



Productivity of mungbean (*Vigna radiata*) as influenced by phosphorus fertilizer

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Summary

A Field experiment was conducted at the agriculture faculty of Kunduz University farm during the summer season of 2023 to study the effect of genotypes and phosphorus levels on growth, yield attributes and yield of mungbean. The experiment was laid out in a split plot design with two genotypes of mugbean viz watani and Zirati, four phosphorus levels viz control (no fertilizer), 20, 40 and 60 kg P₂O₅ ha⁻¹ with three replications. The experimental findings indicated that the growth parameters, yield attributes and yield viz. plant height (63.50cm), days to 50% flowering stage (36.50 days), days to maturity (76.5), LAI at harvest (1.61), dry matter (111.83gr/plant), branches/plant(10.33), pod length (6.73cm), pods/plant (16.66), seeds/pod (7.66), 100 seed weight (32.5gr), seed yield (1227.83 kg/ha), stover yield (1,977.50 kg/ha) and biological yield (3,205.33kg/ha) were enhanced due to watani genotypes along with application of 60 kg P₂O₅ha⁻¹, whereas the minimum growth parameters, yield attributes and yield was obtained in the plots Zirati genotypes with no phosphorus application.

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Introduction

Mungbean (*Vigna radiata* L.) is a Fabaceae plant that is one of the most important legume crops. It grows in tropical and subtropical regions around the world, Mungbean is widely cultivated for human food consumption; it can be used as green manure and livestock feed. On average, mungbean seeds contain 26% protein, 62.5% carbohydrates, 1.4% fiber, vitamins, minerals, calcium, and phosphorus. Because they are easy to digest, they replace the scarce animal protein in the human diet in tropical regions of the world (Kumari et al. 2012).¹⁴ The most common characteristics of this crop are its short life cycle and ability to carry out biological nitrogen fixation that satisfies the nitrogen demand of the crop (Anjum et al. 2006).² Due to its rapid growth and early maturity, this crop can be used to improve planting patterns because it can be planted as a catch and intercrop crop. It can be mainly planted in crop rotation with cereals (Yagoob et al. 2014; Sadiq et al. 2023).^{24,5} The deficiency of zinc appears more in calcareous soils than in neutral or acidic soils. Currently, in Afghanistan, very little research is done on zinc (Zn) application in field crops (Hemmat et al. 2023; Amipara & Makwana 2023).^{7,25}

According to nutritionists, pulses are an excellent source of dietary proteins and can play an important role in fulfilling the food requirements of a rapidly increasing

population. The growth of the human population from 6.1 billion in mid-2001 to 9.3 billion by 2050 should be in par with crop production to ensure food security. Mungbean seed is more palatable, nutritive, digestible and non-flatulent than other pulses grown in the country. It is also known as the king of the pulses (Yadi 2012; Imran 2015; Imran et al. 2016).^{23,9,8} Pulses contain important amino acids known as lysine which is frequently available in mung bean crop but deficient in most of cereal grains and therefore known as poor man meat (Imran et al. 2016).⁹ Besides, being a rich source of protein, it maintains soil fertility through biological nitrogen fixation in soil and thus plays a vital role in furthering sustainable agriculture (Muhammad et al. 2004).¹⁵ The crop is a short-duration crop and therefore has less water requirement as compared to summer crops. Moreover, it is drought resistant and can withstand adverse environmental conditions, and hence successfully be grown in rain-fed areas (Anjum et al. 2006).²

Phosphorus effect on root establishment and development is well known (Hossain et al. 2007).⁷ Phosphorus is one of the three macronutrients that plants must obtain from the soil. It is a major component of compounds whose functions relate to growth, root development, flowering, and ripening (Raboy 2003).¹⁹ The addition of N and P fertilizers enhances root development, which improves the supply of other nutrients and water to the growing parts of the plants, resulting in an increased photosynthetic area and thereby more dry matter Accumulation. Inadequate nutrient status of soil is a particular problem for small landholder farmers of developing countries, (Peter 2003).¹⁷ The introduction of high-yielding varieties and increased cropping intensity requires heavy applications of N and P fertilizers (Bana et al. 2015).³ The poor availability of

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phosphorus fertilizer is one of the major causes depressing the productivity of the crops. On the other hand, soil P fixation depends on the method of application, P broadcasting is exposed for fixation than band application since the broadcast application has created more contact ratio between the fertilizer and soil meanwhile and application narrows the contact ratio between Phosphorus and soil (Shah et al. 2006).²¹ However meager information on phosphorus application rate hinders the improvement of the crop yield in the study area. Therefore, this research is designed with two objectives that is to investigate the effect of phosphorus application rates on phenological stages, growth and yield components of mungbean to determine the yield of genotypes as influenced by phosphorus fertilizations.

Materials and methods

A field experiment was conducted during the summer season of 2023 at the research farm of Kunduz University in Kunduz of Afghanistan. The experimental site was located at 36738, N latitude and 68.869 E longitudes, with an elevation of 356 meters from the sea level. The average annual rainfall 241 mm. Even relative humidity was low and it varied between 9.1 to 23.9% in this period. During this period minimum and maximum temperatures ranged between 21.1° and 43.2°C. Wind speed (mph) ranged between 6.2 to 8.3 km/h during this. Soil (0–15 cm depth) of the experimental site was sandy clay loam in texture (sand 75.2%, silt 13.5% and clay 11.3%) with slightly alkaline, having a pH of 7.15. The experiment was laid out in a split-plot design with two factors, genotypes of mungbean viz. Zirati and Watani and four phosphorus levels viz. control (no fertilizer), 20, 40 and 60 kg P₂O₅/ha with three replications. The treatment combination was genotypes + phosphorus levels viz. T1, Zirati + 0 kgP₂O₅, T2, Zirati + 20 kgP₂O₅, T3, Zirati + 30 kgP₂O₅, T4, Zirati + 40 kgP₂O₅, T5, Watani + 0 kgP₂O₅, T6, Watani + 0 kgP₂O₅, T7, Watani + 0 kgP₂O₅, and T8, Watani + 0 kgP₂O₅. The recommended dose of N 30 kg/ha through urea was applied at the time of sowing and 45 days after sowing. The phosphorus was applied as per treatments through single super phosphate each plot measuring 2m×3m (6 m²). The row-to-row spacing was kept at 25 cm and a distance of 10 cm was maintained between plant-to-plant rows. I was using a seed rate of 25 kg/ha. First irrigation was applied at 25 days after sowing followed by second irrigation at 45 days after sowing to attain the uniform maturity of the crop under all the treatments. Hand weeding was done twice at 20 and 40 days after sowing. The observations on five randomly selected plants from each treatment were recorded at maturity. Harvesting was done manually. Standard procedures followed for recording

and analysing the data on different growth and yield parameters and means were compared using the LSD test at 5% level of significance.

Results and Discussions

Effect of genotypes and phosphorus levels on growth parameters of mungbean

The results of the scientific analysis of variance are presented in Table 1, which indicates that the effects of genotypes and phosphorus levels had a significant impact on plant height. The tallest plant height was recorded in the combination of Watani (57.16 cm) along with 60 kg P₂O₅ ha⁻¹ (63.50 cm), followed by 40 kg P₂O₅ ha⁻¹ (56.04 cm), while the shortest plant height was observed in the control treatment (51.16 cm). Similarly, the effect of 60 kgP₂O₅ha⁻¹ was significant on plant height over control at all the growth stages (14.9 cm, 38.2 and 40.6 cm at 30 DAS, 60 DAS and at harvest. Gajera et al. (2014).⁴ and Kumari et al. (2012).¹⁴ also reported that the application of phosphorus significantly affects the plant height of the mungbean plant. The findings of the scientific analysis of variance as presented in (Table 1), reveal that while genotypes did not have a significant impact on the days to 50% flowering stage, phosphorus levels did have a significant effect. Treatment 60 kg P₂O₅ ha⁻¹ resulted in the least number of days (36.50) to reach the 50% flowering stage, followed by treatment 40 kg P₂O₅ ha⁻¹ (38.16). Conversely, the control plot exhibited the longest duration to reach the 50% flowering stage (43.33 days). Amanullah et al. (2013).¹ and Khalil et al. (2010).¹³ described that increase in phosphorus level results in earlier phenological development. A decrease in Phosphorus levels caused a delay in the phenological development of mungbean.

The results revealed in Table 1 that both genotypes and phosphorus levels had a significant effect on the duration to reach maturity. Specifically, the Zirati genotype exhibited the least number of days (77.03) to reach maturity, followed by the Watani genotype (83.02). Moreover, the application of phosphorus levels also significantly affected the duration to reach maturity. Treatment with 60 kg P₂O₅ ha⁻¹ resulted in the least number of days (76.5) to reach maturity, followed by treatment 40 kg P₂O₅ ha⁻¹ (79.66). Conversely, the control plot exhibited the longest duration to reach maturity (82.83 days). These results agree with those of Amanullah et al. (2013).¹ who reported that mungbean applied with no P (P-control) had delayed flowering and pods formation. Likewise, delayed maturity in In a study conducted by Jan et al. in 2012, it was observed that there were variations in the P-control plots when it came to mung bean.

Table 1. Effect of genotypes and phosphorus levels on growth parameters of Mungbean

Treatments	Plant height (cm)	Days to 50% flowering stage	Days to Maturity	LAI at Harvest	Dry Matter gr/plant	Branches/plant
Genotypes						
Zirati	54.58	40.11	83.02	1.05	97.01	8.41
Watani	57.16	39.50	77.03	1.26	100.91	8.33
SE m±	0.677	0.333	0.340	0.056	0.606	0.215

CD (P=0.05)	2.052	NS	1.041	0.171	1.855	NS
Phosphorus Levels (kg ha⁻¹)						
0 kg P ₂ O ₅ ha ⁻¹	51.16	43.33	82.83	0.84	87.83	6.83
20 kg P ₂ O ₅ ha ⁻¹	52.83	41.02	81.12	0.98	93.24	7.50
40 kg P ₂ O ₅ ha ⁻¹	56.04	38.16	79.66	1.2	103.16	8.83
60 kg P ₂ O ₅ ha ⁻¹	63.50	36.50	76.5	1.61	111.83	10.33
SE m±	0.948	0.477	0.481	0.079	0.857	0.304
CD (P=0.05)	2.902	1.460	1.472	0.242	2.624	0.93

Further, the genotypes and phosphorus levels had a significant effect on the LAI and dry matter production. The watani genotypes exhibited the highest LAI (1.26) and dry matter yield (100.91 g/plant) followed by the zirati genotype. Treatment 60 kg P₂O₅ ha⁻¹ resulted in the highest LAI (1.61), dry matter (111.83 g/plant), followed by treatment 40 kg P₂O₅ ha⁻¹. The same results were recorded by Jat & Ahlawat (2001)¹¹ and Amanullah et al. (2012).¹

The results revealed that while there was no significant difference between the genotypes but phosphorus levels had a significant effect on the number of branches/plants, treatment 60 kg P₂O₅ ha⁻¹ resulted in the highest number of branches/plant (10.33), followed by treatment 40 kg P₂O₅ ha⁻¹ (8.83). In contrast, the control treatment exhibited the lowest number of branches/plants (6.83). Shete et al. (2010)²² also observed results similar to the present findings.

Effect of genotypes and phosphorus levels on yield attributes and yield of Mungbean

The highest number of seeds/pods was observed in treatments 60 kg P₂O₅ ha⁻¹ (7.66), followed by treatment 40 kg P₂O₅ ha⁻¹ (6.33). In contrast, the control treatment exhibited the lowest number of seeds/pod (4.5). (Table 2). This result is closely related to the finding of khaleeq et al. 2023.¹² The results presented in (Table 2) indicate that both the genotypes and phosphorus had a significant effect on the 1000 seeds weight (gr). The

highest 1000 seeds weight (gr) was observed in the Watani genotype (30.58gr), followed by the Zirati genotype (29.62gr). Moreover, the application of phosphorus had a significant effect on the 1000 seeds weight (g), with the highest 1000 seeds weight (g) recorded in treatments 60 kg P₂O₅ ha⁻¹ (32.5g), followed by treatment 40 kg P₂O₅ ha⁻¹ (30.83g). In contrast, the control treatment exhibited the lowest 1000 seed weight (28g). This result is closely related to the finding of Nazir et al. 2022.¹⁶

The results presented in (Table 2) indicate that while the genotypes did not have a significant effect on grain yield, while the genotypes had a significant effect on stover yield. The highest grain and stover yield was observed in treatment 60 kg P₂O₅ ha⁻¹ (1,227.8 and 1977.5 kg/ha, respectively), followed by treatment 40 kg P₂O₅ ha⁻¹. In contrast, the control treatment exhibited the lowest seed yield (699.33 kg/ha). Biological yield also followed the pattern of grain yield. Rasheed et al. (2003)²⁰ also found similar results and they reported application of different phosphorus levels also significantly raised the grain yield. Application of 75 kg P₂O₅ ha⁻¹ resulted significantly maximum grain yield of mungbean over control and 45 kg P₂O₅ ha⁻¹ respectively, whereas, application of 60 kg P₂O₅ ha⁻¹ was at par to 75 kg P₂O₅ ha⁻¹. Prasad et al. (2014)¹⁸ also found 60 kg P₂O₅ ha⁻¹ as the optimum dose for better grain yield of mungbean.

Table 2. Effect of genotypes and phosphorus on yield attributes and yield of Mungbean

Treatments	Pod length (cm)	Pods/plant	Seed/pod	100 seeds weight (gr)	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)
Genotypes							
Zirati	5.70	14.25	5.91	29.62	936.41	1,560.58	2,497.00
Watani	5.87	14.75	6.08	30.58	884	1,671.33	2,555.33
SE m±	0.06	0.20	0.135	0.214	52.878	17.102	47.339
CD (P=0.05)	NS	NS	NS	0.656	NS	52.376	NS
Phosphorus Levels (kg ha⁻¹)							
0 kg P ₂ O ₅ ha ⁻¹	4.95	12.5	4.5	28	699.33	1,338.50	2,162.17
20 kg P ₂ O ₅ ha ⁻¹	5.63	13.83	5.5	29.08	890	1,480.33	2,370.33
40 kg P ₂ O ₅ ha ⁻¹	5.83	15	6.33	30.83	823.66	1,667.50	2,366.83
60 kg P ₂ O ₅ ha ⁻¹	6.73	16.66	7.66	32.5	1,227.83	1,977.50	3,205.33
SE m±	0.085	0.29	0.192	0.303	74.781	24.186	66.947
CD (P=0.05)	0.259	0.889	0.587	0.928	229.023	74.07	205.031

Conclusion

The application of phosphorus fertilizer at the rate of 60 kg P₂O₅ ha⁻¹ along with watani genotype has been found to be the most effective combination for achieving higher yields of mungbean. This approach not only enhances crop productivity but also helps in conserving soil fertility and productivity. Therefore, it is recommended that farmers adopt this practice to optimize their crop yields and improve the overall health of their soil. Further research can be conducted to explore other potential combinations of fertilizers and crop genotypes that may further enhance the productivity and sustainability of agricultural systems.

Declaration of Interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

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