PERFORMANCE OF DIFFERENT FERTILIZERS AND PLANT SPACING ON THE GROWTH OF MUNGBEAN

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ABSTRACT

The experiment was carried out to investigate the effect of nutrient combinations and spacing on the growth performance of mungbean (BARI mung 5) using split plot design. The experiment comprised of 3 levels of spacing; S_1- 20 cm × 10 cm, S_2- 30 cm × 10 cm and S_3- 45 cm × 15 cm; and 6 levels of fertilizers; F_0- Control (without fertilizer), F_1- Recommended dose of NPK, F_2- 5 t ha^{-1} cowdung, F_3- 5 t ha^{-1} cowdung + Recommended dose of NPK, F_4- 2.5 t ha^{-1} cowdung + Recommended dose of NPK and F_5- 2.5 t ha^{-1}cowdung + ½ Recommended dose of NPK. Among different treatments maximum number of leaves (13.70), branches (2.44) and dry weight (10.97g) was recorded from S3 at 60 DAS on the other hand highest number of leaves (13.83) found in F4 and dry matter (8.89g) in F3 at 60 DAS. However, when combined with fertilizers and spacings, the S3F4 treatment had the highest dry matter weight (12.7g) before harvest. In terms of yield performance, applying cowdung @ 2.5 t ha^{-1} along with recommended NPK resulted in the highest seed yield (1156.7 kg ha^{-1}). The number of plant populations was higher in S2 (30 cm 10 cm) than in S_3 (45 cm × 15 cm), so S_2 produced the highest grain yield (1022.8 kg ha^{-1}). It is clear that different fertilizer combinations and spacings have a significant impact on mungbean growth performance. S_2F_4 combinations may be the best choice for improved mungbean cultivation.

Keywords: *Vigna radiate L.*, Plant spacing, Organic fertilizers, Seed yield, Total dry matter.

INTRODUCTION

Mungbean (*Vigna radiata* L.) is a popular and widely grown pulse crop in the world along with Bangladesh. Mungbean plays a significant role to supplement protein in

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the cereal-based low-protein diet of the people of Bangladesh, but the acreage production of mungbean is gradually declining (BBS, 2019). Mungbean is cultivated with lowest tillage, local varieties with no or minimum fertilizers, pesticides and very early or very late sowing, no practicing of irrigation and drainage facilities etc. with other different stress condition.

Integrated use of nutrient may be one of the solutions to increase munghean yield as well as reducing cost of production and make the best use of locally available resources like animal dung, urine, crop residues etc. The combination of chemical fertilizer with organic matter increases the productivity like different agronomic crops (Ebbisa andAmdemariam, 2021; Tadewos et al., 2022; Zheng et al., 2023). Without negative effect on crop and quality (Bilal et al., 2021); and soil fertility status improves by the application of integrated nutrients than the application of organic or chemical fertilizers individually.

Organic fertilizer enhances soil biological activity and the colonization of mycorrhizae. That enhances mutuality association between fungi and higher plants. Organic fertilizer increases root growth due to enhanced soil structure, promoting soil aggregates, enhances cation exchange capacity Organic fertilizer acts as a buffering agent against undesirable soil pH fluctuations (Tian et al., 2022; Choudhary et al., 2022).

A good quality 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 (BARC 2015; Afrad et al., 2021). Organic farming relies on large scale use of animal or farm yard manure (FYM), compost, crop residues, green manuring, vermicompost, bio-fertilizers and bio-pesticides. But it may not be possible to obtain desired production from sole use of organic fertilizers. Equilibrium use of fertilizer is important to obtain maximum seed yield.

Being leguminous in nature, mungbean needs little nitrogen but needs optimum doses of other major nutrients as recommended. Phosphorous (P) is a vital yield determining nutrient in legumes (Chaudhary et al., 2008; Bilal et al., 2021). It is a vital component of key molecules such as nucleic acids, phospholipids and ATP, and consequently, plants cannot grow without a dependable supply of this nutrient. Phosphorus is also essential for the seed formation (Brady and Weil, 1999). Potassium (K) is the third macronutrient essential for plant growth, after nitrogen (N) and phosphorus (P). Unlike N and P; K is not an element of cell structure. Instead, it exists in mobile ionic form, and acts primarily as a catalyst (Akter et al., 2019; Demeke et al., 2020).

Seed yield is determined by genetic potential, planting density (*Mansoor* et al., *2010*) and fertilizer executive (Hussain et al., 2014; Sefera et al., 2021). However, plants require adequate space to grow in residents. In accordance with planting density, proper plant spacing management has an important role in maximizing yield (Ahamed et al., 2011). High planting density increases struggle between the plants and reduces occupation of plant to get light, water and nutrient (Sefera et al., 2021; Dikr, 2022). Therefore, optimum plant population ensures normal plant growth due to efficient utilization of moisture, light, space and nutrients, thus increases the yield of crop (Dikr, 2022).

In Bangladesh, limited studies have been conducted on plant population and organic, inorganic fertilizer performance separately but no report has been found on the combined response of these factors on mungbean. Considering the above facts, the study has been undertaken to find out the influence of plant population along with organic and inorganic fertilizer on growth performance of mungbean.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field at Sher-e-Bangla Agricultural University, Dhaka during the period from March to May2022. The variety of mungbean used for the study conducted was BARI mung5. The experiment comprised of three levels of plant spacing: viz. S_1= 20 cm ×10 cm, S_2= 30 cm ×10 cm and S_3= 45cm ×15cm, and six levels of fertilizers: F_0= Control (without fertilizer), F_1=Recommended dose of NPK, F_2= 5tha^{-1} cowdung, F_3=5 tha^{-1} cowdung with recommended dose of NPK, F_4= 2.5 tha^{-1} cowdung with recommended dose of NPK and F_5= 2.5 tha^{-1}cowdung with half recommended dose of NPK. The experiment was laid out in split-plot design having three replications. Spacing level placed in the main plot whereas fertilizer in the sub plots. All the fertilizers and cowdung were to as per treatment by broadcasting and were mixed with soil thoroughly at the time of final land preparation after making plot. Different intercultural operations (thinning, weeding, irrigation, drainage and plant protection measures etc.) were taken at different days after sowing. The insecticide Sumithion 57 EC was sprayed @ 0.02% at the period of pod formation to control pod borer. No disease was observed in the experimental field. The plant height (cm), number of leaves per plant, number of branches per plant and weight of oven dried per plant (g) was measured from the five randomly samples with the help of scale at 15, 30, 45 DAS and at harvest. The average of five samples was computed and expressed as their units.

Statistical Analysis

Data recorded for different parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done following computer package

IRRI stat 10. Mean differences among the treatments were tested with Least Significant Differences (LSD) at 5% level.

RESULTS AND DISCUSSION

Plant height

From this experiment, result revealed that there was significant effect of spacing on plant height and fertilizer combinations (Fig.1A and 1B). At 30, 45 and 60 DAS maximum plant height (26.18, 43.50 and 47.01 cm) was observed from S_2 treatment whereas lowest plant height (25.45, 41.5 and 45.51 cm) was observed from the treatment of S_3.

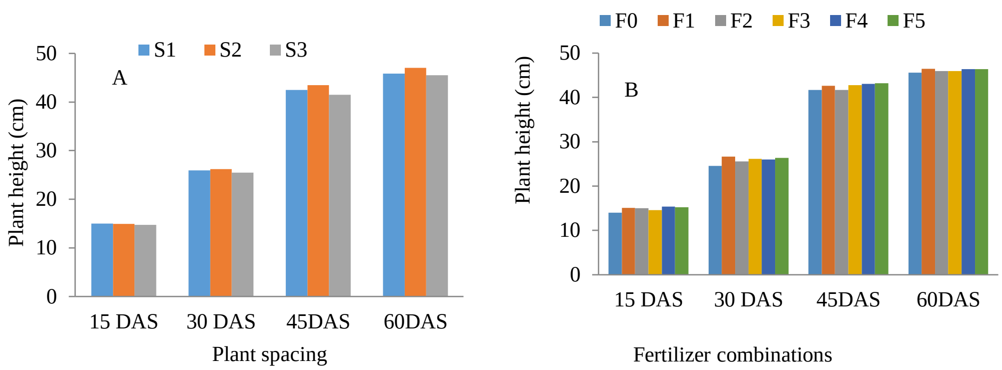

Figure1. Effect of spacing and fertilizer mixtures on plant height of mungbean at different days after sowing.

In case of fertilizer management, the result revealed that F_4 (15.40 cm at 15 DAS), F_1 (26.62 cm at 30 DAS), F_3 (42.77 cm at 45 DAS) and F_1(46.48 cm at 60 DAS) gave the highest plant height whereas lowest plant height (14.01, 24.52, 41.70 and 45.61 cm at 15, 30 45 and 60 DAS respectively) was observed from the treatment of F_0. And interaction effect of spacing and fertilizers showed significant variation on plant height at different days after sowing (Table 1). Result exhibit that highest plant height was found inS_1F_5 (15.73 cm) at 15 DAS, S_2F_1 (27.8 cm) at 30 DAS, S_2F_5 (27.35 and 26.76 cm) at 45 DAS and 60 DAS. Whereas the lowest plant height was observed in S_3F_2 (40.37 and 44.53 cm) at 45 and 60 DAS. Plant height might be varied in different crops due to plant spacing; similar findings were also reported by Sefera et al. (2021) in mungbean. On the other hand, combination of organic and inorganic fertilizers was created better plant height in groundnut (Mohanty et al., 2022; El-sherbeny et al., 2023) and in green gram (Rajendar et al., 2021) than only inorganic fertilizers application.

Table 1. Interaction effect of spacing and combination of fertilizers on plant height of mungbean at different days after sowing

Treatment Combinations	Plant height (cm)			
	15 DAS	30 DAS	45DAS	60DAS
S_1F_0	14.03i	24.59fg	40.91ef	45.13gh
S_1F_1	14.57gh	25.31d-f	42.95b-d	45.97d-f
S_1F_2	15.35b-d	26.05c-e	41.74c-f	45.79d-g
S_1F_3	14.7gh	26.29b-d	42.95b-d	46.07de
S_1F_4	15.6a-c	26.14c-e	43.45a-c	46.39cd
S_1F_5	15.73a	27.35ab	43.01b-d	45.84d-g
S_2F_0	14.8fg	25.13ef	42.06c-f	45.34e-h
S_2F_1	15.1d-f	27.8a	43.11b-d	47.09bc
S_2F_2	14.7gh	26.63bc	43.01b-d	47.51ab
S_2F_3	14.43h	25.98c-e	43.55a-c	46.49cd
S_2F_4	15.23c-e	25.89c-e	44.21ab	47.51ab
S_2F_5	15.17de	25.65c-f	45.07a	48.15a
S_3F_0	13.2j	23.86g	42.13c-e	46.35cd
S_3F_1	15.67ab	26.76a-c	41.75c-f	46.39cd
S_3F_2	14.93e-g	23.99g	40.37f	44.53h
S_3F_3	14.6gh	26.17c-e	41.81c-f	45.39e-g
S_3F_4	15.37a-d	25.89c-e	41.47d-f	45.19f-h
S_3F_5	14.73f-h	26.05c-e	41.48d-f	45.23e-h
$LSD_{(0.05)}$	0.36	1.11	1.67	0.82
CV (%)	1.46	2.58	2.35	1.06

Number of leaves

Different plant spacing showed significant effect on number of leaves plant^{-1} (Fig. 2A and 2B). From the experiment result exhibited that the maximum number of leaves plant^{-1} S_2 (4.38) at 15DAS, S_1 (8.09) at 30 DAS andS_2 (11.68 and 13.70) at 45 and 60 DAS. Whereas minimum number of leaves plant^{-1}S_1 (4.22) at 15DAS, S_3 (7.84) and (10.62 and 13.09) at 45 and 60 DAS respectively. And the maximum number of leaves plant^{-1} F_4 (4.38), F_1(8.07), F_4 (11.79) and F_4 (13.82) at 15, 30, 45 and 60 DAS respectively. Whereas F_0 (4.18), F_2 (7.87) and F_0(10.93 and 13.18) 15, 30, 45 and 60 DAS, respectively (Table 2).

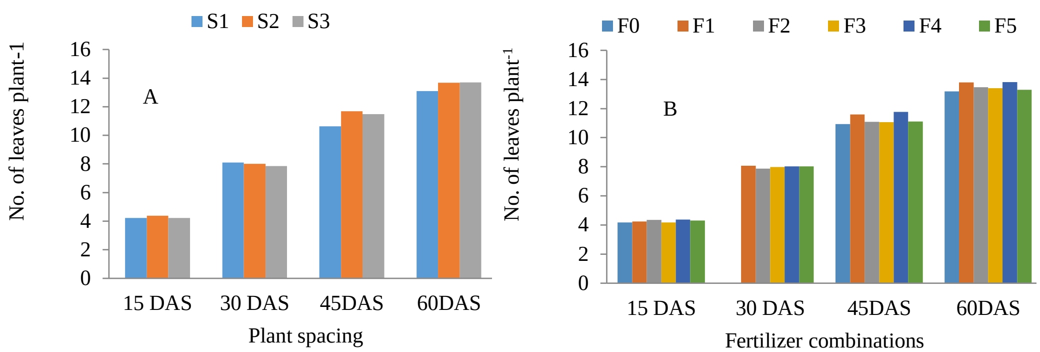

Figure 2. Effect of spacing on numberof leaves plant^{-1} of mungbean at different days after sowing [$LSD_{(0.05)}$ = 0.05,0.07, 0.20 and 0.29 at 15, 30, 45 and 60DAS]

Interaction effect of spacing and different nutrient management showed significant variation on number of leaves plant^{-1} at different days after sowing (Table 2). From the result showed that maximum number of leaves plant^{-1}S_2F_5 (4.67), S_1F_4 (8.47), and S_3F_1 (12.40 and 14.40) at 15, 30, 45 and 60 DAS whereas S_3F_5 (4.07), S_3F_2 (7.53) and S_1F_0 (9.67 and 12.4) gave the minimum number of leaves plant^{-1} (Table2). This result was coincided with the result of the inter-row spacing also affected the leaves of mungbean which might be because of variable availability of light, nutrients, etc. in case of varying spacing (Rasul et al., 2012). Several researchers reported that the leaf area plant^{-1} of mungbean was significantly increased by the application of different doses of inorganic fertilizer (Mondal et al., 2014; Zheng et al., 2023).

Table 2. Interaction effect of spacing and combination of fertilizers on number of leaves plnat^{-1} of mungbean at different days after sowing.

Treatment	Number of leaves			
Combinations	15 DAS	30 DAS	45DAS	60DAS
S_1F_0	4.2de	8cd	9.67h	12.4i
S_1F_1	4.13ef	8cd	10.93ef	13.3e-g
S_1F_2	4.2de	8.13bc	10.2g	12.8hi
S_1F_3	4.13ef	7.93de	11.13c-e	13.2f-h
S_1F_4	4.47b	8.47a	11.13c-e	13.67c-e
S_1F_5	4.2de	8cd	10.67f	13.2fh
S_2F_0	4.2de	8.13bc	12.27a	14.07a-c
S_2F_1	4.47b	8.13bc	11.47c	13.67c-f
S_2F_2	4.33c	7.93de	12.07ab	14.33ab

Treatment	Number of leaves			
Combinations	15 DAS	30 DAS	45DAS	60DAS
S_2F_3	4.27cd	8.2b	11.33c-d	13.67c-f
S_2F_4	4.33c	7.53f	12.13ab	13.53d-g
S_2F_5	4.67a	8.07bd	10.8ef	12.8hi
S_3F_0	4.13ef	7.6f	10.87ef	13.07gh
S_3F_1	4.13ef	8.07bd	12.4a	14.4a
S_3F_2	4.53b	7.53f	11d-f	13.27e-h
S_3F_3	4.13ef	7.8e	10.73f	13.33e-g
S_3F_4	4.33c	8.07bd	12.07ab	14.27ab
S_3F_5	4.07	8cd	11.87b	13.87b-d
$LSD_{(0.05)}$	0.09	0.15	0.34	0.42
CV (%)	1.23	1.11	1.79	1.85

Number of branches

Different plant spacing showed significant effect on number of branches plant^{-1} (Fig. 3A and 3B). From the experiment result exhibited that the maximum number of branchesplant^{-1} (0.05, 2.06 and 2.44 at 30DAS, 45DAS and 60DAS) was observed from S_3treatment. Whereas minimum number of branches plant^{-1} was observed in S_2 (0.03) and S_1 (0.73 and 1.27) at 30, 45 and 60DAS. On the other hand, the maximum number of branches plant^{-1} was observed from the treatment of F_0 (0.13), F_5 (1.76) and F_5 (1.76) at 30, 45 and 60 DAS whereas the minimum number of branches plant^{-1} F_2 (0.00 at 30DAS), F_3 (1.16 at 45 DAS and 1.64 at 60DAS) treatments (Fig.3B).

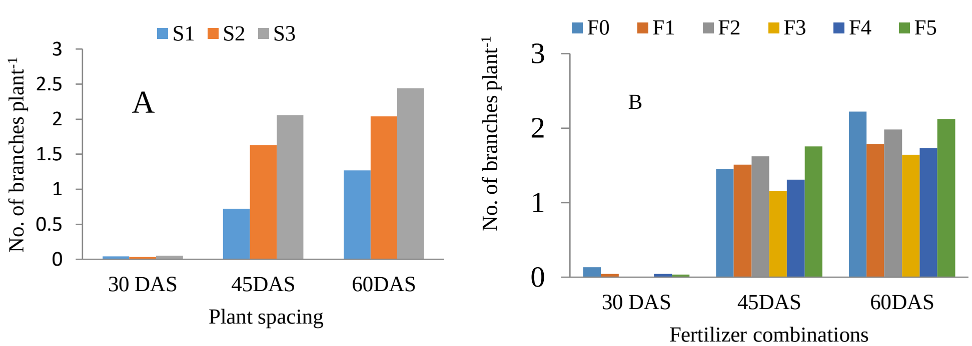

Figure 3. Effect of spacing and fertilizer combinations on number of branches plant^{-1} of mungbean at different days after sowing.

It was also showed that maximum number of branches plant^{-1} at 30, 45 and 60 DAS was recorded in S_1F_0 (0.20), S_3F_0 (2.27) and S_3F_5 (2.70) whereas minimum number of branches plant^{-1} S_3F_3 (0.00), S_1F_1 (0.33 and 0.87) treatment combinations respectively (Table 3).Similar results corroborated that the plant spacing increases the number of branches plant^{-1} (Taufiq and Kristiono 2016; Sefera et al., 2021).On the other hand, the application of different fertilizer doses the number of branches have been changed (Achakzai et al., 2012; Mohanty et al., 2022).

Table 3. Interaction effect of spacing and combination of fertilizers on number of branches plant^{-1} of mungbean at different days after sowing

Treatment	Number of branches/plant		
Combinations	30 DAS	45DAS	60DAS
S_1F_0	0.2a	0.47i	1.67hi
S_1F_1	0.07d	0.33j	0.87k
S_1F_2	0e	1.33fg	1.75hi
S_1F_3	0e	0.53i	1k
S_1F_4	0e	0.6i	1k
S_1F_5	0e	1.07h	1.33j
S_2F_0	0.07d	1.63d	2.47b-d
S_2F_1	0.07d	2c	2.1e
S_2F_2	0e	1.47ef	1.8gh
S_2F_3	0e	1.4efg	1.93fg
S_2F_4	0.07d	1.27g	1.6i
S_2F_5	0e	2c	2.33d
S_3F_0	0.13b	2.27a	2.53bc
S_3F_1	0e	2.2ab	2.4cd
S_3F_2	0e	2.07bc	2.4cd
S_3F_3	0e	1.53de	2ef
S_3F_4	0.07d	2.07bc	2.6ab
S_3F_5	0.1c	2.2ab	2.7a
$LSD_{(0.05)}$	.0005558	0.14	0.14
CV (%)	7.83	5.56	4.44

Dry matter weight

From the experiment result exhibited the maximum dry matter weight plant^{-1} at 15 DAS, 30 DAS, 45 DAS and 60 DAS in S_3(1.84, 4.70, 8.78 and 10.97 g)and minimum was recorded in S_1 (0.92, 3.08, 6.85 and 8.49 g) treatment (Fig. 4A).In case of fertilizer application maximum dry matter weight plant^{-1} was observed in F_5 (1.55 and 4.06 g at 15 DAS and 30 DAS),F_4 (8.19 g at 45 DAS) and F_3 (9.89 g at 60DAS) treatment whereas minimum dry matter weight plant^{-1} was recorded inF_1 (1.37 g and 3.62 g at 15 and 30 DAS), F_2 (7.33 g at 45 DAS) and F4(9.62 g at 60 DAS) treatment (Fig. 4B).

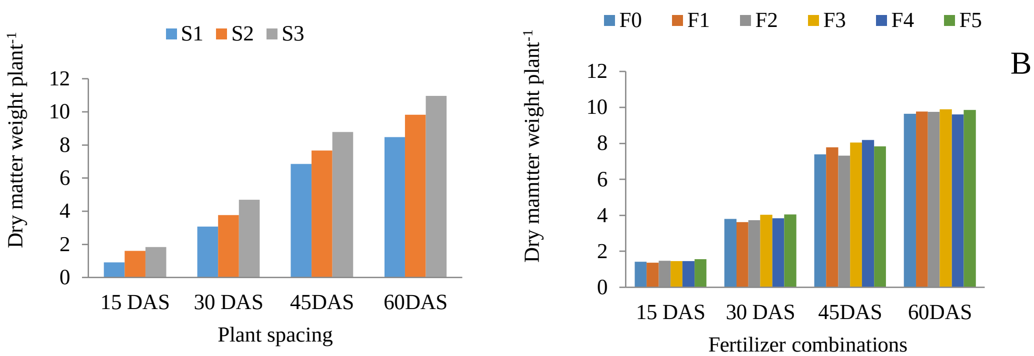

Figure 4. Effect of spacing and fertilizer combinations on dry matter weight plant^{-1} of mungbean at different days after sowing

Note: S_1: 20 × 10 cm^2, S_2: 30 cm × 10 cm, S_3: 45 × 15 cm^2, F_0 = Control, F_1 = Recommended NPK, F_2 = 5 t ha^{-1} cowdung, F3 = 5 t ha^{-1} cowdung + Recommended NPK, F_4= 2.5 t ha^{-1} cowdung + Recommended NPK, F_5= 2.5 t ha^{-1} cowdung + 1/2 Recommended NPK

Among different treatment combinations the maximum dry matter weight plant^{-1} was recorded inS_3F_3 (2.06 g) at 15 DAS and S_3F_4 (5.12, 10.67 and 12.70 g) at30 DAS, 45 DAS and 60 DAS and minimum was found in S_1F_2 (0.81 g) at 15 DAS, S_1F_4 (2.86 g) at 30DAS and S_1F_0 (5.82 and 7.38) at 45 and 60DAS (Table 4). The result of the investigation finally revealed that the maximum grain yield (1156.7 kg ha^{-1}) was observed from S_2F_4 treatment combination whereas minimum grain yield (693.3 kg ha^{-1}) was observed from S_3F_0 treatment combination (Table 4).

Table 4. Interaction effect of spacing and combination of fertilizers on dry matter weight plnat^{-1} of mungbean at different days after sowing

Treatment combinations	Dry matter weightplant^{-1} (g)				Seed Yield (kg ha^{-1})
	15 DAS	30 DAS	45DAS	60DAS	
S_1F_0	0.94h	2.91j	5.82k	7.38l	770k
S_1F_1	0.9h	2.97ij	6.22jk	7.82k	850h-j
S_1F_2	0.81i	3.13i	7.48gh	9.85f	896.7f-h
S_1F_3	0.83i	3.48h	7.32gh	8.77ij	950de
S_1F_4	0.91h	2.86j	6.5j	7.61kl	1046.7bc
S_1F_5	1.15g	3.12i	7.75fg	9.49g	910e-g
S_2F_0	1.69d	4.1de	8.35de	10.43e	853.3h-j
S_2F_1	1.63de	3.66gh	7.43gh	9.83f	996.7cd
S_2F_2	1.69d	3.49h	7.37gh	10.38e	1050b
S_2F_3	1.47f	3.83fg	8.75cd	10.43e	1050b
S_2F_4	1.63de	3.52h	7.42gh	8.54j	1156.7a
S_2F_5	1.49f	3.96ef	6.63ij	9.29gh	1030bc
S_3F_0	1.64de	4.42c	8ef	11.11c	693.3l
S_3F_1	1.58e	4.24d	9.68b	11.69b	803.3jk
S_3F_2	1.92b	4.55c	7.13hi	9.04hi	843.3ij
S_3F_3	2.06a	4.79b	8.07ef	10.48e	893.3f-h
S_3F_4	1.81c	5.12a	10.67a	12.7a	913.3ef
S_3F_5	2.02a	5.09a	9.12c	10.79d	860g-i
$LSD_{(0.05)}$	0.06	0.17	0.48	0.24	47.98
CV (%)	2.67	2.71	3.69	1.47	3.13

Note: S_1: 20 × 10 cm^2, S_2: 30 cm × 10 cm, S_3: 45 × 15 cm^2, F_0 = Control, F_1 = Recommended NPK, F_2 = 5 t ha^{-1} cowdung, F3 = 5 t ha^{-1} cowdung + Recommended NPK, F_4= 2.5 t ha^{-1} cowdung + Recommended NPK, F_5= 2.5 t ha^{-1} cowdung + 1/2 Recommended NPK

Due to less number of plants per unit area in lower population levels, there was less intra plant competition for nutrient, moisture, light and other resources, so they got chance to grow strongly and accumulate more dry matter. The findings of this experiment observed that application of different nutrients combinations had significant effect on the dry matter production of plant (Rana et al.2011; El-sherbeny, et al., 2023). The result found that the crop sown at inter-row spacing of 30 cm gave maximum seed yield while lowest seed yield was obtained at inter-row spacing more than 30cm (Ali et al., 2010; Rasul et al., 2012; Dikr 2022).

CONCLUSION

By observing the result of the experiment, it is found that the different plant spacing and fertilizer combinations significantly influenced the different growth parameters of mungbean. Wider spacing (45cm × 15 cm) with high organic and inorganic combination of fertilizer gave the high vegetative growth like number of branches and dry matter weight of plant. But the plant spacing at30cm × 10 cm (S_2) along with the application of 2.5 t ha^{-1} cowdung with recommended dose of NPK (F_4) increased the overall productivity of mungbean.

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