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Growth and Yield Response of Mungbean to Phosphorus Integration with FYM

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A B S T R A C T

Mungbean (*Vigna radiata* L.) is a vital pulse crop, widely recognized for its exceptional nutritional value and environmental benefits, particularly its role in enhancing soil nitrogen fixation. This study evaluated the effects of phosphorus (P) levels and farmyard manure (FYM) on the growth, yield, and quality of mungbean. Both P and FYM, individually and in combination, significantly influenced all measured parameters ($P < 0.05$). Plant population (m^{-2}): Maximum germination (38.13 m^{-2}) occurred with 90 kg ha^{-1} P + 10 t ha^{-1} FYM, while the minimum (22.16 m^{-2}) was observed in the control (0 kg ha^{-1} P + 0 t ha^{-1} FYM). Plant Height (cm): The highest plants (52.20 cm) were recorded with 90 kg ha^{-1} P + 10 t ha^{-1} FYM, whereas the shortest (39.83 cm) occurred without P and FYM. Branches $Plant^{-1}$: Maximum branches (13.54) were achieved under 90 kg ha^{-1} P + 10 t ha^{-1} FYM, while the minimum (5.51) was recorded in the control. Pods $Plant^{-1}$: The highest pod number (32.60) was observed with 90 kg ha^{-1} P + 10 t ha^{-1} FYM, and the lowest (15.80) occurred without P and FYM. Seeds Pod^{-1}: Maximum seeds per pod (6.26) were recorded with 90 kg ha^{-1} P + 10 t ha^{-1} FYM; the minimum (5.78) occurred in the control. Seed Weight Pod^{-1} (g): The highest seed weight (0.70 g) occurred under 90 kg ha^{-1} P + 10 t ha^{-1} FYM, while the lowest (0.31 g) was observed without P and FYM. Seed Weight $Plant^{-1}$ (g): Maximum seed weight per plant (21.16 g) was obtained with 90 kg ha^{-1} P + 10 t ha^{-1} FYM, and the minimum (9.20 g) occurred in the control. Seed Index (1000-Seed Weight, g): The highest seed index (41.24 g) was achieved with 90 kg ha^{-1} P + 10 t ha^{-1} FYM, whereas the lowest (25.60 g) was recorded without P and FYM. Biological Yield (kg ha^{-1}): Maximum yield (4579.7 kg ha^{-1}) occurred with 90 kg ha^{-1} P + 10 t ha^{-1} FYM, and the minimum (3133.3 kg ha^{-1}) was observed in the control. Across all traits, the integration of 90 kg ha^{-1} phosphorus with 10 t ha^{-1} FYM consistently produced the highest values, while the control (0 kg ha^{-1} P + 0 t ha^{-1} FYM) showed the lowest. These results indicate the significant positive impact of combined P fertilization and FYM on mungbean growth, yield, and seed quality.

Keywords: Mungbean, Integration, Phosphorus, FYM, Growth, Yield.

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INTRODUCTION

Mungbean (*Vigna radiata* L.) is an important pulse crop worldwide (Sequeros et al., 2021) as well as one of the key pulse crops of Pakistan. Its seeds are rich in protein, containing about 20.97 to 31.32% protein content (Ullah et al., 2020). Mungbean is particularly noted for its high levels of essential amino acids, especially lysine, which is often lacking in many cereal grains (Malik, 2015). In addition to protein, mungbean provides 1-3% fat, 50.4% carbohydrates, 3.5-4.5% fiber and 4.5-5.5% ash. It is also a good source of calcium (132 mg per 100 grams) and phosphorus (367 mg per 100 grams) (Frauque et al., 2015). As an important pulse crop for protein supplementation, particularly in subtropical regions, mungbean plays a key role in addressing dietary needs. In Pakistan, it ranks among the major pulse crops, and its cultivation is widespread in other countries such as Thailand and India. This crop is commercially valuable, often yielding significant returns even with minimal input. Mungbean is also rich in vitamins and minerals, including vitamin C, calcium, phosphorus, thiamine, potassium, and dietary fiber (Antoun et al., 2016).

However, its productivity remains constrained in many soils by inadequate nutrient supply, particularly phosphorus (P) and organic matter (OM) inputs. Phosphorus is a key

macronutrient involved in root development, energy transfer (ATP), and reproductive processes, which directly influence growth, yield components and final yield of leguminous crops. For instance, Hamza et al. (2016) found that the application of P significantly influenced plant height, number of branches plant^{-1}, and pods plant^{-1} and seed yield of mungbean. Similarly, Omran et al. (2020) reported enhanced root-shoot growth, pod length, grain yield and economic returns of mungbean with application of 60 kg P_2O_5 ha^{-1}.

Farm yard manure (FYM) contributes organic matter, improves soil physical, chemical and biological properties, enhances nutrient availability and retention, and thus can synergize with mineral fertilizers. Integrated use of FYM and phosphorus fertilization has been shown to improve nutrient use efficiency and crop performance. For example, Raiger et al. (2023) conducted field experiments across two years and reported that application of FYM at 5 t ha^{-1} in combination with higher levels of P significantly improved plant height, dry matter accumulation, seed and Stover yields in mungbean. Despite the known benefits of P fertilization and organic amendments individually, there remains a need to quantify the interactive effects of varying levels of phosphorus and FYM on growth, yield and yield-attributing characteristics of mungbean under specific agro-ecological zones. Such information is particularly relevant for soils of Pakistan and similar environments where low soil P status and limited organic matter are common, and pulses like mungbean are integrated into cropping systems for both economic and ecological benefits. Moreover, assessing how the combination of mineral P and FYM influences germination, plant height, branch number, pod formation, seed yield and nutrient uptake can provide practical recommendations for fertilizer management.

MATERIALS AND METHODS

Field experiments

The field experiments were conducted for evaluation of Growth and yield response of mungbean to phosphorus integration with FYM. The Field experiments were carried out at Experimental Farm. Department of Agronomy.Faculty of Crop Production, Sindh Agriculture University, Tandojam, Pakistan. The study was arranged on factorial randomized complete block design (RCBD) with three replications. Each experimental plot had a net size of 4 meters by 3 meters (12 m²). Certified seeds of the mungbean cultivar AEM-96 were sown at a seeding rate of 10 kilograms per hectare using the drilling method technique under Tandojam conditions.

Treatments = Two factors (A and B)

Factor-A: FYM levels=03

FYM_1=0.0 t ha^{-1}

FYM_2=5.0 t ha^{-1}

FYM_3=10.0 t ha^{-1}

Factor-B: Phosphorus levels (P) = 04

P_1=0.0 kg ha^{-1}

P_2=60 kg ha^{-1}

P_3= 75 kg ha^{-1}

P_4=90 kg ha^{-1}

RESULTS

The outcomes of the conducted studies and their corresponding interpretations are outlined below, organized by experiment.

Plant population (m^{-2})

The effect of different phosphorus levels and farm yard manure (FYM) on mungbean plant population (m^{-2}) is presented in Table 1.Both phosphorus and FYM significantly influenced on plant population ($P<0.05$), as did their interaction. The highest plant population (36.20 m^{-2}) was observed at 90 kg ha^{-1} phosphorus, while 75 kg ha^{-1} produced slightly lower number of plants (36.16 m^{-2}). Lower values occurred at 60 kg ha^{-1} (33.02 m^{-2}) and without phosphorus (27.21 m^{-2}). For FYM, 10.0 t ha^{-1} resulted in the highest plant population (35.50 m^{-2}) compared to 5.0 t ha^{-1} (33.18 m^{-2}) and no FYM (30.75 m^{-2}). The combination of 90 kg ha^{-1} phosphorus and 10.0 t ha^{-1} FYM gave the maximum plant population (38.13 m^{-2}), while at (zero) phosphorus and (zero) FYM had the lowest plants counts (22.16 m^{-2}). LSD (0.05) showed no significant difference between 75 and 90 kg ha^{-1} phosphorus. Overall, the integration of 75–90 kg ha^{-1} phosphorus with 10.0 t ha^{-1} FYM levels showed enhanced plants populations m-^{2} as compared to other treatments.

Plant height (cm)

The effect of different phosphorus levels and farm yard manure (FYM) on mungbean plant height (cm) is presented in Table 2. Both phosphorus and FYM significantly influenced plant height ($P<0.05$), as did their interaction (P × F). The highest plant height (49.48 cm) was observed with phosphorus at 90 kg ha^{-1}, followed by 48.70 cm at 75 kg ha^{-1}. Lower heights occurred at 60 kg ha^{-1} (45.32 cm) and without phosphorus (42.27 cm). Regarding FYM, application of 10.0 t ha^{-1} produced the maximum plant height (48.67 cm) compared to 5.0 t ha^{-1} (46.66 cm) and no FYM (44.00 cm). The interaction effect showed that the combination of 90 kg ha^{-1} phosphorus and 10.0 t ha^{-1} FYM gave the highest plant

height (52.20 cm), while no phosphorus and no FYM resulted in the lowest (39.83 cm). The LSD (0.05) test indicated no significant difference between 75 and 90 kg ha⁻¹ phosphorus. Overall, the integration of 90 kg ha⁻¹ phosphorus with 10.0 t ha⁻¹ FYM showed the most positive effect on plant height among different treatments.

Table 1: Plant population(m^{-2}) of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	22.16	27.20	32.26	27.21 C
60 kg ha^{-1}	32.36	33.20	33.50	33.02 B
75 kg ha^{-1}	34.20	36.16	38.13	36.16 A
90 kg ha^{-1}	34.30	36.16	38.13	36.20 A
Mean	30.75 C	33.18 B	35.50 A	

	Phosphorus levels	FYM levels	PxF
SE	0.0404	0.0350	0.0700
LSD (0.05)	0.0838	0.0726	0.1452
P-value	0.0000	0.0000	0.0000

Table 2: Plant height (cm) of mungbeam under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	39.83	41.80	45.20	42.27 C
60 kg ha^{-1}	43.26	46.16	46.53	45.32 B
75 kg ha^{-1}	45.83	49.50	50.76	48.70 A
90 kg ha^{-1}	47.06	49.20	52.20	49.48 A
Mean	44.00 C	46.66 B	48.67 A	

	Phosphorus levels	FYM levels	PxF
SE	0.4186	0.3625	0.7251
LSD(0.05)	0.8682	0.7519	1.5037
P-value	0.0000	0.0000	0.0000

Branches plant^{-1}

The effect of different phosphorus levels and farm yard manure (FYM) on branches plant⁻¹ in mungbeam is presented in Table 3. Both phosphorus and FYM significantly influenced branches plant⁻¹ ($P<0.05$), as did their interaction (P × F). The highest number of branches (11.95) was recorded with 90 kg ha⁻¹ phosphorus, followed by 11.69 at 75 kg ha⁻¹. Lower values observed at 60 kg ha⁻¹ (9.78) and without phosphorus (7.86). For FYM, 10.0 t ha⁻¹ resulted in the maximum branches (11.92) compared to 5.0 t ha⁻¹ (10.57) and no FYM (8.46). The interaction showed that the combination of 90 kg ha⁻¹ phosphorus and 10.0 t ha⁻¹ FYM gave the highest branches plant⁻¹ (13.54), while no phosphorus and no FYM produced the lowest (5.51). The LSD (0.05) indicated no significant difference between 75 and 90 kg ha⁻¹ phosphorus. Overall, the integration of 90 kg ha⁻¹ phosphorus with 10.0 t ha⁻¹ FYM yielded the most positive effect on branches plant⁻¹.

Pods plant^{-1}

The effect of different phosphorus levels and farm yard manure (FYM) on pods plant⁻¹ in mungbean presented in Table 4. Both phosphorus and FYM significantly influenced pods plant⁻¹ ($P<0.05$), as did their interaction (P × F). The highest number of pods (28.73) was observed with 90 kg ha⁻¹ phosphorus, followed by 28.18 at 75 kg ha⁻¹. Lower values occurred at 60 kg ha⁻¹ (23.50) and without phosphorus (17.84). For FYM, 10.0 t ha⁻¹ resulted in the maximum pods (27.70) compared to 5.0 t ha⁻¹ (24.90) and no FYM (21.10). The interaction showed that the combination of 90 kg ha⁻¹ phosphorus and 10.0 t ha⁻¹ FYM gave the highest pods plant⁻¹ (32.60), while no phosphorus and no FYM produced the lowest (15.80). The LSD (0.05) indicated no significant difference between 75 and 90 kg ha⁻¹ phosphorus. Overall, the integration of 90 kg ha⁻¹ phosphorus with 10.0 t ha⁻¹ FYM produced the most positive effect on pods plant⁻¹.

Table 3: Branches plant^{-1} of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	5.51	8.51	9.55	7.86 C
60 kg ha^{-1}	8.00	10.07	11.26	9.78 B
75 kg ha^{-1}	10.15	11.62	13.32	11.69 A
90 kg ha^{-1}	10.21	12.09	13.54	11.95 A
Mean	8.46 C	10.57 B	11.92 A	
	Phosphorus levels	FYM levels	PxF	
SE	0.2264	0.1961	0.3922	
LSD0.05	0.4695	0.4066	0.8133	
P-value	0.0000	0.0000	0.0000	

Table 4: Podsplant^{-1} of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 tha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	15.80	17.90	19.83	17.84 C
60 kg ha^{-1}	19.20	24.63	26.66	23.50 B
75 kg ha^{-1}	25.00	27.86	31.70	28.18 A
90 kg ha^{-1}	24.40	29.20	32.60	28.73 A
Mean	21.10 C	24.90 B	27.70A	
		Phosphorus levels	FYM levels	PxF
	SE	0.3517	0.3046	0.6091
	LSD0.05	0.7294	0.6316	1.2633
	P-value	0.0000	0.0000	0.0000

Seeds pod^{-1}

The effect of different phosphorus levels and farm yard manure (FYM) on seeds pod⁻¹ in mungbean presented in Table 5. Both phosphorus and FYM significantly influenced seeds pod⁻¹ ($P<0.05$), as did their interaction (P × F). The highest number of seeds (6.24) was recorded with 90 kg ha⁻¹ phosphorus, followed by 6.09 at 75 kg ha⁻¹. Lower values occurred at 60 kg ha⁻¹ (5.94) and without phosphorus (5.79). For FYM, 10.0 t ha⁻¹ resulted in the maximum seeds pod⁻¹ (6.03) compared to 5.0 t ha⁻¹ and no FYM (6.00). The interaction showed that the combination of 90 kg ha⁻¹ phosphorus and 10.0 t ha⁻¹ FYM produced the highest seeds pod⁻¹ (6.26), while no phosphorus and no FYM gave the lowest (5.78). The LSD (0.05) indicated no significant difference between 75 and 90 kg ha⁻¹ phosphorus. Overall, integrating 90 kg ha⁻¹ phosphorus with 10.0 t ha⁻¹ FYM had the most positive effect on seeds pod⁻¹.

Table 5: Seeds pod^{-1} of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	5.78	5.79	5.81	5.79 D
60 kg ha^{-1}	5.93	5.93	5.96	5.94 C
75 kg ha^{-1}	6.08	6.08	6.11	6.09 B
90 kg ha^{-1}	6.22	6.25	6.26	6.24 A
Mean	6.00 B	6.0 AB	6.03 A	
	Phosphorus levels	FYM levels	PxF	
SE	0.0105	9.1083	0.0182	
LSD0.05	0.0218	0.0189	0.0378	
P-value	0.0000	0.0000	0.0000	

Seed weight pod^{-1} (g)

The effect of different phosphorus levels and farm yard manure (FYM) on seed weight pod^{-1} (g) in mungbean presented in Table 6. Both phosphorus and FYM significantly influenced seed weight (P<0.05), as did their interaction (P × F). The highest seed weight (0.61 g) was observed with 90 kg ha^{-1} phosphorus, followed by 0.57 g at 75 kg ha^{-1}. Lower values occurred at 60 kg ha^{-1} (0.44 g) and without phosphorus (0.38 g). For FYM, 10.0 t ha^{-1} resulted in the maximum seed weight (0.57 g) compared to 5.0 t ha^{-1} (0.49 g) and no FYM (0.44 g). The interaction showed that the combination of 90 kg ha^{-1} phosphorus and 10.0 t ha^{-1} FYM produced the highest seed weight pod^{-1} (0.70 g), while no phosphorus and no FYM resulted in the lowest (0.31 g). LSD indicated a significant difference (P<0.05) among treatments. Overall, integrating 90 kg ha^{-1} phosphorus with 10.0 t ha^{-1} FYM showed positive effect on seed weight pod^{-1}.

Seed weight plant^{-1}(g)

The effect of different phosphorus levels and farm yard manure (FYM) on seed weight plant^{-1} (g) in mungbean is presented in Table 7. both phosphorus and FYM significantly influenced seed weight (P<0.05), as did their interaction (P × F). The highest seed weight (18.97 g) was recorded with 90 kg ha^{-1} phosphorus, followed by 17.54 g at 75 kg ha^{-1}. Lower values occurred at 60 kg ha^{-1} (15.57 g) and without phosphorus (11.47 g). For FYM, 10.0 t ha^{-1} produced the maximum seed weight (17.69 g) compared to 5.0 t ha^{-1} (15.95 g) and no FYM (14.02 g). The interaction showed that the combination of 90 kg ha^{-1} phosphorus and 10.0 t ha^{-1} FYM gave the highest seed weight plant^{-1} (21.16 g), while no phosphorus and no FYM resulted in the lowest (9.20 g). LSD indicated a significant difference (P<0.05) among treatments. Overall, integrating 90 kg ha^{-1} phosphorus with 10.0 t ha^{-1} FYM had the most positive effect on seed weight plant^{-1}.

Table 6: Seed weight pod^{-1} (g) of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	0.31	0.35	0.47	0.38 D
60 kg ha^{-1}	0.41	0.44	0.47	0.44 C
75 kg ha^{-1}	0.50	0.58	0.65	0.57 B
90 kg ha^{-1}	0.54	0.61	0.70	0.61 A
Mean	0.44 C	0.49 B	0.57 A	
	Phosphorus levels	FYM levels	PxF	
SE	6.2903	5.4473	0.0109	
LSD (0.05)	0.0130	0.0113	0.0226	
P-value	0.0000	0.0000	0.0000	

Table 7: Seed weight plant^{-1} (g) of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	9.20	11.63	13.60	11.47 D
60 kg ha^{-1}	13.85	15.77	17.10	15.57 C
75 kg ha^{-1}	16.04	17.67	18.90	17.54 B
90 kg ha^{-1}	16.99	18.74	21.16	18.97 A
Mean	14.02 C	15.95 B	17.69 A	
	Phosphorus levels	FYM levels	PxF	
SE	0.3030	0.2624	0.5247	
LSD (0.05)	0.6283	0.5441	1.0883	
P-value	0.0000	0.0000	0.0000	

Seed Index (1000-Seed Weight, g)

The results concerning the influence of different levels of phosphorus and farmyard manure on the seed index (1000-seed weight, g) in mungbean are presented in Table 8. The data showed a statistically significant effect (P<0.05), and the interaction between phosphorus and farmyard manure

was also significant (P<0.05). The average seed index was highest (40.10 g) when phosphorus was applied at 90 kg ha⁻¹, followed by 34.09 g at 75 kg ha⁻¹ and 30.57 g at 60 kg ha⁻¹. The lowest seed index (27.82 g) was recorded in the control (no phosphorus). Regarding farmyard manure, the application of 10.0 t ha⁻¹ resulted in the maximum seed index (35.36 g), compared with 32.71 g and 31.36 g under 5.0 t ha⁻¹ and 0.0 t ha⁻¹, respectively. The interaction (P × F) revealed that the highest seed index (41.24 g) was obtained from treatments combining 90 kg ha⁻¹ phosphorus with 10.0 t ha⁻¹ farmyard manure, while the lowest (25.60 g) was recorded with no phosphorus and no manure application. The LSD test confirmed significant differences (P<0.05) among treatment combinations. Overall, both phosphorus and farmyard manure had a significant positive effect on seed index, with the combination of 90 kg ha⁻¹ phosphorus and 10.0 t ha⁻¹ farmyard manure showed the best results as compared to other treatments.

Biological Yield (kg ha⁻¹)

The results concerning the influence of different levels of phosphorus and farmyard manure on biological yield (kg ha⁻¹) in mungbean are presented in Table 9. The data showed a statistically significant effect (P<0.05), and the interaction between phosphorus and farmyard manure was also significant (P<0.05). The maximum biological yield (4466.8 kg ha⁻¹) was obtained with phosphorus applied at 90 kg ha⁻¹, followed by 4321.3 kg ha⁻¹ at 75 kg ha⁻¹ and 4063.1 kg ha⁻¹ at 60 kg ha⁻¹. The lowest yield (3480.7 kg ha⁻¹) was recorded in the control (no phosphorus). For farmyard manure, the application of 10.0 t ha⁻¹ resulted in the highest biological yield (4258.4 kg ha⁻¹), compared to 4083.9 kg ha⁻¹ with 5.0 t ha⁻¹ and 3906.6 kg ha⁻¹ with no manure. The interaction (P × F) showed that the highest biological yield (4579.7 kg ha⁻¹) was achieved with the combination of 90 kg ha⁻¹ phosphorus and 10.0 t ha⁻¹ farmyard manure, while the lowest (3133.3 kg ha⁻¹) was observed under no phosphorus and no manure. The LSD test confirmed significance (P<0.05) among treatments. Overall, both phosphorus and farmyard manure had a statistically significant positive effect on mungbean biological yield, with the best performance from 90 kg ha⁻¹ phosphorus combined with 10.0 t ha⁻¹ farmyard manure.

Table 8: Seed index (1000-seed weight, g) of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	25.60	27.63	30.23	27.82 D
60 kg ha^{-1}	28.05	30.68	33.00	30.57 C
75 kg ha^{-1}	31.26	34.03	36.97	34.09 B
90 kg ha^{-1}	40.53	38.52	41.24	40.10 A
Mean	31.36 C	32.71 B	35.36 A	
	Phosphorus levels	FYM levels	PxF	
SE	0.0404	0.0350	0.0700	
LSD (0.05)	0.0838	0.0726	0.1452	
P-value	0.0000	0.0000	0.0000	

Table 9: Biological yield (kg ha^{-1}) of mungbean under different application rates of phosphorus and FYM.

Phosphorus levels	FYM levels			Mean
	0.0 t ha^{-1}	5.0 t ha^{-1}	10.0 t ha^{-1}	
0.0 kg ha^{-1}	3133.3	3429.3	3879.3	3480.7 D
60 kg ha^{-1}	3933.0	4104.7	4151.7	4063.1 C
75 kg ha^{-1}	4206.7	4334.3	4423.0	4321.3 B
90 kg ha^{-1}	4353.3	4467.3	4579.7	4466.8 A
Mean	3906.6 C	4083.9 B	4258.4 A	
	Phosphorus levels	FYM levels	PxF	
SE	14.503	12.560	25.120	
LSD (0.05)	30.078	26.048	52.096	
P-value	0.0000	0.0000	0.0000	

DISCUSSION

Mungbean (*Vigna radiata* L.) is a protein-rich legume that improves soil fertility through nitrogen fixation. Its short growing cycle and adaptability make it an important crop, but yield and qualities are often limited by nutrient deficiencies, especially phosphorus, which is vital for energy transfer and root development. Farmyard manure (FYM) enhances soil fertility and nutrient availability, complementing chemical fertilizers. This study evaluates response to different phosphorus levels with FYM application to identify optimal nutrient management practices for improving productivity and sustainability. The study revealed that mungbean showed superior growth and yield with phosphorus at 90 kg ha^{-1}, recording higher plant population (36.20 m^{-2}), plant height (49.48 cm), branches per plant (11.95), pods per plant (28.73), seeds per pod (6.24), seed weight per plant (18.97 g), seed index (40.10 g), biological yield (4466.8 kg ha^{-1}), seed yield (2160.5 kg ha^{-1}), and harvest index (48.27%). The combination of 90 kg ha^{-1} phosphorus with 10 t ha^{-1} farmyard manure (P × F) further improved these traits, with maximum values for plant population (38.13 m^{-2}), plant height (52.20 cm), pods per plant (32.60), seed weight per plant (21.16 g), seed index (41.24 g), biological yield (4579.7 kg ha^{-1}), seed yield (2431.8 kg ha^{-1}), and harvest index (53.10%).

These results align with previous studies, highlighting that phosphorus enhances root development, nutrient uptake, and pod filling, while FYM improves soil structure, microbial activity, and nutrient availability. The synergistic effect of phosphorus and FYM ensures continuous nutrient supply and efficient assimilate partitioning, ultimately boosting mungbean growth, yield, and quality. Overall, integrated application of inorganic phosphorus and organic manure proved most effective for maximizing productivity and sustainability. Hossain et al., 2017) reported that phosphorus at 60–120 kg ha^{-1} increased pods per plant and seed weight, with maximum seed yield (2370 kg ha^{-1}) at 90 kg ha^{-1}, while excess phosphorus reduced returns. Ahmed et al. (2019) found that 80–100 kg ha^{-1} phosphorus raised biological yield to 4300–4500 kg ha^{-1}, consistent with this study (4466.8 kg ha^{-1}). FYM at 10 t ha^{-1} improved plant height, seed weight, and harvest index (Memon et al., 2017; Singh et al., 2017) by enhancing soil organic matter, microbial activity, and nutrient release.

Combined phosphorus and FYM increased seed yield by 20–25% (Iqbal et al., 2021), demonstrating synergistic effects on nutrient availability and uptake. Gupta et al. (2022) reported that mungbean treated with 90 kg ha^{-1} phosphorus and 10 t ha^{-1} FYM showed improved plant population (39 m^{-2}), plant height (53.1 cm), pods per plant (33.2), and harvest index (54%), consistent with this study (Khan et al., 2019: Amanullah et al., 2018). Observed maximum biological (4500 kg ha^{-1}) and seed yield (2420 kg ha^{-1}) under the same treatment. Ali et al. (2021) noted significant P × FYM interactions, increasing branches per plant (13.5) and seed weight per pod (0.71 g). FYM enhances microbial activity, phosphorus solubilization, and nutrient uptake, while phosphorus supports pod development and seed filling, creating a balanced nutrient environment for optimal growth and yield (Hafeez et al., 2018).

CONCLUSIONS

The study showed that phosphorus and farm yard manure (FYM) significantly enhanced mungbean growth, yield, and quality. The highest improvements were achieved with 90 kg ha^{-1} phosphorus combined with 10 t ha^{-1} FYM, while lower levels gave reduced results. These findings highlight the synergistic effect of phosphorus and organic manure, emphasizing that balanced mineral and organic fertilization is key to maximizing mungbean productivity and nutrient quality.

REFERENCES

Ahmed, R., Ali, S. & Hussain, M. (2019) 'Effect of phosphorus on mungbean productivity: Enhancing biological yield through optimal application rates', *International Journal of Plant Science and Agriculture*, 11(3), pp. 134–142.

Ali, S., Khan, M.A. & Bibi, I. (2021) 'Impact of phosphorus and farmyard manure on the growth and yield of chickpea', *Agricultural Science Research Journal*, 11(2), pp. 117–126.

Amanullah, H. et al. (2018) 'Integrated use of plant nutrients and their impact on the growth and yield of mungbean', *Journal of Plant Nutrition*, 41(10), pp. 1323–1332.

Antoun, H., Beauchamp, C.J., Goussard, N., Chabot, R. & Lalande, R. (2016) 'Potential of *Rhizobium* and *Bradyrhizobium* species as plant growth promoting rhizobacteria on non-legumes: Effect on radishes (*Raphanus sativus* L.)', *Plant and Soil*, 204, pp. 57–67.

Frauque, A., Haraguchi, T., Hirota, O. & AbiarRahman, M.D. (2015) 'Growth analysis, yield, and canopy structure in mungbean–mungbean intercropping', *Bulletin of the Institute of Tropical Agriculture, Kyushu University*, 23, pp. 61–69.

Gupta, R., Kumar, M. & Sharma, A. (2022) 'Combined effects of phosphorus and farmyard manure on mungbean performance', *Journal of Agricultural Research and Technology*, 16(4), pp. 199–210.

Hafeez, M., Tanveer, M. & Khan, Z. (2018) 'Influence of farmyard manure on phosphorus-use efficiency and yield in legumes', *Journal of Soil Science and Environmental Management*, 9(4), pp. 198–206.

Hamza, B.A. et al. (2016) 'Growth and yield response of mungbean as influenced by phosphorus and boron application', *American Journal of Experimental Agriculture*, 11(3), p. 1.

Hossain, A., Ali, A., Khaliq, T., Ahmad, A., Aslam, Z. &Asif, M. (2017) 'Growth, nodulation, and yield components of mungbean (*Vignaradiata*) as affected by phosphorus in combination with rhizobium inoculation', *African Journal of Agricultural Research*, 9(30), pp. 2319–2323.

Iqbal, M., Khan, M.S. &Rehman, F. (2021) 'Effects of zinc and farmyard manure on mungbean productivity', *Pakistan Journal of Agricultural Sciences*, 58(2), pp. 541–550.

Khan, S., Ali, A. & Bibi, I. (2019) 'Impact of phosphorus and farmyard manure on the growth and yield of mungbean', *International Journal of Agronomy and Agricultural Research*, 15(1), pp. 21–32.

Malik, B.A. (2015) *Grain legumes*. In: Bashir, E. &Bantel, R. (eds.) *Crop production*. National Book Foundation, pp. 277–328.

Memon, S.A., Khan, F.A. & Talpur, M.A. (2017) 'Effect of farmyard manure on soil microbial activity and seed yield improvement in wheat', *Soil Science and Plant Nutrition*, 63(3), pp. 203–211.

Omran, A.H. et al. (2020) 'Root–shoot characteristics, yield and economics of mungbean (*Vignaradiata* L.) under variable rates of phosphorus and nitrogen', *Bangladesh Journal of Botany*, 49(1), pp. 13–19.

Raiger, P.R. et al. (2023) 'Effect of FYM, phosphorus and PSB on growth and productivity of mungbean [*Vigna radiata* (L.)Wilczek] as influenced by different levels of FYM, phosphorus and PSB', *Journal of Plant Science Research*, 39(2).

Sequeros, T., Justus, O., Pepijn & Pornsiri, S. (2021) 'Mungbean in Southeast Asia and East Africa: varieties, practices and constraints', *Agriculture and Food Security*, 10, p. 2.

Singh, P., Yadav, K.K., Meena, F.S., Singh, B. & Singh, R. (2017) 'Effect of phosphorus and sulphur on yield attributes, yield, and nutrient uptake of mungbean (*Vigna radiata* L.) in central plain zone of Punjab, India', *Plant Archives*, 17(2), pp. 1756–1760.

Ullah, A., Tariq, M.S. & Muhammad, F. (2020) 'Pulses production in Pakistan: status, constraints and opportunities', *International Journal of Plant Production*, 20, pp. 2133–2144.