbiosis between legume crops and root nodule bacterium *Bradyrhizobium* can ameliorate these problem by reducing the chemical N-fertilizer input required to ensure productivity (Hayat *et al.*, 2004; Khanam and Bhuiyan, 2007).

Now a day a number of organisms like *Bradyrhizobium* has been identified to use as biological agent for fixing atmospheric nitrogen by processing with legume crops and make available to the plants. *Bradyrhizobium* inoculation increased mungbean seed yield from 15% to 45% (BINA, 2008; Bhuiyan *et al.*, 2008). Bhuiyan *et al.* (2007) reported that *Rhizobium* inoculation significantly increased root nodules, plant height, total biomass and pods plant^{-1} compared to the control resulting higher seed yield in pulses.

In Bangladesh, few studies have been conducted on the effects of biofertilizer along with urea compared to control on mungbean. Considering the above facts, the present study was undertaken to assess the effect of biofertilizer along with different levels of nitrogenous fertilizer on growth and yield of mungbean varieties.

Materials and Methods

A field experiment was carried out at the field laboratory of Bangladesh Institute of Nuclear Agriculture, Mymensingh (24^{0}75″ N and 90^{0}50″ E), Bangladesh, during February to June 2010. The soil of the experiment was sandy loam having a total nitrogen 0.06%, organic matter 1.05%, available phosphorus 18.5 ppm, exchangeable potassium 0.28 meq%, sulphur 18 ppm and pH 6.8. The experiment comprised of four fertilizer combinations *viz.*, (i) control (No biofertilizer and urea, F_0), (ii) Biofertilizer with no urea (F_1), (iii) Biofertilizer with 1/3rd urea (13 kg urea ha^{-1}) of recommended dose (F_2), (iv) Recommended dose of urea (40 kg urea ha^{-1}) with no biofertilizer (F_3) and two varieties *viz.*, BINAmung-5 and BINAmung-6. The experiment was laid out in two factors randomized complete block design with three replications. The recommended doses of TSP, MoP and gypsum were applied in each plot. Total amount of urea, TSP, MP and gypsum were applied at basal doses during final land preparation. The size of the unit plot was 2.5 m x 3.0 m. All the fertilizers were incorporated into the soil before sowing of seeds. In case of biofertilizer, seeds of mungbean varieties were inoculated with *Rhizobium* inoculants just before sowing. The seeds were kept in polythene bags and were mixed with molasses for adhering to the biofertilizer. Then the biofertilizer was mixed thoroughly with the seeds and were kept in shade and cool place to avoid sticking together. The seeds were sown in furrows on 17 March 2010 and furrows were covered by soils soon after seeding. The line to line and plant to plant distances were maintained at 30 cm and 10 cm, respectively. To obtain data on growth characteristics, a total of two harvests were made: the first one at reproductive stage (flowering and fruiting stage at 35 days after sowing, DAS) and the second one at fruiting stage (50 DAS). Five plants from each plot were randomly

selected and uprooted for obtaining data of necessary parameters. The plants were separated into leaves, stems and roots and the corresponding dry weights were recorded after oven dry at 80 ± 2 ^{0}C for 72 hours. The leaf area of each sample was measured by LICOR automatic leaf area meter (LI 2000 USA). The growth analyses like absolute growth rate and relative growth rate were carried out following the formulae of Hunt (1978). Nodule was counted at 50 DAS. Chlorophyll was determined at 50 DAS following the method of Yoshida *et al*. (1976). Other morphological and yield attributes were recorded at harvest. Pods were harvested three times. Harvests were completed by 28 May 2010. Finally, seed weights were taken on individual plot basis at moisture content of about 12% and converted into kg ha^{-1}. Harvest index was calculated by dividing economic yield to biological yield of plot by multiplying with 100 and expressed in percentage. The collected data were analyzed statistically using the computer package programme, MSTAT-C and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT).

Results and Discussion

The effects of different fertilizer combinations on plant height, number of branches and nodules plant^{-1}, leaf area (LA) plant^{-1} and chlorophyll content in leaves were significant (Table 1). Results revealed that the above parameters were greater in biofertilizer and urea applied plant (single or combined application) than control plants, where no urea or biofertilizer was used. These results indicate that application of biofertilizer and urea alone or in combination had tremendous effects on plant growth and development compared to control in mungbean. The effect was more pronounce in combined application of urea and biofertilizer than single application. The highest plant height, branch and nodule number, LA and chlorophyll was recorded in F_2 treatment (biofertilizer with 1/3 urea, 13 kg urea ha^{-1}) followed by the treatment of F_1 where biofertilizer with no urea was applied. However, there had no significant differences in above studied plant parameters between F_1 (biofertilizer with no urea) and F_3 (urea with no biofertilizer) treatments.

Growth parameters such as total dry mass (TDM) plant^{-1}, absolute growth rate (AGR) and relative growth rate (RGR) were significantly influenced by the different combinations of urea and biofertilizer application (Table 2). Results revealed that the growth parameters were greater in biofertilizer and urea applied plants than control plants. However, biofertilizer with 1/3 urea (13 kg urea ha^{-1}) applied plant showed the highest TDM and AGR while reverse trend was observed in RGR. These results indicate that application of biofertilizer with urea performed better in growth and development than single application of biofertilizer or urea. These results have conformity with Khanam and Bhuiyan (2007) who reported that application of biofertilizer and urea enhanced plant growth and development in mungbean. Inoculants fixing atmospheric nitrogen and stimulating plant growth through synthesis of plant promoting substances especially gibberalic acid (GA). Asad *et al.* (2004) recorded higher GA and indole acetic acid (IAA) in biofertilizer applied plants compared to that of control in mungbean. In the present experiment, similar phenomenon happened resulting increased plant growth in biofertilizer applied plants than control plants.

Combined or single application of biofertilizer and urea had no significant effect on pod length, single pod weight and number of seeds pod^{-1} but had significant effect on number of pods plant^{-1} and 1000-seed weight (Table 3). Furthermore, though 1000-seed weight was significantly influenced by biofertilizer and urea application but it was not greatly influenced like number of pods plant^{-1}. These results disagrees with Anjum *et al.* (2006) and Uddin *et al.* (2009) who reported that pod and seed size of mungbean greatly influenced by fertilizer application including biofertilizer. Pod and seed size mainly controlled by gene not by environment (Singh *et al*., 2008). Therefore, in present experiment, pod and seed size may not be influenced by fertilizer application. The highest number of pods plant^{-1} was recorded in the treatment of biofertilizer with 1/3 urea (13 kg urea ha^{-1}) followed by the treatment of only biofertilizer application. However, there had no significant difference in pod number plant^{-1} between F_1 (biofertilizer with no urea) and F_3 (urea with no biofertilizer) treatments. In contrast, the lowest number of pods plant^{-1} was observed in control plants. These results are consistent with Prasad and Ram (1992) who reported that application of biofertilizer with urea increased pod production in mungbean. The higher pods in biofertilizer and urea applied plants due to increased LA and chlorophyll in leaves (Table 1) that might produced more assimilate than the other treatments (Dutta *et al.* 1998).

Table 1. Effect of different fertilizer combination and variety on morphological characters and chlorophyll content in leaves in mungbean

Treatments	Plant Height (cm)	Branches plant^{-1}	Leaf area plant^{-1} (cm^2)	Nodules plant^{-1}	Chlorophyll (mg g^{-1}fw)
Fertilizers combination					
Control: No biofertilizer and urea (F_0)	42.30 c	1.20 c	733 b	11.11 d	1.76 b
Biofertilizer with no urea (F_1)	47.85 b	1.43 b	823 a	17.65 b	2.02 a
Biofertilizer with ⅓ urea (F_2)	52.35 a	1.65 a	876 a	22.45 a	2.20 a
Urea with no biofertilizer (F_3)	47.45 b	1.39 b	823 a	15.20 c	1.88 b
Variety					
BINAmung-5	54.53 a	1.86 a	942 a	21.40 a	1.93
BINAmung-6	40.45 b	0.98 b	686 b	11.80 b	2.01
CV (%)	4.39	10.46	4.74	7.75	6.00

In a column, figures having no or same letter do not differ significantly at P ≤ 0.05 by DMRT

Table 2. Effect of different fertilizer combination and variety on growth parameters in mungbean

Treatments	Total dry mass plant^{-1} (g) at		Absolute growth rate (mg plant^{-1} day^{-1})	Relative growth rate (mg g^{-1} day^{-1})
	Flowering start stage	Fruiting stage		
Fertilizers combination				
Control: No biofertilizer and urea (F_0)	5.68 c	11.25 c	558 c	66.5 a
Biofertilizer with no urea (F_1)	7.02 b	14.21 b	719 ab	69.6 a
Biofertilizer with ⅓ urea (F_2)	8.85 a	16.59 a	758 a	62.2 b
Urea with no biofertilizer (F_3)	6.99 b	14.02 b	703 b	69.1 a
Variety				
BINAmung-5 (V1)	7.88 a	16.51 a	863 a	74.9 a
BINAmung-6 (V_2)	6.38 b	11.53 b	506 b	58.7 b
CV (%)	4.76	4.40	5.80	4.87

In a column, figures having same letter(s) do not differ significantly at $P \leq 0.05$ by DMRT

Table 3. Effect of different fertilizer combination and variety on yield attributes in mungbean

Treatments	Pods plant^{-1}	Pod length (cm)	Single pod wt. (mg)	Seeds pod^{-1}	1000-seed wt. (g)
Fertilizers combination					
Control: No biofertilizer and urea (F_0)	12.90 c	8.25	656	9.90	47.40 b
Biofertilizer with no urea (F_1)	17.85 b	8.39	671	10.28	48.10 ab
Biofertilizer with ⅓ urea (F_2)	22.30 a	8.53	685	10.43	49.63 a
Urea with no biofertilizer (F_3)	17.05 b	8.43	671	10.30	48.20 ab
Variety					
BINAmung-5	20.60 a	8.24	572 b	10.08	45.35 b
BINAmung-6	14.45 b	8.56	770 a	10.38	51.32 a
CV (%)	7.89	2.66	2.98	3.35	2.66

In a column, figures having no or same letter(s) do not differ significantly at $P \leq 0.05$ by DMRT

Table 4. Effect of different fertilizer combination and variety and their interaction on seed yield, biological yield and harvest index of mungbean

Treatments	Seed wt. plant^{-1} (g)	Biological yield (g plant^{-1})	Seed yield (kg ha^{-1})	Harvest index (%)
Fertilizers combination				
Control: No biofertilizer and urea (F_0)	5.63 c	18.53 c	1018 c	30.45 b
Biofertilizer with no urea (F_1)	8.21 b	25.12 b	1482 b	32.80 ab
Biofertilizer with ⅓ urea (F_2)	10.7 a	30.60 a	1905 a	35.13 a
Urea with no biofertilizer (F_3)	7.87 b	24.35 b	1428 b	32.70 ab
Variety				
BINAmung-5	9.11 a	28.48 a	1588 a	31.75 b
BINAmung-6	7.09 b	20.82 b	1328 b	33.79 a
Interaction of variety and fertilizer combination				
BINAmung-5: Control: No biofertilizer and urea (F_0)	6.53 e	21.77 d	1121 d	30.01 b
BINAmung-5: Biofertilizer with no urea (F_1)	9.39 b	29.50 b	1647 b	31.80 ab
BINAmung-5: Biofertilizer with ⅓ urea (F_2)	12.3 a	35.78 a	2128 a	34.33 ab
BINAmung-5: Urea with no biofertilizer (F_3)	8.24 c	26.86 bc	1455 c	30.90 ab
BINAmung-6: Control: No biofertilizer and urea (F_0)	4.72 f	15.28 e	914 e	30.91 ab
BINAmung-6: Biofertilizer with no urea (F_1)	7.02 de	20.75 d	1316 c	33.80 ab
BINAmung-6: Biofertilizer with ⅓ urea (F_2)	9.12 b	25.42 c	1682 b	35.97 a
BINAmung-6: Urea with no biofertilizer (F_3)	7.50 d	21.83 d	1400 c	34.50 ab
CV (%)	4.54	7.59	6.47	6.41

In a column, figures having same letter(s) do not differ significantly at $P \leq 0.05$ by DMRT

The seed yield both per plant and per hectare, biological yield (BY) plant^{-1} and harvest index (HI) of mungbean was significantly influenced by the application of biofertilizer and urea (Table 4). The seed yield, BY and HI was greater in biofertilizer and urea applied plants than control plants. The highest seed yield (10.7 g plant^{-1} and 1905 kg ha^{-1}), BY (30.60 g plant^{-1}) and HI (35.13%) was recorded in biofertilizer with 1/3 urea (13 kg urea ha^{-1}) applied plants due to increase production of pods plant^{-1}. Furthermore, the highest HI in F_2 treatment (biofertilizer with 1/3 urea) indicating dry matter partitioning to economic yield was better when biofertilizer was applied with 1/3 urea (13 kg urea ha^{-1}) of recommended dose (40 kg urea ha^{-1}). The lowest seed yield was observed in control plants due to poor plant growth and development with inferior HI. Though yield performance of single application of

biofertilizer and urea was similar but urea is more costly than biofertilizers, even biofertilizer is eco-friendly. Therefore, we may suggest use of biofertilizer in stead of urea for increase seed yield of mungbean as well as increase soil health.

The variety, BINAmung-5 and BINAmung-6 differed significantly with each other in their morphological, growth, yield attributes and yield except chlorophyll content in leaves and number of seeds pod^{-1} (Table 1-4). Differences in plant parameters between two varieties were under genetic control (Poehlman, 1991). However, the morphological and growth parameters, pod number and seed yield was higher in BINAmung-5 than BINAmung-6 while reverse trend was observed in case of chlorophyll content in leaves, pod and seed sizes and HI.

The interaction effect of variety and different fertilizer combination on seed yield, BY and HI was significant (Table 4). In both varieties, seed yield and BY as well as HI were greater in F_2 treatment (biofertilizer with 1/3 urea of recommended dose) than the other treatment combinations but the magnitude was higher in BINAmung-5 (1.90 fold higher than control) than BINAmung-6 (1.84 times higher than control).

In conclusion, it may be said that single application of biofertilizer or urea or in combination of biofertilizer and urea as basal dose enhance plant growth and development which resulted increase seed yield in mungbean. Among the fertilizer combinations, biofertilizer with 1/3 urea (13 kg urea ha^{-1}) of recommended dose had superiority in plant growth, yield components and yield over other fertilizer combinations. Therefore, biofertilizers with 13 kg urea ha^{-1} may be recommended for increase seed yield of mungbean after few more field trials under different AEZ of Bangladesh.

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