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Response of planting geometry and phosphorus doses on growth and yield of mung bean (*Vigna radiata* L.) in Eastern Uttar Pradesh

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Abstract

A field experiment was conducted during Zaid season 2023-24 at Agriculture Research Farm of Shri Durga Ji Post Graduate College, Chandeshwar, Azamgarh (U.P.) to evaluate the effect of planting geometry and phosphorus levels on growth and yield of mung bean (*Vigna radiata* L.). The experiment was laid out in Randomized Block Design with twelve treatment combinations comprising three planting geometries (30×10 cm, 30×15 cm and 30×20 cm) and four phosphorus levels (0, 20, 40 and 60 kg ha⁻¹) replicated three times. Growth parameters such as plant height, number of branches plant⁻¹, dry matter accumulation and leaf area index were recorded along with yield attributes and grain yield. Results revealed that closer spacing (30×10 cm) and phosphorus application up to 40-60 kg ha⁻¹ significantly enhanced vegetative growth and yield attributes. Maximum grain yield was recorded under 30×10 cm spacing combined with 40-60 kg phosphorus ha⁻¹. The findings suggest that optimized planting geometry and balanced phosphorus management improve mung bean productivity under Eastern Uttar Pradesh conditions.

Keywords: Mung bean, planting geometry, phosphorus, growth, yield, economics

Introduction

Mung bean (*Vigna radiata* L.) is a vital pulse crop in India, known for its high nutritional value and ability to improve soil fertility through biological nitrogen fixation. It is particularly important in the cropping systems of Eastern Uttar Pradesh, where it is cultivated during the Kharif, Rabi, and summer seasons. Mung bean contributes significantly to the dietary protein intake of the population, with seeds containing approximately 24-26% protein (Dahiya *et al.*, 1977) ^[1].

Spacing plays an important role in contributing to the higher yield because thick plant population will not get proper light for photosynthesis and high infestation of diseases. On the other hand, very low plant population will also reduce the yield. As a result, a typical population is required for good production. The benefit of optimal spacing in irrigated conditions is related to lower light competition because light is no longer a limiting factor when moisture is lacking, and the advantage of uniform spacing is gone. It is the most significant non-monetary input that may be modified to get the highest possible output per unit area. (Naga *et al.*, 2018) ^[3].

Phosphorus is a critical nutrient that significantly influences the growth, development, and yield of mung bean. It plays a vital role in root development, energy transfer, and the overall metabolic processes of the plant. Proper phosphorus management can enhance the efficiency of nutrient uptake, leading to better plant growth and increased yield. Various studies, such as those by (Singh *et al.*, 2018) ^[5], have demonstrated the positive effects of optimal phosphorus doses on the growth and yield of mung bean.

In Eastern Uttar Pradesh, the traditional practices often do not fully exploit the potential benefits of optimal planting geometry and phosphorus application. Studies have indicated that proper adjustments in these factors can lead to significant improvements in crop performance. For instance, Singh *et al.* (2018) ^[5] observed that altering row spacing and phosphorus levels led to a

yield increase of up to 20% in mung bean, highlighting the importance of these agronomic practices.

Optimizing crop geometry along with balanced phosphorus application is therefore essential for maximizing mung bean growth and yield. The present investigation was undertaken to identify suitable planting geometry and phosphorus dose for summer mung bean under Eastern Uttar Pradesh conditions.

Materials and Methods

The experiment was conducted at Agriculture Research Farm of

Shri Durga Ji Post Graduate College, Chandeshwar, Azamgarh (U.P.). The experimental site is situated about 8 km away from Azamgarh district headquarters. The experiment was laid out in Randomized Block Design (RBD) with twelve treatment combinations replicated three times.

The mung bean variety Pusa Vishal, a high yielding summer variety tolerant to Yellow Mosaic Virus and suitable for Eastern Uttar Pradesh conditions, was used for the study.

Treatment Details

A.	Planting geometry	Symbols
1.	30 cm×10 cm	S ₁
2.	30 cm×15 cm	S ₂
3.	30 cm×20 cm	S ₃
B.	Phosphorus Doses (kg/ha)	
1.	0	P ₀
2.	20	P ₁
3.	40	P ₂
4.	60 kg/ha.	P ₃

Results and Discussion

Different growth attributes were recorded at various stages of mung bean *i.e.*, at 25 DAS, 50 DAS and at harvest. The results and discussion are described here under as follows:

1. Growth Parameters

Initial Plant Population and Plant Height

Planting geometry significantly influenced plant population and height. Closer spacing (30×10 cm) recorded maximum plant population. Phosphorus application increased plant height significantly up to 60 kg ha⁻¹.

The result revealed that the effect of planting geometry was significantly more count in respect to initial plant population at closer planting geometry of 30 cm × 10 cm over broader planting geometry of 30 cm × 15 cm and 30 cm × 20 cm, respectively due to the closer planting geometry results in higher plant population per unit area, thus providing competition among plants for nutrients, space and light. (Singh and Singh, 2020)^[4] was recorded with planting geometry 30 cm × 10 cm in planting geometry.

(Venktarao) Also found similar results on effect of phosphorus levels on plant height of summer moong.

Table 1: Effect of planting geometry and phosphorus levels on initial plant population (m⁻²) and plant height (cm) at 25 DAS, 50 DAS and harvest stage.

Treatments	Initial plant population (m ⁻²) (20 DAS)	Plant height(cm)		
		25 DAS	50 DAS	Harvesting stage
Planting geometry				
30 cm × 10 cm	31.00	23.60	39.65	43.05
30 cm × 15 cm	20.50	22.25	37.10	41.7
30 cm × 20 cm	15.75	21.95	35.05	38.25
S.Em. ±	0.554	0.435	0.435	0.919
CD at 5%	1.626	1.276	1.276	2.694
Phosphorus Levels (kg/ha.)				
0	21.67	16.03	28.87	36.10
20	22.33	21.50	35.53	39.10
40	23.00	25.83	41.03	44.10
60	22.67	27.43	43.63	44.70
S.Em. ±	0.64	0.502	0.706	1.061
CD at 5%	N.S.	1.473	2.070	3.111

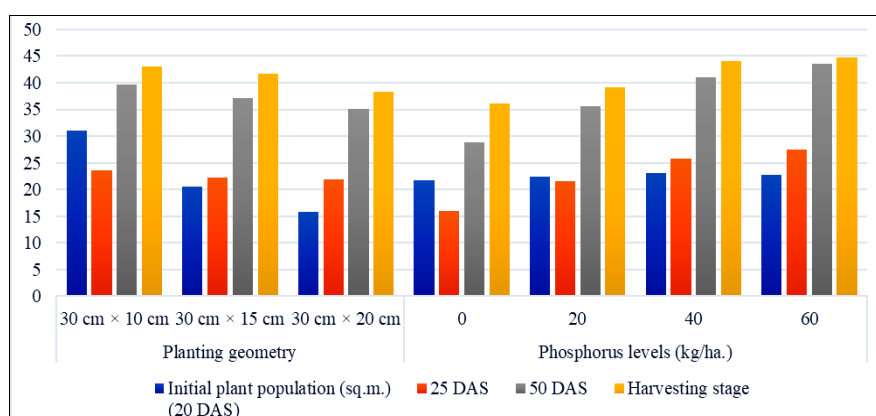


Fig 1: Effect of planting geometry and phosphorus levels on plant height at different growth stages

Dry Matter Accumulation

Dry matter accumulation increased significantly under closer spacing and higher phosphorus levels.

The dry matter accumulation at all stages was also increased significantly under 30 cm × 15 cm planting geometry due to the competition of plants for solar and soil energy was probably the minimum due to which individual plants were benefitted for the growth and development processes. (Kadam and Khanvilkar, 2015) also reported higher dry matter accumulation at planting geometry of 30 cm × 15 cm over other treatments at different stages of crop growth.

Table 2: Effect of planting geometry and phosphorus levels on dry matter accumulation (g m⁻²) at 25 DAS, 50 DAS and harvest.

Treatments	Dry matter accumulation		
	25 DAS	50 DAS	Harvesting stage
Planting geometry			
30 cm × 10 cm	110.50	324.70	405.88
30 cm × 15 cm	115.50	350.80	438.50
30 cm × 20 cm	104.25	307.40	384.25
S.E.m. ±	2.451	6.27	6.52
CD at 5%	7.189	18.389	19.123
Phosphorus Levels (kg/ha.)			
0	108.27	270.67	338.33
20	109.67	306.67	383.33
40	110.67	364.53	455.67
60	111.73	368.67	460.83
S.E.m. ±	2.830	7.240	7.529
CD at 5%	N.S.	21.233	22.081

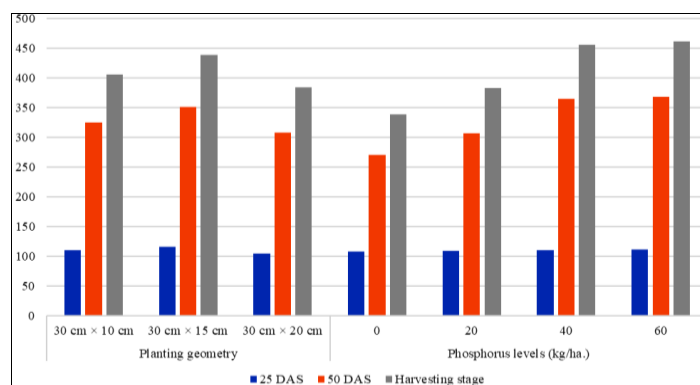


Fig 2: Dry matter accumulation under different treatment combinations

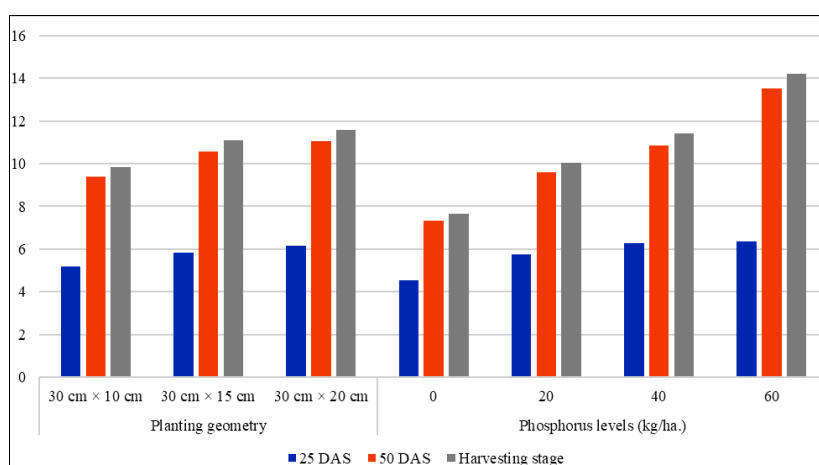


Fig 3: Leaf area index at 25 and 50 DAS under different treatments

Number of Branches and Leaf Area Index

The number of branches per plant and leaf area index were significantly influenced by phosphorus levels.

The number of branches improved at all stages in 60 kg/ha phosphorus dose over all lower doses in present study due to phosphorus governing physiochemical processes and help in root development to enhance availability of nutrients and moisture which ultimately resulted in higher number of branches. (Nissa *et al.*) also observed that the number of branches increased significantly by the application of 60 kg/ha. Phosphorus dose than rest of phosphorus doses in the summer moong.

Table 3: Effect of planting geometry and phosphorus levels on number of branches per plant.

Treatments	No. of Branches/plant		
	25 DAS	50 DAS	Harvesting stage
Planting geometry			
30 cm × 10 cm	5.18	9.40	9.83
30 cm × 15 cm	5.85	10.55	11.08
30 cm × 20 cm	6.15	11.05	11.60
S.E.m. ±	0.119	0.161	0.220
CD at 5%	0.349	0.472	0.644
Phosphorus Levels (kg/ha.)			
0	4.53	7.33	7.67
20	5.73	9.60	10.03
40	6.27	10.87	11.43
60	6.37	13.53	14.20
S.E.m. ±	0.137	0.186	0.254
CD at 5%	0.403	0.545	0.744

Table 4: Effect of planting geometry and phosphorus levels on leaf area index.

Treatments	Leaf area index	
	25 DAS	50 DAS
Planting geometry		
30 cm × 10 cm	1.10	2.70
30 cm × 15 cm	1.19	3.05
30 cm × 20 cm	1.16	2.93
S.E.m. ±	0.022	0.048
CD at 5%	0.065	0.141
Phosphorus Levels (kg/ha.)		
0	1.10	2.47
20	1.13	2.83
40	1.17	3.07
60	1.20	3.20
S.E.m. ±	0.026	0.056
CD at 5%	N.S.	0.163

2. Yield Attributes

Phosphorus application significantly improved number of pods per plant, pod length and grains per pod.

It is also clear from the result presented in the foregoing chapter that planting geometry of 30 cm × 20 cm was considerably better than other geometry in respect of total number of pods/plant because of more interception of sunlight which helped increase in the number of pods per plant. (Hangsing *et al.*, 2020) [2] also reported increase in number of pods per plant due to application of planting geometry.

Table 5: Effect of planting geometry and phosphorus levels on yield attributes.

Treatments	No. of pods/plant	Length of pods(cm)	No. of Grains/pod
Planting geometry			
30 cm × 10 cm	28.45	7.00	6.33
30 cm × 15 cm	30.65	7.50	6.80
30 cm × 20 cm	31.45	7.70	6.98
S.E.m. ±	0.646	0.186	0.112
CD at 5%	1.895	0.545	0.328
Phosphorus Levels (kg/ha.)			
0	26.13	6.40	5.8
20	30.20	7.40	6.7
40	31.80	7.80	7.07
60	32.60	8.00	7.23
S.E.m. ±	0.746	0.215	0.129
CD at 5%	2.189	0.630	0.378

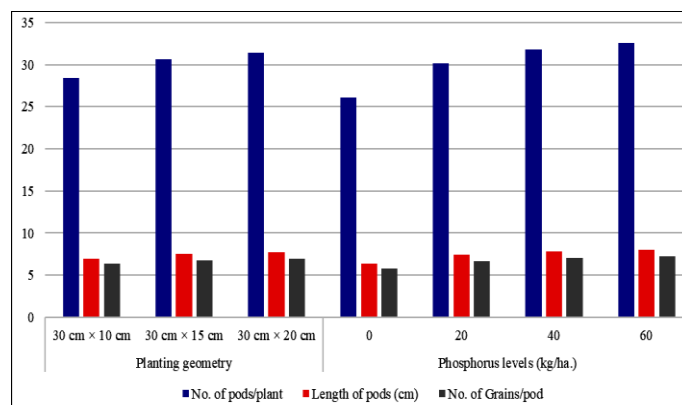


Fig 4: Number of pods per plant under different treatments.

3. Yield and Harvest Index

Grain yield increased significantly with phosphorus application up to 40-60 kg ha⁻¹. The interaction of 30×10 cm spacing and 40-60 kg P ha⁻¹ produced highest grain yield.

In present study the crop responded significantly up to 60 kg/ha phosphorus level due to low soil phosphorus and continued mining of soil phosphorus in exhaustive rotations followed prior to the present experiment. (Ahmad *et al.*, 2015) reported that harvest index was statistically at par when plots were treated with 100 kg/ha phosphorus dose.

Table 6: Effect of planting geometry and phosphorus levels on grain yield (q ha⁻¹), straw yield (q ha⁻¹) and harvest index (%).

Treatments	Biological yield (q/ha)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
Planting geometry				
30 cm × 10 cm	29.09	9.75	19.28	33.44
30 cm × 15 cm	35.21	10.74	24.47	30.45
30 cm × 20 cm	33.64	10.10	23.54	29.94
S.E.m. ±	0.394	0.238	0.376	0.662
CD at 5%	1.155	0.698	1.104	1.942
Phosphorus Levels (kg/ha.)				
0	29.98	8.37	21.61	27.97
20	31.46	9.51	21.94	30.58
40	35.41	11.48	23.93	32.53
60	33.67	11.43	22.23	34.03
S.E.m. ±	0.455	0.275	0.435	0.765
CD at 5%	1.334	0.806	1.275	2.242

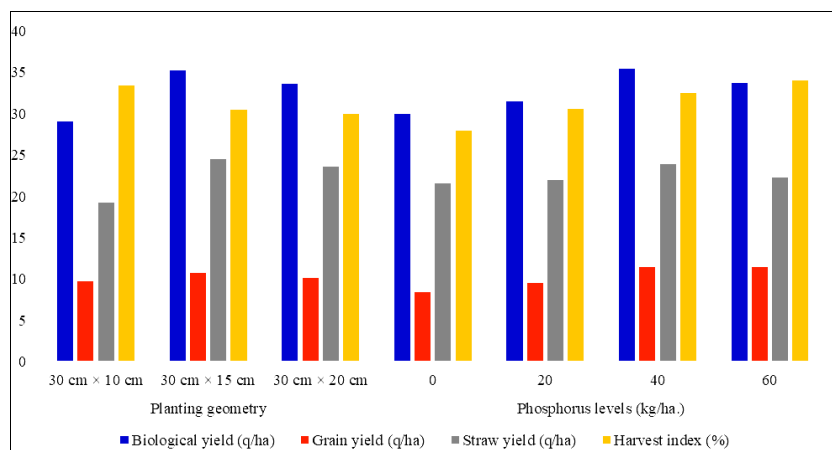


Fig 5: Grain yield response to planting geometry and phosphorus levels.

4. Quality Parameters

The protein content in grain increased significantly due to use of 60 kg/ha phosphorus dose in present study. It may be due to important role of phosphorus element in cell division and cell

contents of nucleoproteins, amino acids, DNA etc. (Tiwari *et al.*) and (Tomar *et al.*, 2004) [7] also observed positive effect of phosphorus application on protein content of grain in summer moong.

Table 7: Effect of planting geometry and phosphorus levels on protein content and protein yield

Treatments	Protein content in grain (%)	Protein content in straw (%)	Total protein yield (kg ha ⁻¹)
Planting geometry			
30 cm × 10 cm	20.94	6.55	171.78
30 cm × 15 cm	21.48	6.78	176.66
30 cm × 20 cm	21.88	6.89	179.79
S.E.m. ±	0.467	0.126	3.138
CD at 5%	N.S.	N.S.	9.204
Phosphorus Levels (kg/ha.)			
0	19.38	6.46	161.46
20	21.04	6.65	173.05
40	22.19	6.77	180.99
60	23.13	7.08	188.80
S.E.m. ±	0.540	0.146	3.624
CD at 5%	1.583	0.427	10.628

5. Economics

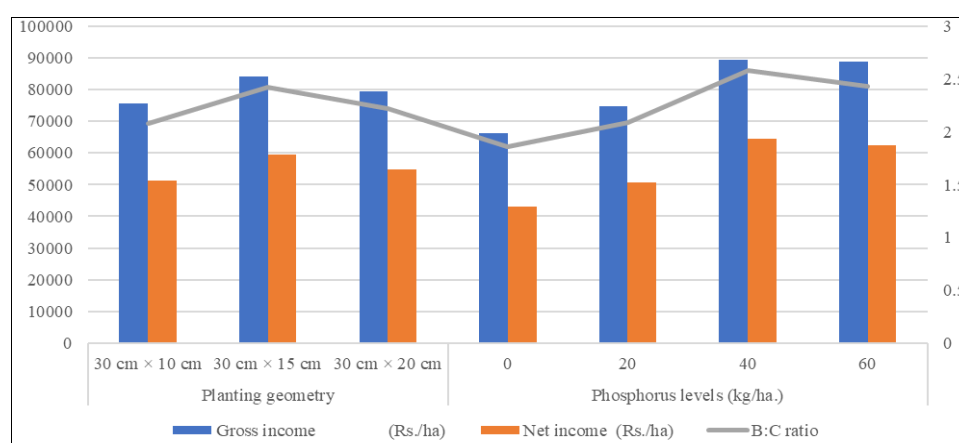
Cost of cultivation, gross return, net return and benefit-cost ratio was significantly influenced by treatment combinations.

The B: C ratio investment also increased progressively with

doses of phosphorus upto 40 kg/ha phosphorus level with amount of Rs. 2.58 in present trial. The similar results recorded by (Chaudhary *et al.*, 2017) and (Tahir *et al.*, 2015)^[6].

Table 8: Effect of planting geometry and phosphorus levels on economic returns.

Treatments	Gross income (₹ ha ⁻¹)	Net income (₹ ha ⁻¹)	B: C ratio
Planting geometry			
30 cm × 10 cm	75751.88	51199.88	2.08
30 cm × 15 cm	84267.94	59465.94	2.42
30 cm × 20 cm	79362.50	54810.50	2.22
S.E.m. ±	17.65	204.76	0.022
CD at 5%	36.849	427.385	0.046
Phosphorus Levels (kg/ha.)			
0	66270.00	43068.00	1.86
20	74671.09	50569.08	2.09
40	89500.34	64498.33	2.58
60	88735.00	62499.67	2.43
S.E.m. ±	20.39	236.43	0.025
CD at 5%	42.550	0493.502	0.053

**Fig 6:** Benefit-cost ratio under different treatments.

Conclusion

The study revealed that planting geometry of 30×10 cm combined with 40-60 kg phosphorus ha⁻¹ significantly improved growth, yield and profitability of summer mung bean in Eastern Uttar Pradesh. Adoption of these practices can enhance productivity and economic returns for farmers.

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