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Physiological attributes of mungbean (*Vigna radiata* L.) influenced by different sources of nutrients (NPK) in Madhupur tract region of Bangladesh

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ABSTRACT

An experiment was conducted at the Sher-e-Bangla Agricultural University farm from April to June 2017 in Kharif season to evaluate the performance of two mungbean varieties under different NPK fertilizers doses in field conditions. The experiment was laid out in Randomized Complete Block Design (RCBD), comprising six treatments with three replications. In the experiment, varieties used were BARI mung-6 and BARI mung-5 and the combination of the treatment were T0 = (control), T1 (10-40-25 NPK kg ha^{-1}), T2 (10-60-45 NPK kg ha^{-1}), T3 (20-50-35 NPK kg ha^{-1}), T4 (30-40-25 NPK kg ha^{-1}) and T5 (30-40-45 NPK kg ha^{-1}), respectively. Mungbean cultivars responded noticeably to the supplementary NPK fertilizers as the crop characters were significantly influenced by different levels of NPK fertilizers. Data were recorded on plant height, leaves plant^{-1}, branches plant^{-1}, pods plant^{-1}, seeds pod^{-1}, 1000-seed weight, seed, and straw yield at different days after sowing. Of the two varieties, BARI mung-6 gave the highest seed yield (1.72 t ha^{-1}) next to the higher plant growth and straw yield On the contrary, BARI mung-5 cultivar produced the lowest seed yield (1.57t ha^{-1}), plant growth, and straw yield. The results showed that T3 (20-50-35 NPK kg ha^{-1}) treatment was the best treatment as regards plant growth and yield parameters. The highest seed yield was produced by treated plot T3 (20-50-35 NPK kg ha^{-1}) over the untreated control plot, T1, T2, T4, and T5, respectively. As for the combined effect, V1T3 (BARI mung-6 and T3 = 20kg N + 50kg P + 35kg K ha^{-1}) performed the best results in all growth and development characters. Therefore, the combined application of 20-50-35 kg NPK ha^{-1} might be considered to be found optimal to get a considerable seed yield of mungbean variety BARI mung-6.

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I. Introduction

Mungbean (*Vigna radiata* L.) known as green gram or golden gram is one of the most important pulse crops in Bangladesh. It belongs to the family Leguminosae. It is native to the Indian subcontinent and mainly cultivated in India, China, Thailand, Philippines, Indonesia, Mayanmar, Bangladesh, Laos and Cambodia but also in hot and dry regions of Europe and the United States. Pulse is a popular crop in the daily diet of the people of Bangladesh. Due to shortage of production 291 thousand metric ton pulses was imported in Bangladesh in 2006-2007 fiscal years (BBS, 2010). Cultivation of pulses increases soil fertility status through nitrogen fixation. As a whole, mungbean could be considered as inevitable component of sustainable agriculture. Mungbeanis, one of the important pulse crops of Bangladesh, grows well all over Bangladesh. The majority portion is being produced in southern part of the country. Among the pulse crops, the largest area is covered by lentil (40.17%), and the mungbean is grown in only 6.34% (BBS, 2005). The cultivation of mungbean in Bangladesh is to increase and it covers 54, 57 and 68 thousand acres respectively in the 2008-2009, 2009-2010 and 2010-2011 fiscal years (BBS, 2011). At present, the average yield of mungbean grain in our country is about 279 kg acre^{-1} (BBS, 2010). So, mungbean can be a good answer for the increasing need of plant protein. Among the pulse crops, mungbean has special importance in intensive crop production system of the country for its short duration growing period (Ahmed et al., 1978). In Bangladesh, it can be grown in late winter and summer season. Summer mungbean can tolerate high temperature exceeding 40^{0}C and grown well in the temperature ranges between 30-35^{0}C (Singh and Yadav, 1978). So, cultivation of mungbean in the summer season could be an effective attempt to increase pulse production in Bangladesh. Low yields of grain legumes, including mungbean make the crop less competitive with cereals and valued crops. For that reason, to meet up the condition, it is indispensable to make better the production scenario through varietal development and proper cultural and management practices as well as summer mungbean cultivation in Bangladesh.

The possibilities of growing mungbean in summer are being experimented and some successes have already been made in Bangladesh. Mungbean is exceedingly quick to respond to chemical fertilizers and organic manures. It has a noticeable response to nitrogen (N), phosphorus (P) and potassium (K). These nutrients play a key function in plant physiological process. A reasonable supply of essential plant nutrients is obligatory for optimum plant growth. Long term continuous use of huge amount of N, P and K are predictable to influence not only the availability of other nutrients to plants because of possible interaction between them but also the increase of some of the essential plant nutrients creating imbalances in soils and plants leading to decrease fertilizer use efficiency (Nayyar and Chhibbam,1992). Especially for legume crops, mungbean, nitrogen is more useful. Though the legume cropsfix atmospheric N_2 by symbiotic process but supplementary addition of nitrogen fertilizer as basal dose becomes helpful in increasing the growth and yield of legume crops (Ardeshana et al., 1993).

Nitrogen (N) is most functional for pulse crops because it is an important and foremost component of protein (Anon., 2005). Nitrogen enhances the uptake of other nutrients by synergistic effects with other nutrients and increasing nitrogen uptake and content in the crop, which increases protein content of mungbean (Singh and Singh, 1979). Phosphorus (P) plays a significant role in plant physiological processes. It is an essential constituent of majority of enzymes which are of immense importance in the transformation of energy in carbohydrate metabolism in different types of plants and is intimately related to cell division and grain development. Phosphorus deficiency causes growth and yield reduction by limiting plant growth (Poehlman, 1991). It influences nutrient uptake by promoting root growth and development and also nodulation (Singh and Singh, 1979). Potassium (K) also plays a fundamental role in plant physiological processes, which causes yield reduction by limiting plant growth. The farmers of Bangladesh generally grow mungbean with almost no fertilizers in their field due to lack of modern cultivation technology from research organizations. So, there is a sufficient scope of increasing the yield of mungbean/unit area by using balanced fertilization with organic and inorganic fertilizers. Taking into consideration the above facts, the present investigation has been undertaken to determine the effects of nitrogen, phosphorus and potassium fertilizers on growth and yield attributes of mungbean in field conditions.

II. Materials and Methods

An experiment conducted in field farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period of kharif season from April to June 2017, to determine the effects of nitrogen, phosphorus and potassium fertilizers on growth and yield attributes of mungbean. The soil of the experimental field belongs to the Tejgaon series under the Agro ecological Zone, Madhupur Tract (AEZ-28) and the General Soil Type is Deep Red Brown Terrace Soils. Initial physical and chemical properties of experimental field soils characterized by Sand 33%, Silt 41%, Clay 26%, Silty-clay textural class, pH 5.7, organic matter (%) 1.09, total N (%) 0.05, available P (ppm), 21.54, exchangeable K (me/100 g soil) 0.15. Mungbean cultivars, BARI mung-6 (V1) and BARI mung-5 (V2) used as test crop, and fertilizer doses nitrogen (N) phosphorus (P) potassium (K) were used as nutrient treatments. There were six (6) fertilizer dose combinations as follows: T0 =Control, T1 = 10 kg N + 40 kg P+25 kg K ha^{-1} , T2 = 10 kg N + 60 kg P + 45 kg K ha^{-1} , T3 = 20 kg N + 50 kg P + 35 kg K ha^{-1} , T4 = 30 kg N + 40 kg P + 25 kg K ha^{-1} and T5 = 30 kg N + 40 kg P + 45 kg K ha^{-1}. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The sources of N, P_2O_5, and K_2O from urea, triple super phosphate (TSP), muriate of potash (MoP), were applied, respectively. Whole amount of urea, the total amounts of TSP, MoP were applied during the final land preparation. Well rotten cow dung (10 t/ha) was also mixed thoroughly with soils during final experimental plot preparation. Ten (10) plants from each plot were selected at random and tagged for the data collection. The data were analyzed using MSTAT-C statistical tool to find out the significance of the difference among the treatments and the mean values of all the parameters were evaluated and analysis of variance performed by using Duncan's Multiple Range Test (DMRT).

III. Results and Discussion

Plant height

The statistical analysis showed significant ($p<0.05$) differences among the treatments in affecting the height of the plant of mungbean cultivars. Data presented in Figures 01 and Figure 02 showed that in response to variety and various levels of NPK fertilizers to plant height of mungbean showed that cultivars behaved differentially in attaining the height of mungbean plant. There was a significant variation of variety on mungbean plant height throughout the growing season (Figure 01). Variety V1 (BARI mung-6) was recorded with longest plant height (33.76, 50.5 and 62.18 cm at 30, 45 and 60 DAS) while variety V2 (BARI mung-5) was observed with shortest plant height (32.35, 49.21 and 61.32 cm at 30, 45 and 60 DAS). On the other hand, significant variation was observed in plant height due to added fertilizer doses (Figure 02). In addition, T3 treatment showed the highest plant height (36.3, 54.02 and 64.2 cm at 30, 45 and DAS) and untreated control plot (T0) attained the lowest (28.81, 41.75 and 58.7 cm at 30, 45 and 60 DAS) plant height of mungbean. The lowest plant height was obtained at untreated control plot (0 kg ha^{-1}) irrespective of genotypes of mungbean cultivars that might be due to the fact that genotypes itself are dependable for variation in plant height while applied nitrogen improved the growth of mungbean. Increment in plant height of mungbean at higher nitrogen doses may be attributed to increase of nitrogen content in chlorophyll formation. Which increased photosynthesis in mungbean plant and enhanced meristematic activity in cells of plant (Asghar et al., 2006).

More to the point, nitrogen is an essential component of amino acids which are vital structures for development of tissues of plant and accordingly increased plant height. Plant height, being a genetically control plant growth character, varied in respect of various doses of supplementary NPK fertilizers and cultivars also recorded by many researchers. The results of this experiment were in agreement with the findings of Gopala et al., (1993) who affirmed that longest plant height of mungbean was found at the rate of 20 kg N ha^{-1}. On the other hand, plant height was appreciably affected by the interaction effects of variety and treatment (Table 01). Mungbean longest plant height was found from the combination of V1T3 (36.79, 54.0 and 64.8 cm at 30, 45 and 60 DAS) treated plot. The shortest plant was found from the combination of V1T0 (28.56, 41.67 and 57.7 cm at 30, 45 and 60 DAS) treated plot. A perusal of the data exposed that there was a significant result of various treatments on plant height.

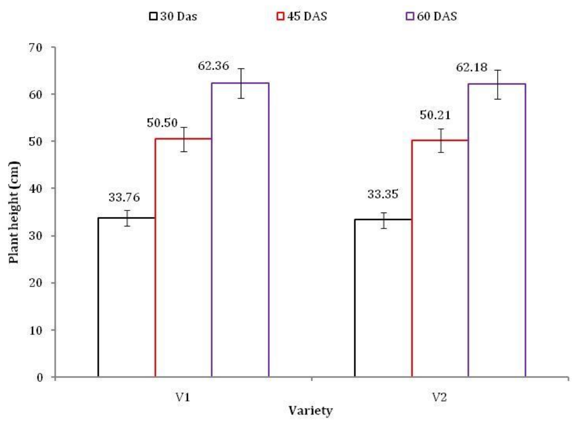

Figure 01. Effect of variety on plant height (cm) of mungbean

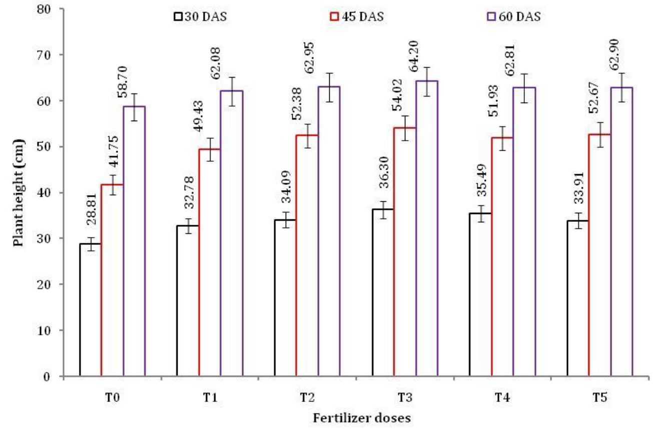

Figure 02. Effect of fertilizers on plant height (cm) of mungbean

The increment in plant height by application of nitrogen along with phosphorus fertilizers might be due to the availability of sufficient addition of nitrogenous compounds to the plant, which increases the foliage of the plant and thereby increases the photosynthesis process in the plant. A satisfactory supply of the three major nutrients NPK is needed to regulate plant morpho-physiological process (Shree et al., 2014). These findings are also conformity with the findings reported by Singh and Sangama (2000), who reported that phosphorus is a prime ingredient of nucleoprotein, known to play a principal role in photosynthesis process, cell division and tissue formation in plant might be due to availability of nitrogen and thereby uptake that increasingly improved the quantitative growth of tomato plant (Ewulo et al., 2015). These findings are in agreement with the findings earlier reported by Solaiman and Rabbani (2006) in tomato. And, also, the tallest plants of mungbean were recorded by 150kgNPK ha^{-1} fertilizer due to the application of major nutrients, which increased the photosynthesis process, chlorophyll formation, nitrogen metabolism and auxin production in the plants, which eventually increased the plant height. This result is in agreement with Ekwu et al. (2012), who reported that the plant height improved as the fertilizer doses increased from 0 kg to 150kgNPK ha^{-1}. Likewise, Aminifard et al. (2010) reported similar results that nitrogen application enlarged plant height at vegetative stage, and level of 150kgN ha^{-1} fertilizer produced the tallest and shortest plants in control treated plot.

Table 01. Interaction effect of fertilizer doses and varieties on plant height of mungbean at different days after sowing

Treatment	Plant height at			Number of leaves plant^{-1} at			No. of branches plant^{-1} at	
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	45 DAS	60 DAS
V1T0	28.56 d	41.67 c	57.70 c	4.80 c	7.63 f	10.87 e	1.0 d	1.26 de
V1T1	32.37 bc	50.17 ab	62.03 b	5.73 b	8.80 b-d	13.87 b-d	1.40 c	1.53 cd
V1T2	33.83 ab	52.80 a	63.23 ab	5.86 ab	8.90 b-d	14.50 a-c	1.73 a-c	1.90 a-c
V1T3	36.79 a	54.00 a	64.80 a	6.40 a	9.40 a	15.53 a	2.06 a	2.26 a
V1T4	36.25 ab	51.82 ab	62.42 ab	6.00 ab	9.10 a-c	14.10 b-d	1.86 ab	2.13 ab
V1T5	34.81 ab	52.60 a	62.93 ab	5.90 ab	8.66 c-e	14.00 b-d	1.73 a-c	1.86 a-c
V2 T0	29.05 cd	41.83 c	59.70 c	4.70 c	7.50 f	10.80 e	0.86 d	1.13 e
V2 T1	33.19 ab	48.70 b	62.13 b	5.60 b	8.30 e	13.13 d	1.60 bc	1.86 a-c
V2 T2	34.36 ab	51.97 ab	62.67 ab	5.70 b	8.53 de	13.40 b-d	1.66 a-c	1.80 bc
V2 T3	35.82 ab	54.03 a	63.60 ab	6.20 ab	9.23 ab	14.53 ab	2.06 a	2.20 ab
V2 T4	34.73 ab	52.03 ab	63.20 ab	5.86 ab	9.13 a-c	13.30 d	1.80 a-c	2.00 ab
V2 T5	33.00 ab	52.73 a	62.87 ab	5.96 ab	8.83 b-d	13.33 cd	1.86 ab	2.00 ab
SE	1.16	1.16	0.75	0.18	0.15	0.36	0.13	0.13
CV (%)	5.96	3.97	2.08	5.43	3.06	4.57	14.04	11.93

In a column means having common letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.V1 = BARI mung-6, V2 = BARI mung-5, T0 = control treatment, T1 = 10kg N + 40kg P+ 25kg K ha^{-1}, T2 =10kg N + 60kg P+ 45kg K ha^{-1}, T3 = 20kg N + 50kg P+ 35kg K ha^{-1}, T4 = 30kg N + 40kg P+ 25kg K ha^{-1}, T5 = 30kg N + 40kg P+ 45kg K ha^{-1}

Number of leaves plant^{-1}

Results concerning the number of leaves plant^{-1} of mungbean exhibited that there was a significant ($p<0.05$) differences among various treatments of NPK when compared with their control treated treatment (T0). There was significant effect of variety on number of leaves plant^{-1} throughout the growing season (Figure 03). Variety V1 was recorded with higher number of leaves plant^{-1} (5.78, 8.75 and 13.81 at 30, 45 and 60 DAS) while variety V2 was observed with number of leaves plant^{-1} (3.98, 7.58 and 12.51 at 30, 45 and 60 DAS). Significant variation was observed in number of leaves plant^{-1} due to different fertilizer doses (Figure 04). During the whole growing period, T3 treatment produced the highest number of leaves plant^{-1} (6.3, 9.31 and 15.3 at 30, 45 and DAS) which was statistically similar to the treatments of T2, T4, T5 and control treatment (T1) attained the lowest (4.75, 7.56 and 10.83 at 30, 45 and 60 DAS, respectively). The results were in agreement with the findings of Asif et al. (2003). Number of leaves plant^{-1} was significantly affected by the interaction of variety and treatment (Table 01). Highest number of leaves plant^{-1} was observed from the combination of V1T3 (6.4, 9.4 and 15.53 at 30, 45 and 60 DAS) and the lowest number of leaves plant^{-1} was found from the treatments combination of V2T0 (4.7, 7.5 and 10.8 at 30, 45 and 60 DAS).The findings of Akpan et al. (2016) who reported that the cultivars in all the traits experimented were highly significant on number of leaves per plant. Reasons for more number of leaves at 20 kg N + 50 kg P + 35 kg K ha^{-1} with BARI mung-6 cultivar may be due to primordial effects of macronutrients on vegetative growth, which finally lead to more photosynthetic behavior in plant. This conforms with the result of Umar and Momoh (2015), who confirmed that the interaction of fertilizer and variety on some of the growth and yield attributes such as number of branches, leaves and flowers per plant showed that the two cultivars behaved differently under different inorganic fertilizer combinations in soybean plants in field trial.

Number of branches

Results showed in figure 03 that cultivars responded significantly ($p<0.05$) to receiving various doses of added NPK fertilizers. There was a significant difference between the mungbean varieties in number of leaves plant^{-1} (Figure 05). The maximum number of branches plant^{-1} (1.53 and 1.84 at 45 and 60 DAS) while variety V2 was observed with minimum number of branches plant^{-1} (1.12 and 1.44 at 45 and 60 DAS).

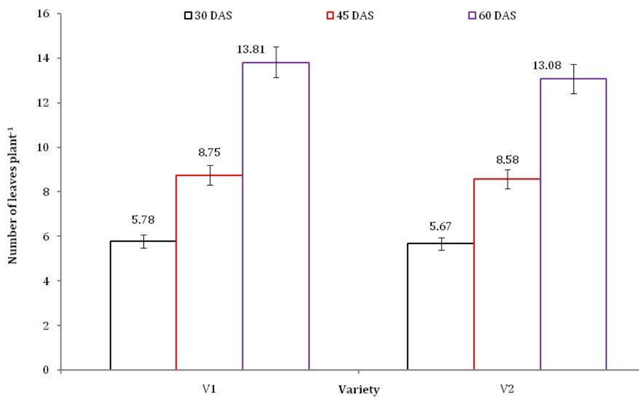

Figure 03. Effect of variety on leaves plant^{-1} of mungbean

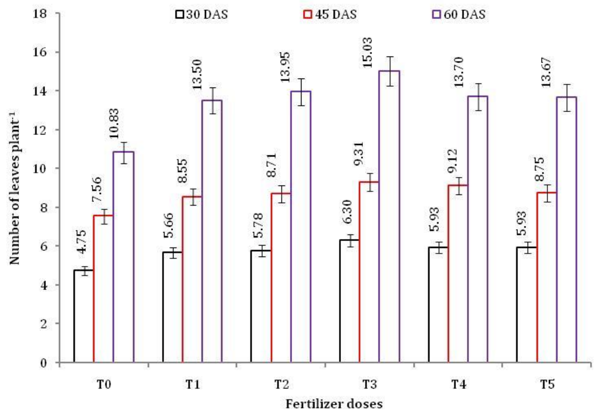

Figure 04. Effect of fertilizers on leaves plant^{-1} of mungbean

Significant variation was observed in number of branches plant^{-1} due to different fertilizer doses (Figure 06). In respect of fertilizers treatments, T3 treatment produced the maximum number of branches plant^{-1} (2.06 and 2.23 at 45 and 60 DAS) and control treatment (T0) attained the minimum results. The results conformed to Sultana et al. (2009), who observed that application of 20 kg N ha^{-1} as basal dose showed significantly higher standards of all growth parameters similar to number of branches plant^{-1}. The combined effect of different fertilizer doses and varieties on the number of branches plant^{-1} of mungbean was found statistically significant (Table 01). The highest number of branches plant^{-1} was observed from the combination V1T3 and V2T3 (2.06 and 2.26 at 45 and 60 DAS) and the lowest number of branches plant^{-1} was found from the treatment combination of V2T0 (0.86 and 1.13 at 45 and 60 DAS). Similarly, Umar and Momoh (2015) reported that the interaction of fertilizer and mungbean cultivar on some of the growth and yield parameters such as number of branches, number of leaves and number of flowers shows that the two varieties behaved in a different way under different supplementary NPK fertilizer levels.

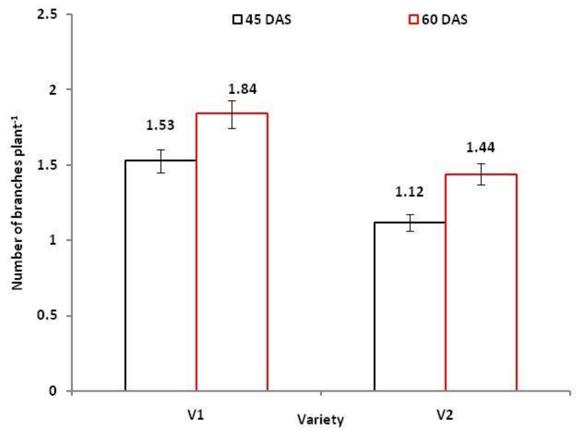

Figure 05. Effect of variety on branches plant^{-1} of mungbean

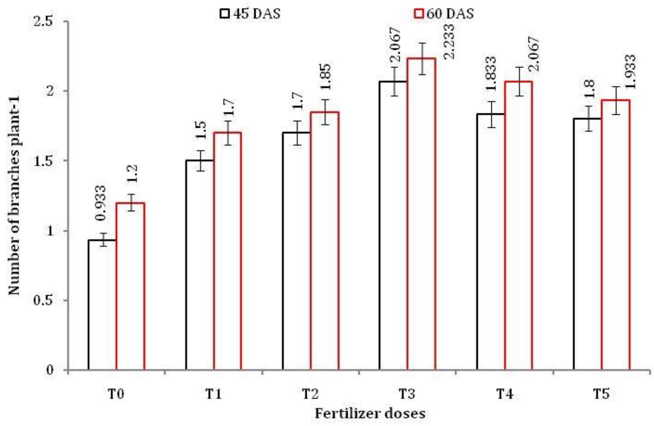

Figure 06. Effect of fertilizers on branches plant^{-1} of mungbean

Number of flowers

The data on number of flowers plant^{-1} of mungbean as influenced by different doses of additional doses of NPK fertilizers and cultivars are presented in Figure 07 and Figure 08. Variety V1 performed higher number of flowers plant^{-1} (5.12), where variety V2 was observed lower number with number of flowers plant^{-1} (4.54) of mungbean. On the treatment combinations, treatment T3 produced the highest number of flowers plant^{-1} (6.53) and the unfertilized control (T0) treated plot produced the lowest results. The results were in agreement with the findings of Malik et al. (2003). The combined effect of different fertilizer doses and varieties on the number of flowers plant^{-1} of mungbean was found statistically significant (Table 02). The highest number of flowers plant^{-1} was observed from the treatment combination of V1T3 (6.73). The lowest number of flowers plant^{-1} was found from the combination of V1T0 (3.86) treated plot. It may be due to the availability of nitrogen and phosphorus has affirmative effect, especially of phosphorus, on flower initiation and on its formation capacity in plant. By the supply of major nutrients such as nitrogen and phosphorus performed better in fruit formation (Balemi, 2008). Another possible reason may be due to the increased supply of essential plant nutrition to tomato plant, their availability, acquisition, mobilization and influx into the plant tissues improved and thus enhanced of numbers of flower cluster^{-1} and numbers of fruits cluster^{-1} (Shukla et al., 2009). Similar results have also been noticed by Haque et al. (2011) in tomatoes. According to Aminifard et al. (2010) stated that nitrogen improved the reproductive development of plant that were in agreement with the findings of Satpal and Saimbhi (2003), Nawaz et al. (2012), Hozhbryan (2013) and Kumar et al. (2013) in tomato plant.

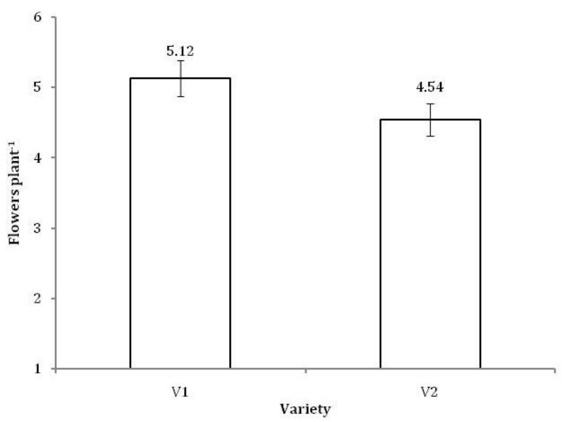

Figure 07. Effect of variety on flowers plant^{-1} of mungbean

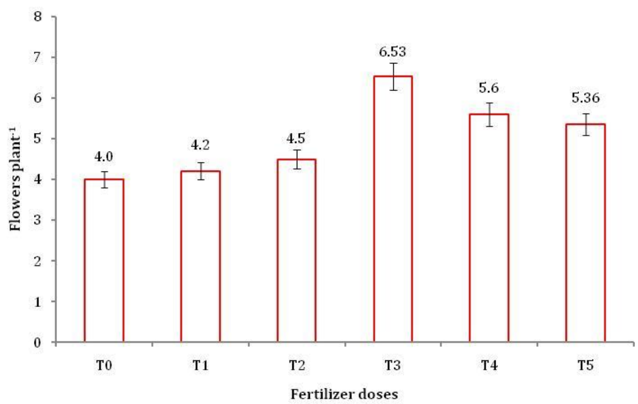

Figure 08. Effect of fertilizers on flowers plant^{-1} of mungbean

Number of pods

The numbers of pods plant^{-1} of mungbean were found statistically significant due to the effect of mungbean cultivars and added inorganic fertilizers (Figure 09 & Figure 10). Variety V1 showed higher number of pods plant^{-1} (2.7 and 21.48 at 45 and 60 DAS) while variety V2 showed lower number of pods plant^{-1} (2.66 and 21.32 at 45 and 60 DAS). The results were in agreement with the findings of Uddin et al. (2009), who confirmed that BARI mung-6 obtained highest number of pods plant^{-1} than the other mungbean varieties. Significant variations were observed for number of pods plant^{-1} due to different inorganic fertilizers levels (Figure 10). In the whole growing period, T3 treatment produced the highest number of pods plant^{-1} (3.36 and 23.36 at 45 and 60 DAS), which were about 181% and 34% higher than the control T0 (1.53 and 17.48 at 45 and 60). The results were in agreement with the observations of Sultana et al. (2009) who reported that application of 20 kg N ha^{-1} as basal dose produced highest number of pods plant^{-1}. Similar results also found by Rajinder et al. (2002). The combined effect of different fertilizer doses and varieties on the number of pods plant^{-1} of mungbean was statistically significant (Table 02). Highest number of pods plant^{-1} was observed from the combination of V1T3 (3.46 and 23.47 at 45 and 60 DAS) and the lowest number of pods plant^{-1} was found from the combination of V1T0 (1.46 and 17.33 at 45 and 60 DAS) which were statistically similar to the combination of V2T0. It may be due to the availability of nitrogen and phosphorus has affirmative effect, especially of phosphorus, on flower initiation and on its formation capacity in plant. By the supply of major essential plant nutrients such as nitrogen and phosphorus resulted in a better role in fruit formation (Balemi, 2008). Another possible reason may be due to the additional supply of essential plant nutrients in tomato; their availability, acquisition, mobilization, and influx into the plant tissues increased and thus enhanced the numbers of flower cluster^{-1} and numbers of fruits cluster^{-1} (Shukla et al., 2009). Similar results have also been reported by Haque et al. (2011) in tomatoes. According to Aminifard et al. (2010) stated that nitrogen improved reproductive growth that were in accord with findings of Satpal and Saimbhi (2003), Nawaz et al. (2012), Hozhbryan (2013) and Kumar et al. (2013) in tomato.

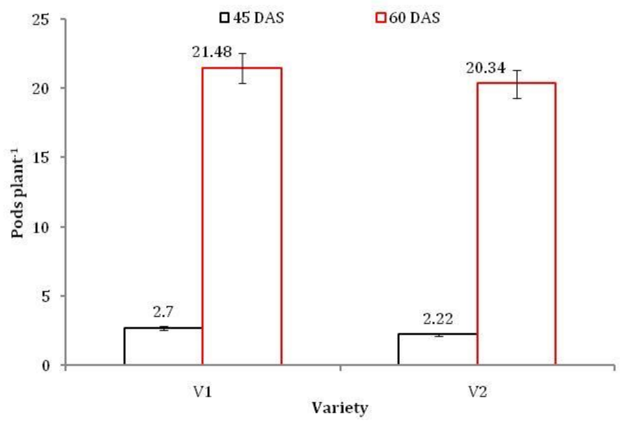

Figure 09. Effect of variety on pods plant^{-1} of mungbean

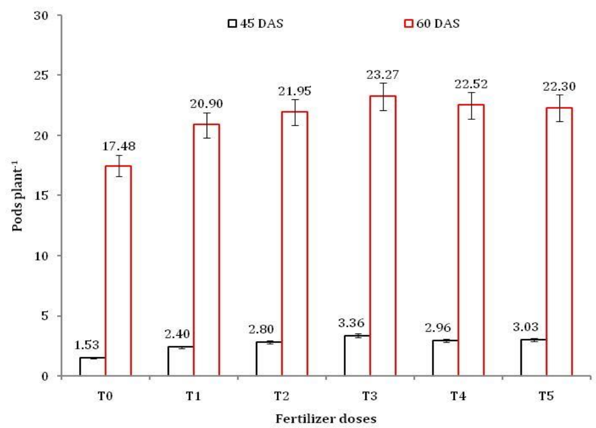

Figure 10. Effect of fertilizers on pods plant^{-1} of mungbean

Seeds per pod

Results obtained for seeds per pods showed a significant difference between mungbean cultivars and NPK doses of fertilizers (Figure 11 & Figure 12). Variety V1 (BARI mung-6) recorded higher seeds pod^{-1} (10.8) while variety V2 (BARI mung-5) produced lower seeds pod^{-1} (9.7). The results agreed with the findings of Uddin et al. (2009), who observed that BARI mung-6 produced highest number of seeds plant^{-1} than the other mungbean varieties. Significant variation was observed in seeds pod^{-1} due to different supplementary fertilizer levels (Figure 12). In case of fertilizer treatment, T3 treatment produced the highest seeds pod^{-1} (11.57 seeds pod^{-1}) which was 32.22% more than the control, T0 (8.75 seeds pod^{-1}). The results were in agreement with the findings of Asif et al. (2003), Satish et al. (2003) and Srinivas et al. (2002). The data of numbers of seed pod^{-1} was significantly affected by the interaction effects of variety and fertilizers treatment (Table 02). The highest number of seeds pod^{-1}was noticed with the application from the combination of V2T4 (11.70). The lowest seeds pod^{-1} was found from the treatment combination of V2T1 (8.70) which was statistically similar to the V1T1 treated plot.

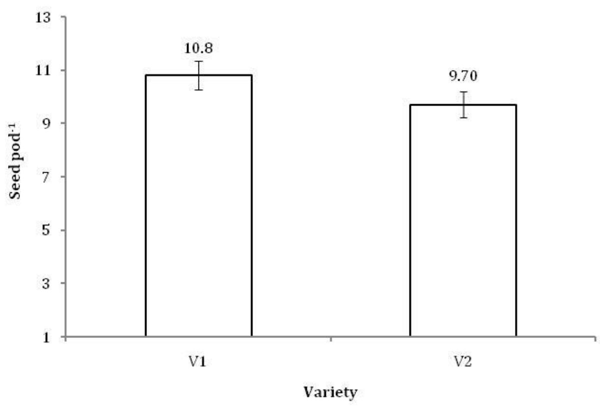

Figure 11. Effect of variety on seeds pod^{-1} of mungbean

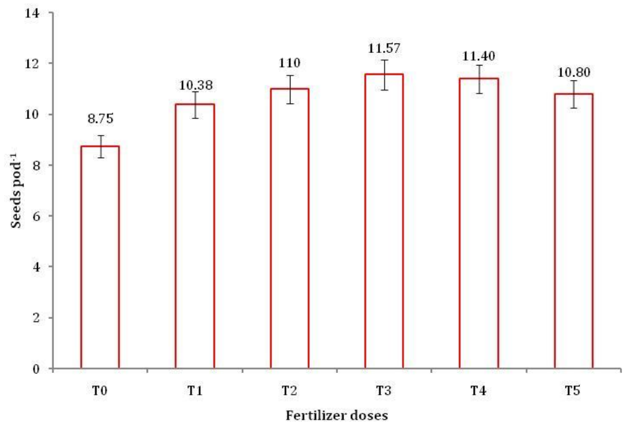

Figure 12. Effect of fertilizers on seeds pod^{-1} of mungbean

1000-seed weight (g)

There was a significant effect of variety on 1000-seed weight (Figure 13) of mungbean. Variety V1 was recorded as the highest 1000-seed weight (42.77 gm), while variety V2 was observed with lowest 1000-seed weight (37.78 gm). The results agreed with the findings of Uddin et al. (2009), who observed that BARI mung-6 yielded highest 1000-seed weight.

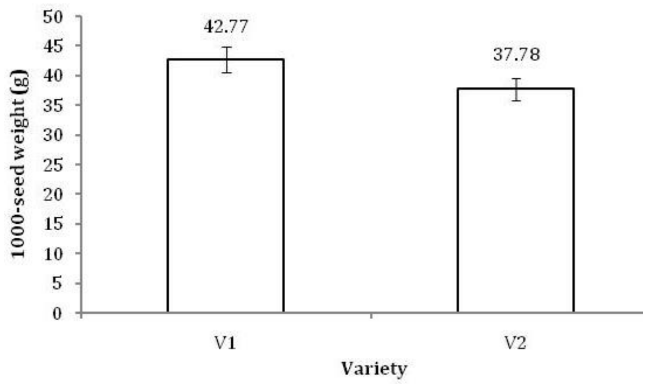

Figure 13. Effect of variety on 1000-seed weight (g) of mungbean

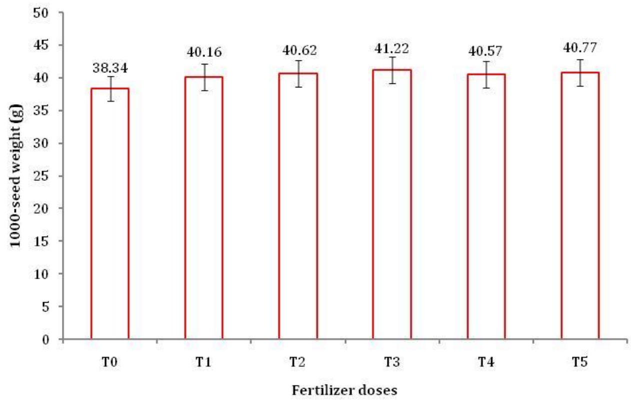

Figure 14. Effect of fertilizers on 1000-seed weight (g) of mungbean

There was significant variation observed for 1000-seed weight due to different fertilizer doses (Figure 14) of mungbean. Treatment T3 produced the highest 1000-seed weight (41.22 gm) and control treatment (T0) attained the lowest (38.34 gm) 1000-seed weight of mungbean. The results were in agreement with the findings of Srinivas et al. (2002) and Umar et al. (2001). 1000-seed weight was significantly affected by the interaction of variety and treatment (Table 02). The highest 1000-seed weight was observed from the combination of V2T3 (43.63 g) and the lowest 1000-seed weight was found from the treatment combination of V2T0 (35.98 g). The combined application of NPK amplified availability of major essential plant nutrients to plant due to better early root architectural growth and cell division and multiplication foremost to more absorption of other nutrients from deeper layers of soils by increasing surface area in due course, resulting in increased plant growth attributes and finally improved yield. Further, the translocation and accumulation of photosynthetic products and by-products from the sources to sink resulted in augmented seed, stover and biological yields in plants. Enlarged yield promoting attributes and yield by various researchers have been noticed at different places with integrated nutrients management (INM) system by Rajkhowa et al. (2003) and Patel et al. (2003).

Table 02. Interaction effect of varieties and fertilizer doses in case of yield contributing characters of Mungbean

Treatment	Flowers plant^{-1}	Pods plant^{-1}at 45 DAS	Pods plant^{-1}at 60 DAS	Seeds pod^{-1}	1000-seed weight (g)	Seed yield (t/ha)	Straw yield (t/ha)
V1T0	3.86 e	1.46 e	17.33 e	8.80 e	40.70 b	1.19 f	1.89 f
V1T1	4.40 de	2.33 d	20.40 d	10.27 cd	42.82 a	1.56 b-d	2.41 bc
V1T2	4.53 de	2.86 a-d	22.03 bc	11.17 a-d	43.08 a	1.58 a-c	2.47 ab
V1T3	6.73 a	3.46 a	23.47 a	11.70 a	43.63 a	1.78 b	2.54 a
V1T4	5.60 bc	3.06 a-c	22.73 a-c	11.57 a	43.10 a	1.61 ab	2.53 a
V1T5	5.60 bc	3.00 a-d	22.93 ab	11.47 ab	43.33 a	1.59 a-c	2.52 ab
V2 T0	4.13 e	1.60 e	17.63 e	8.70 e	35.98 e	1.16 f	1.91 f
V2 T1	4.00 e	2.46 cd	21.40 cd	10.50 b-d	37.50 d	1.49 e	2.15 e
V2 T2	4.46 de	2.73b-d	21.87 bc	10.83 a-d	38.16 cd	1.52 de	2.27 d
V2 T3	6.33 ab	3.26 ab	23.07 ab	11.43 ab	38.81 c	1.6 b-d	2.31 cd
V2 T4	5.60 bc	2.86 a-d	22.30 a-c	11.23 a-c	38.04 cd	1.54 c-e	2.30 d
V2 T5	5.13 cd	3.06 a-c	21.67b-d	10.13 d	38.21 cd	1.53 c-e	2.29 d
SE	0.29	0.22	0.43	0.32	0.27	0.01	0.04
CV (%)	9.79	14.03	3.48	5.20	1.18	1.70	2.66

In a column means having common letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability; V1 = BARI mung-6, V2 = BARI mung-5, T0 = control treatment, T1 = 10kg N + 40kg P+ 25kg K ha^{-1}, T2 =10kg N + 60kg P+ 45kg K ha^{-1}, T3 = 20kg N + 50kg P+ 35kg K ha^{-1}, T4 = 30kg N + 40kg P+ 25kg K ha^{-1}, T5 = 30kg N + 40kg P+ 45kg K ha^{-1}

Seed yield (t ha^{-1})

The statistical analysis of data showed that there were significant differences between treatments and mungbean cultivars. There was a significant effect of variety on seed yield (Figure 15). Variety V1 was recorded the highest seed yield (1.72 t/ha), while variety V2 was observed the lowest seed yield (1.57 t/ha). The results were in conformity with the findings of Jahan et al. (2009) and Uddin et al. (2009) who reported that BARI mung-6 produced more seed from all other mungbean varieties in Bangladesh.

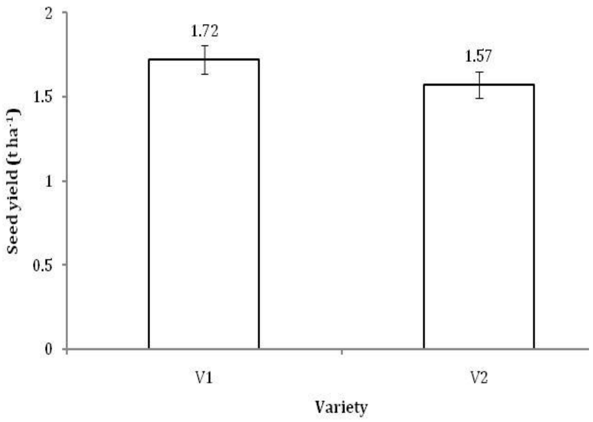

Figure 15. Effect of variety on seed yield (t ha^{-1}) of mungbean

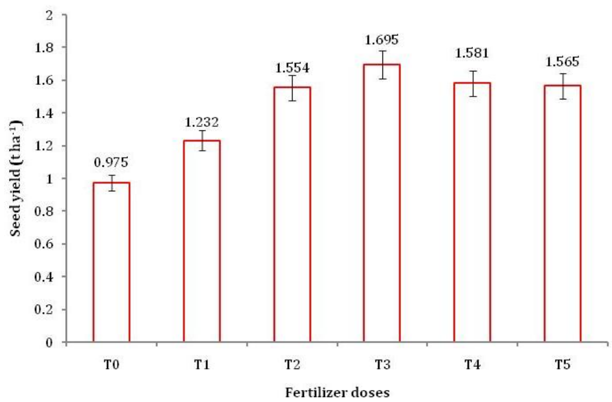

Figure 16. Effect of fertilizers on seed yield (t ha^{-1}) of mungbean

There was significant variation observed for seed yield due to different fertilizers treatment levels. Significantly maximum grain yield was recorded on T3 treatment and produced the highest seed yield (1.69 t ha^{-1}), which is about 73% higher than the control treatment, T0 (0.98 t ha^{-1}), through NPK fertilizer doses as compared to all other treatments (Figure 16). The results were in similar to the findings of Umar et al. (2001), who observed that seed yield of mungbean improved significantly by application of phosphorus along with nitrogen. Seed yield was significantly affected by the interaction of variety and fertilizers treatment (Table 02). Highest seed yield was observed from the combination of V1T3 (1.78 t ha^{-1}) and the lowest seed yield was found from the combination of V2T0 (1.16 t ha^{-1}). Significantly increased grain yield in mungbean because additional application of NPK inorganic fertilizers could be approved to their direct inclined on dry matter production at successive stages by good worth of increased photosynthetic efficiency in leaves of plant. At the same time, indirect influence to be due to boost in plant height. The deep influence of supplementary essential plant nutrients application on biological yield seems to be a report of its influence on growth and development of plant. The interaction between varieties and fertilizer levels were also depicted non-significant. The water stress causes a noteworthy function in decrease grain yield due to decrease of nutrient complement, while stress during garin filling lessen grain yield through grain weight (Sankar et al., 2007).The plant biomass enlarged might be due to the elementary contribution of nitrogen, phosphorus and potassium in a large number of enzymatic reactions as well as other metabolic processes, energy transfer, and biological and genetic processes which accelerate cell partitioning and growth in plants. Another probable reason may be owing to fruit yield plant^{-1} augmented with the application of nitrogen and phosphorus suitable to the further carbohydrate fabrication and absorption in fruit by the result of essential plant nutrients or inorganic fertilizers supplementation (Bidari and Hebsur, 2011).

Stover yield (t ha^{-1})

There was a significant effect of variety on stover yield (Figure 17) of mungbean. Variety V1 was recorded the highest stover yield (2.59 t ha^{-1}) while variety V2 was observed as the lowest stover yield (2.2 t ha^{-1}). The results were in concord with the answer of Jahan et al. (2009) who reported that BARI mung-6 produced the highest seed and stover yield of all mungbean varieties. There was significant variation observed for stover yield due to different fertilizer levels (Figure 18). T3 treatment produced the highest stover yield (2.42 t ha^{-1}), which was 27.4% higher than the control treatment, T0 (1.9 t ha^{-1}). The results were in agreement with the findings of Jahan et al. (2009), who reported that the stover yield of mungbean of all varieties were increased with the augment of potassium application up to 35 kg ha^{-1}. Stover yield was significantly affected by the interaction of variety and treatment (Table 02). Highest stover yield was observed from the combination of V1T3 (2.54 t ha^{-1}) and the lowest stover yield was found from the combination of V1T0 (1.89 t ha^{-1}). According to Rao et al. (2014), with rising in nitrogen might have assisted in superior photosynthesis and nitrogen being an indispensable ingredient of protoplasm and chloroplast might have motivated meristematic cell growth and thus amplified the growth of plant and increases plant dry matter production as well as weight of plant. Similar findings were obtained from Baloch et al. (2014) in radish. It might be due to plant vigor by the uptake and utilized soil inherent and added nutrients available for the plants vegetative and reproductive growth. Other possible reason may be the increment in supply of essential plant nutrients to plant, their availability, mobilization, and influx into the plant tissues amplified and thus enhanced fruit size (Shukla et al., 2009). According to Kumar et al. (2013), nitrogen and phosphorus nutrition supplied in sufficient amount promote flower initiation and fruit setting with identical fruit size but surplus dose of nitrogen and phosphorus deferred fruit maturity and decreased fruit shape and size. Present results were in agreement with the findings of earlier reports by Solaiman and Rabbani (2006) and Kumar et al. (2013) in tomato.

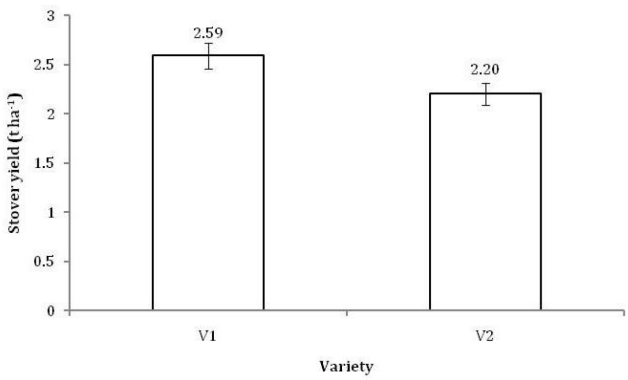

Figure 17. Effect of variety on stover yield (t ha^{-1}) of mungbean

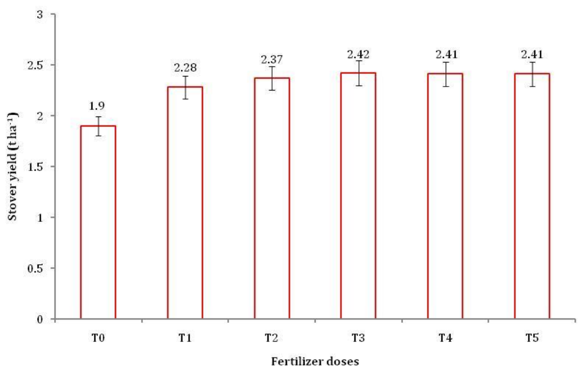

Figure 18. Effect of fertilizers on stover yield (t ha^{-1}) of mungbean

IV. Conclusion

The outcome of this experiment with mungbean cultivar and inorganic fertilizers, it may be accomplished that the combined application of T3 (20-50-35 kg NPKha^{-1}) inorganic fertilizers doses may be suggested for receiving higher grain production of mungbean cultivar BARI mung-6. It is rational and financially feasible to use the optimum dose of nitrogen, phosphorus and potassium for maximum yield of mungbean. The study's findings indicated that nitrogen, phosphorus and potassium fertilizer individual and combined application enhanced the growth and yield contributing characters effectiveness of mungbean in field condition. So, further investigation is looked-for in this path with other varieties of mungbean to specific the present findings of this research.

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Conflicts of Interest

The authors declare that there is no conflict of interest concerning the publication of this paper.

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