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Growth Performance and Development Attributes of Mungbean (*Vigna radiata* L.) as Influenced by Organic Manure and Inorganic Fertilizer

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Authors' contributions

This work was carried out in collaboration between all authors. Author MSI designed the study. Author MEH performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MSI and MSR managed the analyses of the study. Author MSR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was carried out at the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka during the period from March to June 2015 (Kharif-I season) to find out the growth performance and development attributes of mungbean (*Vigna radiate* L.) as influenced by organic manure and inorganic fertilizer. The experiment consisted of two factors: factor A: five levels of manures and inorganic fertilizers [T_0 = Control (no fertilizer or manure), T_1 = Recommended dose of fertilizer (R) (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}), T_2 = R + cow dung (3 t ha^{-1}), T_3 = R + poultry manure (2 t ha^{-1}), T_4 = R + vermicompost (2.5 t ha^{-1})] and factor B: two mungbean varieties; (V_1 = BARI Mung 5 and V_2 = BARI Mung 6). The experiment was laid out in split- plot design with three replications. The growth performance and development attributes of Mungbean varieties were found significant with the combined effect of different organic manures and recommended doses of inorganic fertilizers. The largest plant height, number of leaves $plant^{-1}$, number of branches $plant^{-1}$, dry weight of plant, minimum days to first emergence, 80% emergence, 80% flowering and 80% pod maturity (46.05 cm at 55 DAS, 24.16 at 55 DAS, 7.92 at

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55 DAS, 40.68 g at 55 DAS, 1.80 days, 3.16 days, 32.21 days and 46.56 days, respectively) were found from the combined effect of V_2 varieties with T_4 treatment. Among the different treatment combination T_4 [(recommended doses of fertilizer + vermicompost (2.5 t ha^{-1})] showed the best results. So, BARI Mung 6 performed the best performance with the application of vermicompost @ 2.5 t ha^{-1} with the recommended dose of fertilizer.

Keywords: BARI Mung; organic manures; vermicompost and inorganic fertilizers.

1. INTRODUCTION

Mung bean (*Vigna radiata* L. Wilczek*)* belongs to the family Fabaceae [1]. It is an important grain legume and is extensively grown in tropical and subtropical countries of the world [2]. After chickpea, mungbean called as poor people diet owing to its protein nature and is meeting the major protein demand of the people [3]. Its edible grain characterized by good digestibility, flavor, high protein content and absence of any flatulence effects [4]. Its seed has 24.7% protein, 0.6% fat, 0.9% fiber and 3.7% ash [5]. It has the ability to fix nitrogen in the soil because of its root nodules [6].

Average yields to mungbean in Bangladesh is very low, which is primarily due to substandard methods of cultivation, poor crop stand, imbalanced nutrition, poor plant protection measures and lack of high yielding varieties. The low yield of mungbean besides other factors may partly be due to lack of knowledge about nutrition and modern production technology [7]. Moreover, lack of attention on fertilizer used is also hampered by the lowering of mungbean yields [8]. Mungbean yields and quality can be improved by the balanced use of fertilizers and by managing the organic manures properly [9]. Mungbean is highly responsive to fertilizers and manures. Being leguminous in nature, mungbean needs low nitrogen but need best doses of other major nutrients as recommended. Soil organic matter could affect the soil microbial community and increase the crop growth and yield [10]. Organic materials hold great promises as a source of multiple nutrients and ability to improve soil characteristics [11]. This may not only improve the efficiency of chemical fertilizers along with their minimal use of crop production besides of increasing the crop yield and improving available major and minor nutrients [12]. Organic farming preserves the ecosystem. Integrated nutrient management includes the intelligent use of organic, inorganic, and online biological resources to sustain best yields, improve or keep up the soil physical and chemical properties and give crop nutrition packages which are technically sound, economically attractive, practically possible and environmentally safe [13]. The management practices and use of organic materials influence agricultural sustainability by improving the physical, chemical and biological properties of soils [14]. Cowdung is an organic and nitrogen-rich material, and is easily degraded in the soil. Cow dung also exhibits plant growth promoter properties [15]. Poultry manure also improves nutrient status in soil and at the same time may cut soil pollution, which developed from the continuous use of chemical fertilizer. Vermicompost supplies both macros and micronutrients in the soil for best plant growth [16]. Plant available N, P and K were higher in plots supplied with both vermicompost and NPK fertilizers [17]. Management of soil organic matter has now become a major issue in dealing with the problems of soil fertility and productivity in Bangladesh. The integrated nutrient management paid little attention to agriculture areas of the developing world [18]. A good soil should have at least 2.5% organic matter, but in Bangladesh, most of the soils have less than 1.5%, and some soils even less than 1% organic matter [19]. Based on the above conditions present experiment conducted with an aim to test the performance of organic manures and inorganic fertilizers on the growth and development attributes of mungbean varieties.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at the Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka and it was in 24.09° N latitude and 90.26° E longitudes. The area belongs to the Agro ecological Zone (no.28): (Madhupur Tract).

2.2 Climate and Soil

The climate of the experimental site is sub-tropical, wet and humid. Heavy rainfall occurs in the monsoon (mid-April to mid-August) and scanty during rest of the year. The soil of the

experimental area was silty clay in texture. Soil pH was 6.7 and has organic carbon 0.45%.

2.3 Experimental Treatments

Mungbean varieties were used in the experiment. The experiment consisted of two factors: factor A: five levels of manures and inorganic fertilizers [T_0 = Control (no fertilizer or manure), T_1 = Recommended dose of fertilizer (R) (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}), T_2 = R + cow dung (3 t ha^{-1}), T_3 = R + poultry manure (2 t ha^{-1}), T_4 = R + vermicompost (2.5 t ha^{-1})] and factor B: two mungbean varieties; (V_1 = BARI Mung 5 and V_2 = BARI Mung 6). The experiment was laid out in split plot design with three replication. Each block of 10 plots resulting 30 plots in total. The size of each unit plot was 6 m^2. The distance between plots 0.5 m and replication 1.0 m.

Table 1. Chemical analysis of soil of the experimental plot

Soil properties	Amount
Soil pH	5.8
Organic carbon (%)	0.95
Organic matter (%)	0.77
Total nitrogen (%)	0.075
Available P (ppm)	12.78
Exchangeable K (%)	0.32
Available K (ppm)	43.29
Available S (ppm)	16.17

Source: Soil Resource Development Institute [20]

2.4 Crop Husbandry

The experimental land was prepared and weeds, stubble and crop residues were removed. Except for urea, all manures (cow dung, poultry manure and vermicompost) were applied along with TSP and MoP as per treatments during the final land preparation. All manures (cow dung, poultry manure and vermicompost) were applied as treatments each different plot of last land preparation. The urea was applied for two intervals: First half was applied during last land preparation and rest was applied at 25 DAS followed by light irrigation. Healthy seeds of mungbean @ 35 kg ha^{-1} were sown by hand as uniformly as possible in furrows with 15 cm hills to hill distance and 30 row to row distance. Seeds were sown in the afternoon and immediately covered with soil to avoid sunlight. Gap filling, weeding, application of irrigation water and plant protection measures were taken properly when needed.

Table 2. Chemical compositions of the organic manures used for the experiment (Oven dry basis)

Organic fertilizer	N (%)	P (%)	K (%)
Cowdung	0.9	0.5	1.1
Poultry manure	1.3	0.5	1.3
Vermicompost	1.3	2.7	9.2

Source: Soil Resource Development Institute [20]

Table 3. Recommended doses of inorganic fertilizers

Inorganic fertilizer	Kg ha^{-1}
Urea	45
TSP	100
Mop	58

Source: Bangladesh Agricultural Research Institute [21]

2.5 Data Collection

Ten pre-selected plants per plot from which different data were collected. Data on the following parameters were recorded during the course of the experiment such as - plant height, number of leaves $plant^{-1}$, number of branches $plant^{-1}$, dry weight of plant (g $plant^{-1}$), days to first emergence, days to 80% emergence, days to 80% flowering and days to 80% pod maturity.

Total dry matter weight of stem $plant^{-1}$ (g) was recorded at different DAS by uprooting three random plant samples and separating the stem carefully. The plant samples were then oven dried at 72 °C temperatures.

$$\text{Dry matter content of plant (\%)} = \frac{\text{Weight of oven dried plant}}{\text{Fresh weight of plant}} \times 100$$

2.6 Statistical Analysis

All the collected data were tabulated and analyzed statistically using analysis of variance technique and later Least Significance Difference (LSD at 5%) for comparing the treatment means, by MSTAT-C software [22].

3. RESULTS AND DISCUSSION

3.1 Plant Height

Significant differences observed due to the different mungbean varieties at 35, 45 and 55

DAS on plant height except 15 and 25 DAS (Fig. 1). At 15, 25, 35, 45 and 55 DAS, the tallest plant (13.27, 29.37, 38.94, 40.24 and 43.71 cm) recorded from V_2 variety (BARI Mung 6) and the shortest plant (12.33, 27.01, 36.48, 38.55 and 41.24 cm) were found from V_1 variety (BARI Mung 5).

Significant differences observed due to applying different levels of manures and inorganic fertilizers at 45 and 55 DAS on plant height except 15, 25 and 35 DAS (Fig. 2). At 25, 35, 45 and 55 DAS, the tallest plant (29.61, 38.97, 40.38 and 45.67 cm, respectively) recorded from T_4 treatment [Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})] and the shortest plant (26.70, 35.25, 37.53 and 41.26 cm, respectively) found from T_0 treatment (control).

Significant differences observed due to applying different levels of manures and inorganic fertilizers with different mungbean varieties at 25, 35, 45 and 55 DAS on plant height except for 15 DAS (Table 4). At 15, 25, 35, 45 and 55 DAS, the highest plant height (14.43, 30.85, 41.20, 42.88 and 46.05 cm, respectively) recorded from V_2T_4 treatment combination and the shortest plant (11.81, 24.73, 32.86, 36.20 and 39.01 cm, respectively) was found from V_1T_0 treatment combination. It seems from the results that combination of vermicompost and inorganic fertilizers much increased the plant height vermicompost supply higher amount of N, P and K to the plants compare to other manures such as cow dung and poultry manures which have very low N, P and K than vermicompost. Plant available N, P and K were higher in plots supplied with both vermicompost and NPK fertilizers [17]. Actually organic fertilizers help to increase the organic matter content of a soil, thus reducing the bulk density and decreasing compaction. Thus plants get a suitable growing environment which promotes better growth and development. Similar sort of findings was found by many scientists while experimenting with various crops. Combination of organic and inorganic fertilizers was found better in groundnut [23] and in green gram [24] than only inorganic fertilizers. The results were in conformity with [25] in plant height of chickpeas.

3.2 Number of Leaves Plant^{-1}

Significant differences observed due to the different varieties of mungbean at 35, 45 and 55 DAS on number of leaves plant^{-1} except 15 and 25 DAS (Fig. 3). At 15, 25, 35, 45 and 55 DAS, the greatest number of leaves plant^{-1} (10.44, 19.86, 20.88, 21.85 and 22.84 respectively) were observed from V_2 variety (BARI Mung 6) and the smallest number of leaves plant^{-1} (9.74, 18.91, 19.40, 20.56 and 21.78) was found from V_1 variety (BARI Mung 5).

Significant differences were observed due to the application of different levels of manures and inorganic fertilizers at 25, 35, 45 and 55 DAS on number of leaves plant^{-1} except for 15 DAS (Fig. 4). At 15, 25, 35, 45 and 55 DAS, the largest number of leaves plant^{-1} (10.78, 20.05, 21.17, 22.45 and 23.30, respectively) recorded from T_4 treatment [Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})] and the smallest number of leaves plant^{-1} (9.48, 18.31, 19.53, 20.78 and 21.68, respectively) found from T_0 treatment (control).

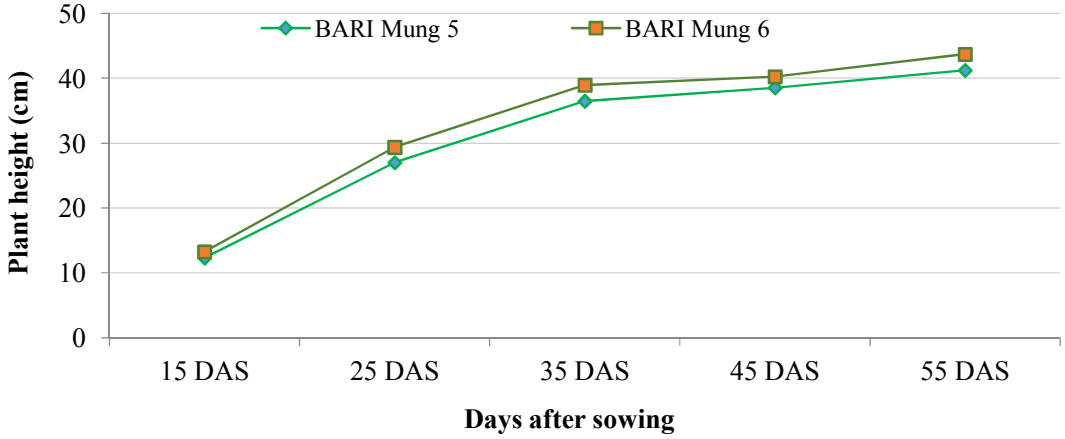

Fig. 1. Effect of variety on plant height of mungbean ($LSD_{0.05}$ = 0.79, 1.72, 1.77, 1.58 and 2.43 at 15, 25, 35, 45 and 55 DAS, respectively)

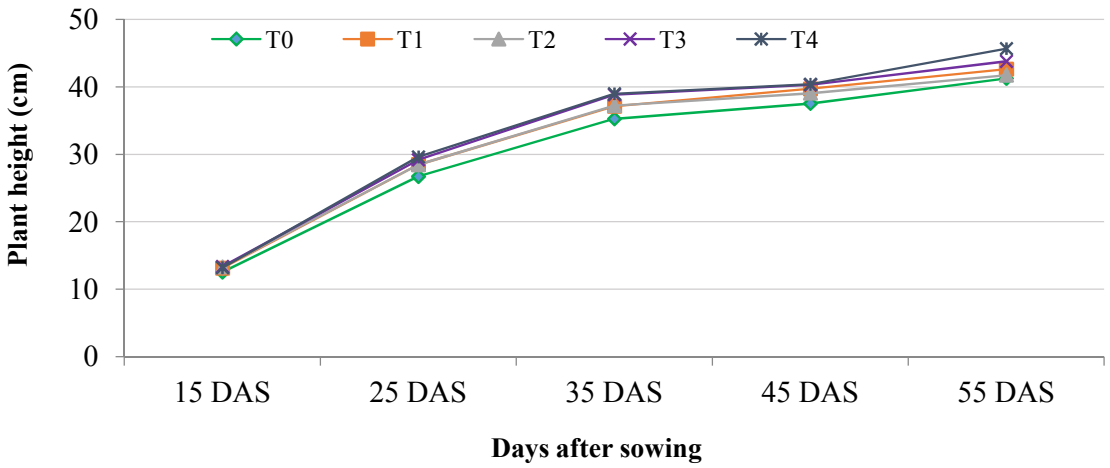

Fig. 2. Effect of manure and inorganic fertilizers on plant height of mungbean ($LSD_{0.05}$= 1.25, 2.72, 2.80, 2.51 and 3.85 at 15, 25, 35, 45 and 55 DAS, respectively)

Table 4. Interaction effect of manures and inorganic fertilizers with different mungbean varieties on plant height at different days after sowing (DAS)

Treatment	Plant height (cm)				
	15 DAS	**25 DAS**	**35 DAS**	**45 DAS**	**55 DAS**
V_1 T_0	11.81c	24.73 b	32.86 d	36.20 b	39.01 d
V_1 T_1	13.25 abc	28.37 ab	38.43 abc	38.53 ab	44.86 abc
V_1 T_2	13.61 ab	28.36 ab	38.06 bc	39.73 ab	41.30 abcd
V_1 T_3	12.28 bc	28.32 ab	35.43 cd	37.13 b	39.56 cd
V_1 T_4	13.717 ab	29.41 a	37.60 bc	41.16 a	41.49 abcd
V_2 T_0	13.28 abc	28.06 ab	37.63 bc	38.86 ab	43.53 abcd
V_2 T_1	13.01 abc	28.56 ab	35.83 cd	39.61 ab	40.59 bcd
V_2 T_2	12.99 abc	28.03 ab	38.70 abc	39.86 ab	42.41 abcd
V_2 T_3	12.67 abc	28.06 ab	40.34 ab	41.01 a	46.00 ab
V_2 T_4	14.43 a	30.85 a	41.20 a	42.88 a	46.05 a
LSD $_{(0.05)}$	**1.77**	**3.85**	**3.97**	**3.55**	**5.44**
CV %	**7.89**	**7.84**	**6.14**	**5.26**	**7.48**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

V_1: BARI Mung 5, V_2: BARI Mung 6, T_0: Control (no fertilizer or manure), T_1: Recommended dose of fertilizer (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}), T_2: Recommended dose of fertilizer + cow dung (3 t ha^{-1}), T_3: Recommended dose of fertilizer + poultry manure (2 t ha^{-1}), T_4: Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})

Significant differences observed due to applying different levels of manures and inorganic fertilizers with different mungbean varieties at 25, 35, 45 and 55 DAS on number of leaves plant^{-1} except for 15 DAS (Table 5). At 15, 25, 35, 45 and 55 DAS, the highest number of leaves plant^{-1} (10.80, 20.26, 21.01, 23.30 and 24.16) recorded from V_2T_4 treatment combination and the lowest values (8.56, 17.40, 18.83, 20.10 and 21.01) were found from V_1T_0 treatment combination. The results showed that combine vermicompost and inorganic fertilizers much increased the number of leaves plant^{-1} than sole use of inorganic fertilizers. As organic fertilizers help to improve the soil condition and inorganic fertilizers assure the quick availability of essential nutrients, mix two proved better than the single use of the each. Better growth by using the combination of manures and inorganic fertilizers than only inorganic fertilizers in mungbean plant [26].

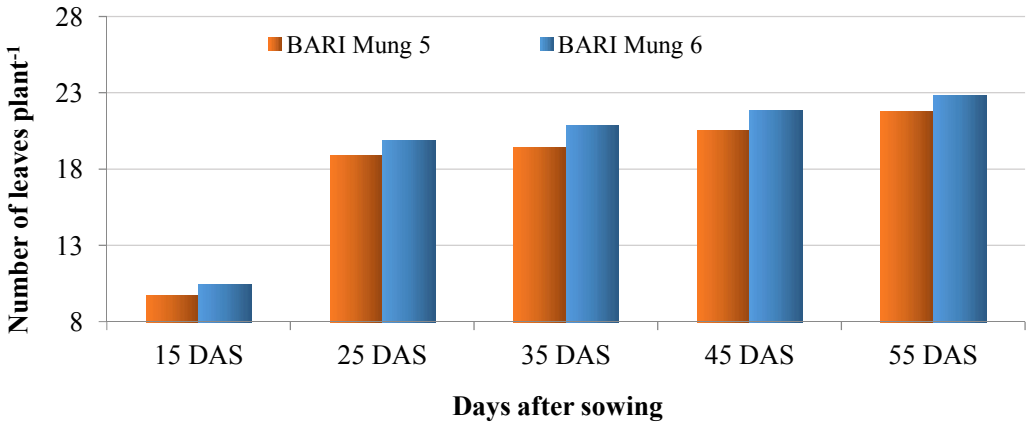

Fig. 3. Effect of variety on number of leaves of mungbean plants ($LSD_{0.05}$= 0.54, 0.56, 0.91, 0.95 and 0.77 at 15, 25, 35, 45 and 55 DAS, respectively)

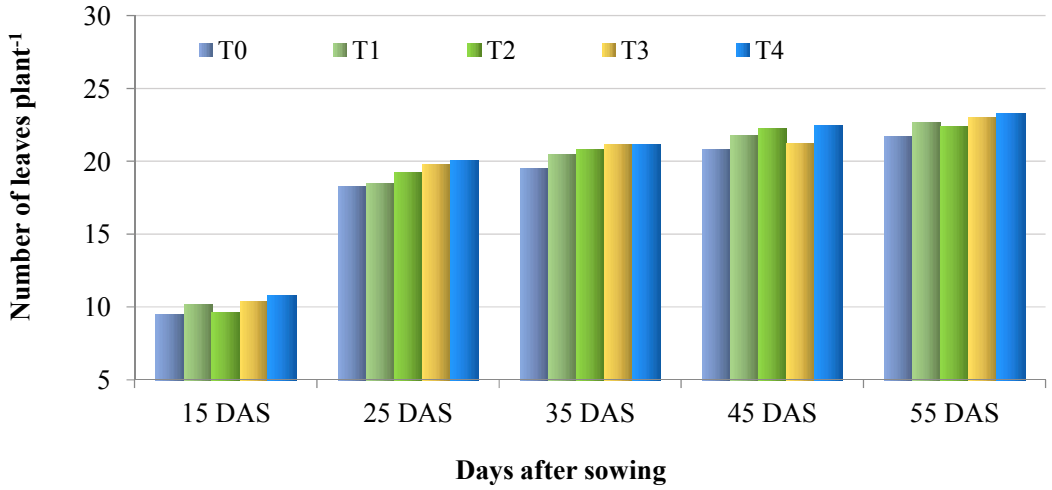

Fig. 4. Effect of manure and inorganic fertilizers on number of leaves of mungbean plant ($LSD_{0.05}$= 0.86, 0.89, 1.44, 1.51 and 1.22 at 15, 25, 35, 45 and 55 DAS, respectively)

3.3 Number of Branches Plant^{-1}

Significant differences observed due to the different varieties of mungbean plant at 35, 45 and 55 DAS on number of branches plant^{-1} except for 25 DAS (Table 6). At 25, 35, 45 and 55 DAS, the most number of branches plant^{-1} (1.48, 2.69, 4.42 and 6.90) recorded from V_2 variety (BARI Mung 6) and the least branches plant^{-1} (1.47, 2.26, 4.02 and 6.47) were found from V_1 variety (BARI Mung 5).

Significant differences observed due to applying different levels of manures and inorganic fertilizers at 25, 35, 45 and 55 DAS on the number of branches plant^{-1}(Table 7). At 25, 35, 45 and 55 DAS, the most number of branches plant^{-1} (1.51, 2.61, 4.34 and 7.08) recorded from T_4 treatment [Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})] and the least number of branches plant^{-1} (1.36, 1.99, 3.72 and 6.21) were found from T_0 treatment (control).

Significant differences observed due to applying different levels of manures and inorganic fertilizers with different varieties of mungbean plant at 35, 45 and 55 DAS on number of branches plant^{-1} except for 25 DAS (Table 8). At 25, 35, 45 and 55 DAS, the highest number of branches plant^{-1} (1.51, 3.71, 5.44 and 7.92) recorded from V_2T_4 treatment combination and the lowest number of branches plant^{-1} (1.35, 2.03, 3.76 and 6.24) were found from V_1T_0 treatment combination. Combination of

vermicompost and inorganic fertilizers much increased the number of branches plant^{-1} than sole use of inorganic fertilizer. As organic fertilizers help to improve the soil condition and inorganic fertilizers assure the quick availability of essential nutrients, mix two proved better than a single use of the each. The combined application of vermicompost @ 2.5 t ha^{-1} + RDF (25:50:50 kg NPK ha^{-1}) + copper ore tailing recorded higher several branches (6.92) in mungbean [23]. Similar results from increasing rates of NPK and they noted that the number of branches plant^{-1} generally increased with apply inorganic fertilizers [27].

3.4 Dry Weight of Plant (g Plant^{-1})

Significant differences observed due to the different varieties of mungbean plants at 15, 25, 35, 45 and 55 DAS on dry weight plant^{-1} (Table 9). At 15, 25, 35, 45 and 55 DAS, the greatest dry weight of plant (0.92, 6.15, 15.22, 25.38 and 30.17 g) recorded from V_2 variety (BARI Mung 6) and the smallest dry weight of plant (0.61, 5.73, 14.27, 21.11 and 27.06 g) were found from V_1 variety (BARI Mung 5).

Significant differences observed due to applying different levels of manures and inorganic fertilizers at 15, 25, 35, 45 and 55 DAS on dry weight plant^{-1} (Table 10). At 15, 25, 35, 45 and 55 DAS, the largest dry weight plant^{-1} (0.71 g, 5.98 g, 16.49 g, 30.84 g and 36.49 g) recorded from T_4 treatment [Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})] and the smallest dry weight of plant (0.78 g, 6.05 g, 12.63 g, 19.33 and 25.01 g) were found in T_0 treatment (control).

Table 5. Interaction effect of variety and manures and inorganic fertilizers on number of leaves plant^{-1} of mungbean at different days after sowing (DAS)

Treatment	Number of leaves plant^{-1}				
	15 DAS	25 DAS	35 DAS	45 DAS	55 DAS
V_1 T_0	8.56 b	17.40 d	18.83 b	20.10 c	21.01 d
V_1 T_1	10.80 a	19.40 abc	20.70 ab	22.43 ab	23.33 abc
V_1 T_2	9.60 ab	18.93 c	20.86 ab	21.50 abc	22.66 abcd
V_1 T_3	9.60 ab	19.01 c	20.53 ab	21.60 abc	22.63 abcd
V_1 T_4	10.13 a	19.83 abc	21.06 a	22.20 abc	24.30 a
V_2 T_0	9.63 ab	19.23 bc	20.23 ab	20.26 c	22.36 bcd
V_2 T_1	10.76 a	19.60 abc	19.93 ab	21.13 bc	22.03 cd
V_2 T_2	10.40 a	19.63 abc	21.43 a	21.46 ac	21.68 cd
V_2 T_3	10.60 a	20.60 a	21.80 a	23.08 ab	23.96 ab
V_2 T_4	10.80 a	20.26 ab	21.01 a	23.30 a	24.16 a
LSD $_{(0.05)}$	**1.22**	**1.26**	**2.04**	**2.14**	**1.73**
CV %	**7.08**	**3.80**	**5.78**	**5.76**	**4.44**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

V_1: BARI Mung 5, V_2: BARI Mung 6, T_0: Control (no fertilizer or manure), T_1: Recommended dose of fertilizer (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}), T_2: Recommended dose of fertilizer + cow dung (3 t ha^{-1}), T_3: Recommended dose of fertilizer + poultry manure (2 t ha^{-1}), T_4: Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})

Table 6. Effect of variety on the number of branches plant^{-1} of mungbean at different days after sowing (DAS)

Treatment	Number of branches plant^{-1}			
	25 DAS	35 DAS	45 DAS	55 DAS
V_1	1.47	2.26 b	4.02 b	6.47 b
V_2	1.48	2.69 a	4.42 a	6.90 a
LSD $_{(0.05)}$	**ns**	**0.32**	**0.32**	**0.31**
CV %	**3.70**	**16.27**	**9.70**	**6.16**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

Table 7. Effect of manure and inorganic fertilizers on number of branches of mungbean plant at different days after sowing (DAS)

Treatment	Number of branches plant^{-1}			
	25 DAS	35 DAS	45 DAS	55 DAS
T_0	1.36 b	1.99 b	3.72 b	6.21 b
T_1	1.51 a	2.58 a	4.31 a	6.79 a
T_2	1.51 a	2.82 a	4.55 a	7.03 a
T_3	1.51 a	2.87 a	4.60 a	6.82 a
T_4	1.51 a	2.61 a	4.34 a	7.08 a
LSD $_{(0.05)}$	**0.07**	**0.50**	**0.50**	**0.51**
CV %	**5.53**	**18.67**	**11.17**	**7.09**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

Table 8. Interaction effect of variety and manures and inorganic fertilizers on number of branches plant^{-1} of mungbean at different days after sowing (DAS)

Treatment	Number of branches plant^{-1}			
	25 DAS	35 DAS	45 DAS	55 DAS
V_1 T_0	1.35 b	2.03 cd	3.76 cd	6.24 cd
V_1 T_1	1.51 a	2.52 bc	4.25 bc	6.73 bc
V_1 T_2	1.51 a	2.44 c	4.17 c	6.65 c
V_1 T_3	1.51 a	2.62 bc	4.35 bc	6.83 bc
V_1 T_4	1.51 a	2.71 bc	4.44 bc	6.92 bc
V_2 T_0	1.36 b	1.36 d	3.09 d	5.57 d
V_2 T_1	1.51 a	2.64 bc	4.25 bc	6.85 bc
V_2 T_2	1.51 a	3.21 ab	4.37 bc	7.42 ab
V_2 T_3	1.51 a	2.52 bc	4.94 ab	6.73 bc
V_2 T_4	1.51 a	3.71 a	5.44 a	7.92 a
LSD $_{(0.05)}$	**0.10**	**0.71**	**0.70**	**0.71**
CV %	**3.70**	**16.27**	**9.70**	**6.16**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

V_1: BARI Mung 5, V_2: BARI Mung 6, T_0: Control (no fertilizer or manure), T_1: Recommended dose of fertilizer (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}), T_2: Recommended dose of fertilizer + cow dung (3 t ha^{-1}), T_3: Recommended dose of fertilizer + poultry manure (2 t ha^{-1}), T_4: Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})

Table 9. Effect of variety on plant dry weight of mungbean plant at different days after sowing (DAS)

Treatment	Plant dry weight (g)				
	15 DAS	25 DAS	35 DAS	45 DAS	55 DAS
V_1	0.61 b	5.73 b	14.27 a	21.11 b	27.06 b
V_2	0.92 a	6.15 a	15.22 a	25.38 a	30.71 a
LSD $_{(0.05)}$	**0.10**	**0.32**	**0.89**	**2.75**	**3.17**
CV %	**17.42**	**7.07**	**7.84**	**14.52**	**13.62**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

Significant differences observed due to applying different levels of manures and inorganic fertilizers with different varieties of mungbean plant at 15, 25, 35, 45 and 55 DAS on dry weight plant^{-1} (Table 11). At 15, 25, 35, 45 and 55 DAS, the highest dry weight plant^{-1} (1.83, 7.23, 18.02, 35.55 and 40.68 g, respectively) recorded from V_2T_4 treatment combination and the lowest dry weight plant^{-1} (0.33, 4.86, 11.69, 18.79 and 24.36 g, respectively) were found from V_1T_0 treatment combination. Results showed that combine organic and inorganic fertilizers much increased the dry weight plant^{-1} than sole use of inorganic fertilizer. As organic fertilizers help to improve the

soil condition and inorganic fertilizers assure the quick availability of essential nutrients, mix two proved better than a single use of the each. Applying vermicompost @ 5 t ha^{-1} + 50% RDF recorded much higher value of growth yield components and yield of mungbean and sunflower compared to FYM @ 5 t ha^{-1} + RDF [28]. The combined application of vermicompost @ 2.5 t per ha + RDF (25:50:50 kg NPK per ha) + copper ore tailing recorded higher seedling dry weight in groundnut [23].

3.5 Days to 1st and 80% Emergence

Significant differences observed due to the different varieties of mungbean plant on days to 1st and 80% emergence (Table 12). The least days to 1st and 80% emergence (2.02 and 3.96 days) were found from V_2 variety (BARI Mung 6) and on the other hand the most days (2.32 and 4.12 day) recorded from V_1 variety (BARI Mung 5).

Significant differences observed due to applying different levels of manures and inorganic fertilizers on days to 1st and 80% emergence (Table 13). The least days to 1st and 80% emergence (1.90 and 3.33 days, respectively) were found from T_4 [Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})] treatment and on the other hand, the largest days (2.56 and 4.60 days, respectively) recorded from T_0 (control) treatment.

Significant differences observed due to applying different levels of manures and inorganic

Table 10. Effect of manure and inorganic fertilizers on the dry weight of mungbean plants at different days after sowing (DAS)

Treatment	Plant dry weight (g)				
	15 DAS	**25 DAS**	**35 DAS**	**45 DAS**	**55 DAS**
T_0	0.78 b	6.05 ab	12.63 c	19.33 c	25.01 c
T_1	0.71 b	5.98 b	15.38 ab	23.31 bc	29.76 bc
T_2	0.73 b	5.83 b	14.24 b	23.25 bc	28.37 bc
T_3	0.36 c	5.31 c	15.22 ab	26.99 ab	32.30 ab
T_4	1.25 a	6.53 a	16.49 a	30.84 a	36.49 a
LSD (0.05)	**0.16**	**0.51**	**1.40**	**4.36**	**5.02**
CV %	**13.62**	**8.44**	**7.54**	**14.26**	**10.53**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

Table 11. Combined effect of variety and organic and inorganic fertilizers on plant dry weight of mungbean plant at different days after sowing (DAS)

Treatment	Plant dry weight (g)				
	15 DAS	**25 DAS**	**35 DAS**	**45 DAS**	**55 DAS**
V_1 T_0	0.33 g	4.86 f	11.69 f	18.79 f	24.36 d
V_1 T_1	0.66 c-e	5.83 bcde	14.96 bcd	26.13 bcd	32.30 bc
V_1 T_2	0.76 cd	6.46 bc	15.77 bc	26.44 bc	30.93 bcd
V_1 T_3	0.46 e-g	5.61 de	14.24 cde	25.01 bcde	30.40 bcd
V_1 T_4	1.11 b	5.90 bcde	15.18 bcd	24.17 bcdef	32.31 bc
V_2 T_0	0.83 c	6.51 b	12.71 ef	22.44 cdef	25.65 cd
V_2 T_1	0.60 def	6.06 bcd	15.26 bcd	28.98 b	27.21 bcd
V_2 T_2	0.70 cd	5.21 ef	13.57 def	20.07 def	25.81 cd
V_2 T_3	0.40 fg	5.76 c-e	16.53 ab	19.87 ef	34.21 ab
V_2 T_4	1.83 a	7.23 a	18.02 a	35.55 a	40.68 a
LSD (0.05)	**0.23**	**0.72**	**1.99**	**6.16**	**7.10**
CV %	**17.42**	**7.07**	**7.84**	**14.52**	**13.62**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

V_1: BARI Mung 5, V_2: BARI Mung 6, T_0: Control (no fertilizer or manure), T_1: Recommended dose of fertilizer (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}), T_2: Recommended dose of fertilizer + cow dung (3 t ha^{-1}), T_3: Recommended dose of fertilizer + poultry manure (2 t ha^{-1}), T_4: Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})

fertilizers with different varieties of mungbean on days to 1st and 80% emergence (Table 14). The least days to 1st and 80% emergence (1.80 and 3.16 days, respectively) were found from V_2T_4 treatment combination and on the other hand, the highest days (2.90 and 4.91 days, respectively) recorded from V_1T_0 treatment combination. Among the interactions, application of vermicompost and inorganic fertilizers (Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1}) recorded much lower several days for 1st and 80% emergence which was much lower when compared to the rest of treatments. Significantly higher several days for 1st and 80% emergence noticed in the plots supplied with control (no manure and fertilizers) compared to rest of the treatments. The early emergence of Mungbean pants made due to the uptake of best amount of nutrients (N, P and K) which supplied by different manures such as vermicompost, poultry manure and cow dung, respectively than other inorganic and control treatments. Organic manures and inorganic fertilizers give the favorable condition to the Mungbean plant for nutrients uptake which gives early emergence than control treatments. The similar results also reported by [29,30].

3.6 Days to 80% Flowering and Pod Maturity

Significant differences observed due to the different varieties of mungbean plant on days to 80% flowering and pod maturity (Table 12). The smallest days to 80% flowering and pod maturity (32.16 and 47.62 days, respectively) were found from V_2 variety (BARI Mung 6) and on the other hand, the largest days (35.22 and 50.90 days, respectively) recorded from V_1 variety (BARI Mung 5).

Significant differences observed due to applying different levels of manures and inorganic fertilizers on days to 80% flowering and pod maturity (Table 13). The least days to 80% flowering and pod maturity (31.36 and 47.45 days, respectively) were found from T_4 (Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1}) treatment and on the other hand, the most days (34.10 and 50.51 days, respectively) recorded from T_0 (control) treatment.

Significant differences observed due to applying different levels of manures and inorganic fertilizers with mungbean varieties on days to 80% flowering and pod maturity (Table 14). The least days to 80% flowering and pod maturity (32.21 and 46.56 days, respectively) were found from V_2T_4 treatment combination, while the largest (36.43 and 54.47 days, respectively) recorded from V_1T_0 treatment combination. Among the interactions, application of vermicompost and inorganic fertilizers (Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1}) recorded lower several days for 80% flowering and pod maturity which was much lower when compared to the rest of treatments. Significantly higher several days for 80% flowering and pod maturity noticed in the plots supplied with control (no manure and fertilizers) compared to rest of the treatments. The early flowering and pod maturity of Mungbean pants made due to the uptake of the most amount of nutrients (N, P and K) which supplied by different manures such as vermicompost, poultry manure and cow dung, respectively than other inorganic and control treatments. The interaction of organic manures and inorganic fertilizers give the favorable condition to the Mungbean plant for nutrients uptake which gives early flowering and pod maturity than control treatments. Significantly higher several days for 50% flowering noticed in the plots supplied with FYM + 0% FRD (44 and 57 DAS) compared to rest of the treatments [31]. The similar results about the pod maturity of mungbean also reported by [29,30,32].

Table 12. Effect of variety on days to 1st emergence, days to 80% emergence, days to 80% flowering and days to 80% pod maturity of mungbean

Treatment	Days to 1st emergence	Days to 80% emergence	Days to 80% flowering	Days to 80% pod maturity
V_1	2.32 a	4.12 a	35.22 a	50.90 a
V_2	2.02 b	3.96 b	32.16 b	47.62 b
$LSD_{(0.05)}$	**0.22**	**0.10**	**1.61**	**1.84**
CV %	**12.67**	**3.22**	**6.23**	**4.87**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

Table 13. Effect of manure and inorganic fertilizers on days to 1st emergence, days to 80% emergence, days to 80% flowering and days to 80% pod maturity of mungbean

Treatment	Days to 1st emergence	Days to 80% emergence	Days to 80% flowering	Days to 80% pod maturity
T_0	2.56 a	4.60 a	34.10 a	50.51 a
T_1	2.46 a	4.30 b	33.86 a	49.25 ab
T_2	2.40 a	4.08 c	34.41 a	50.01 ab
T_3	2.30 a	4.12 c	31.41 b	49.08 ab
T_4	1.90 b	3.33 d	31.36 b	47.45 b
LSD (0.05)	**0.35**	**0.16**	**2.54**	**2.91**
CV %	**11.53**	**2.34**	**4.85**	**3.07**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

Table 14. Interaction effect of manures and inorganic fertilizers with variety on days to 1st emergence, days to 80% emergence, flowering and pod maturity of mungbean

Treatment	Days to 1st emergence	Days to 80% emergence	Days to 80% flowering	Days to 80% pod maturity
V_1 T_0	2.90 a	4.91 a	36.43 a	54.47 a
V_1 T_1	2.41 a-c	3.30 ef	33.03 a-d	51.47 ab
V_1 T_2	2.21 cd	4.23 d	34.51 a-d	50.61 a-c
V_1 T_3	2.23 b-d	4.40 cd	36.23 a-c	50.46 a-c
V_1 T_4	2.01 cd	3.50 e	31.32 d	46.71 c
V_2 T_0	2.80 a	4.51 bc	36.13 ab	49.43 bc
V_2 T_1	2.73 ab	4.30 cd	32.41 cd	47.53 bc
V_2 T_2	2.01 cd	4.66 b	32.23 d	47.40 bc
V_2 T_3	2.21 cd	3.52 e	36.13 ab	48.03 bc
V_2 T_4	1.80 d	3.16 f	32.21 d	46.56 c
LSD (0.05)	**0.50**	**0.22**	**3.60**	**4.12**
CV %	**12.67**	**3.22**	**6.23**	**4.87**

In a column means having the similar letter(s) are statistically similar and those having the dissimilar letter(s) differ much by LSD at 0.05 level of chance

V_1: BARI Mung 5, V_2: BARI Mung 6, T_0: Control (no fertilizer or manure), T_1: Recommended dose of fertilizer (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP/ha), T_2: Recommended dose of fertilizer + cow dung (3 t ha^{-1}), T_3: Recommended dose of fertilizer + poultry manure (2 t ha^{-1}), T_4: Recommended dose of fertilizer + vermicompost (2.5 t ha^{-1})

4. CONCLUDING REMARKS

Irrespective of varieties and doses, plant height, leaves plant^{-1}, branch plant^{-1}, dry weight of plant and least days to 80% emergence, 80% flowering and 80% pod maturity were increased (18.07%), (14.99%), (26.92%), (67.00%), (55%), (13%) and (16%), respectively with applying vermicompost (2.5 t ha^{-1}) and inorganic fertilizers (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}) than that of control. Both BARI Mung 5 and BARI Mung 6 performed the best two on most of the growth and developmental attributes. Finally, vermicompost (2.5 t ha^{-1}) and best dose of inorganic fertilizers (45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}) with BARI Mung 6 exhibited the superior combinations than that of control on most the limits studied.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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