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Optimization of phosphorus fertilizer doses on growth and yield of mung bean (Vigna radiata) in northeast agro-ecology of Afghanistan

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Abstract

An Experiment was conducted at the Research Farm of Kunduz University during cropping season of 2023 to investigate optimization of phosphorus fertilizer doses on growth and yield of mung bean in northeast agro-ecology of Afghanistan, the experiment laid out in Randomized Complete Block Design with three replications, the experiment consist of 4 treatments: 0 kg p_2o_5/ha, 20 kg p_2o_5/ha, 40 kg p_2o_5/ha and 60 kg p_2o_5/ha, result shown the highest plant height (63.50 cm), Branches/plant (12.40), Leave area Index (2.10), minimum days to maturity (76.50), pod length (6.73 cm), Seeds/pod (9.27), pods/plant (18.33), 1000 seed weight (39.32 gr), grain yield (1.35 t/ha), straw yield (2.17 t/ha) and Biological yield (3.52 t/ha) were in phosphorus application of 60 kg p_2o_5/ha, these finding suggest the potential for optimizing phosphorus fertilizer application to enhance mung bean productivity and profitability in similar agro-ecological zones.

Keywords: growth, mung bean, optimization, phosphorus fertilizer, yield

Introduction

Mung bean (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 *(Kumari., 2012*). Mung bean is widely cultivated for human food consumption, it can be used as green manure and livestock feed. On average, mung bean 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 (*Ali, 2012*). 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., 2006;*

Khaleeq et al., 2023a). 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., 2014*). 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*). The crop is a short duration crop therefore has less water requirement as compared to summer crops. Moreover, it is drought resistant that can withstand adverse environmental conditions and hence successfully be grown in rain fed areas (*Anjum et al., 2006*; *Khaleeq et al., 2023b*). Phosphorus effect on root establishment and development is well known (*Hossain et al., 2007; Khaleeq et al., 2024*a).

Phosphorus is one of the three important 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 (*Khaleeq et al., 2023a*). Addition of N and P fertilizer 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 (*Raboy et al., 2003* and *Nazir et al., 2022*). Inadequate nutrient status of soil is a particular problem for small landholder farmers of the developing countries, where much grain-legume production couldn't apply that mach (*Peter et al., 2003* and *Khaleeq et al., 2023e*).

Introduction of high yielding varieties and increased cropping intensity requires heavy applications of N and P fertilizers. As in (*Khan et al., 2004* and *Hemmat et al., 2023*) disclosed the yield of different crops have been noticed from the soil application of the deficient macronutrient, therefore the poor availability of phosphorus fertilizer is one of the major causes depressing the productivity of the crops. On the other hand, soil Phosphorus fixation depends on method of application, Phosphorus broadcasting expose for fixation than band application since broadcast application has create more contact ratio between the fertilizer and soil meanwhile and application narrowing the contact ratio between Phosphorus and soil (*Shah et al., 2006; Farkhari et al., 2023; Khaleeq et al., 2024b*).

Phosphorous is second most essential nutrient after nitrogen in growth and progress of plants. Soil founds 95 - 99% phosphorous in organic form, the rest of it is inorganic form and accessible to plants. The most important function of phosphorus is that it is involved in early root and shoot development, stem elongation, cell division and plays a vital role in meristematic activity of plants. The most important drawback of phosphorous fertilization in its quick fixation in clays important to severe deficiency problem in soils as well as in plants. There are many factors which can improve the phosphorous availability to plants such as composting, lower pH of soil and enhanced bacterial activity in soil (*Anderson and Magdoff*, 2005 and *Sadiq et al., 2023*). The objective of this study is to provide recommendation for sustainable phosphorus fertilization practices to enhance mung bean production in the northeast climate of Afghanistan.

Materials and Methods

A field experiment was conducted at the agronomic research farm of Kunduz University during cropping season of 2023 to evaluate optimization of phosphorus fertilizer doses on growth and yield of mung bean in northeast agro-ecology of Afghanistan, the experiment laid out in Randomized Complete Block Design with three replications, the experiment consist of 4 treatments: absolute Control, 20 kg p_2o_5/ha, 40 kg p_2o_5/ha and 60 kg p_2o_5/ha respectively, the mung bean genotype was Watani genotype obtained from agronomy department of Kunduz University, net plot size was 12 m^2, the experiment site was low in nitrogen and phosphorus, medium in potash and low in organic matter, all phosphorus fertilizer applied at the basal application before sowing while 40 kg N/ha applied at 20 days and 40 days after sowing, pH was 7.2, seeds were sown 3 cm depth, 30 cm row spacing and 10 cm plant to pant respectively, Immediately irrigated after sowing, 20 days after sowing and 40 days after sowing also irrigated, all growth data parameter have taken from 5 plants, yield components and yield date have taken form net plot area. The data recorded at different growth stages and on yield attributes were analyzed statistically by using analysis of variance (ANOVA) and treatment means were compared using least significance difference at 5% level of significance.

Results and Discussions

The scientific analyzed date revealed on table (1) phosphorus fertilizer levels significantly affected of growth parameters, the highest plant height (63.50 cm), Branches/plant (12.40), Leave area Index (2.10) and the minimum days to maturity (76.50) were in application of 60 kg P_2O_5 ha^{-1}, followed by application of 40 kg P_2O_5 ha^{-1} and the minimum all growth parameters plant height, branches/plant and leave area Index recorded in Absolute Control treatment. Similar result with the finding *of Dikr and Garkebo, (2022)* reported phosphorus application at the rate 60 kgp_2o_5/ha was the highest plant height and branches/plant. *Khaleeq et al., (2023b)* who also reported the highest pant height, branches/plant and leave area Index was in application of 60 p_2o_5 over other treatments. *Seerat et al., (2023)* reported the optimum level of phosphorus was the highest growth parameters of Black-eyed bean, application of 60 kg p_2o_5/ha was the best level for enhancing growth parameters.

Table (1): Effect of phosphorus levels on plant height, Branches/plant, Leave Area Index and Days to Maturity of mung bean

Treatments	Plant height (cm)	Branches /plant	Leave Area Index	Days to Maturity
Absolute Control	51.16c	8.20c	1.09c	82.83a
20 kg P_2O_5 ha^{-1}	52.83bc	9.00c	1.27bc	81.00b
40 kg P_2O_5 ha^{-1}	56.04b	10.60b	1.56b	79.66b
60 kg P_2O_5 ha^{-1}	63.50a	12.40a	2.10a	76.50c
SE m±	3.201	0.210	0.034	0.701
CD (P=0.05)	3.575	0.916	0.369	1.673

Phosphorus fertilizer levels significantly affected on yield components of mung bean depicted on figure (1), the highest pod length (6.73 cm), Seeds/pod (9.27), pods/plant (18.33) and 1000 seed weight (39.32 gr) were in phosphorus application of 60 kg p_2o_5/ha followed by phosphorus application of 40 kg p_2o_5/ha, 20 kg p_2o_5/ha respectively and the minimum yield components pod length (4.95 cm), Seeds/pod (5.44), pods/plant (13.75) and 1000 seed weight (33.88 gr) were in absolute control plots. This increased yield component due to appropriate dose of using phosphorus fertilizer. Our finding is similar with the result of *Samim et al., (2023)* reported application of phosphorus at the rate of 60 kg p_2o_5/ha were the highest seeds/pod, pod length, pods/plant and 1000 seed weight of mung bean. *Khaleeq et al., (2023b*) also reported 60 kg p_2o_5/ha was the highest pods/pant, pod length and yield component of mung bean. *Khaleeq et al., (2023d)* reported 60 kg p_2o_5/ha is optimum level for enhancing growth and yield parameters of cotton crop.

Phosphorus levels significantly influenced on grain yield, straw yield and Biological yield revealed on figure (2), the highest grain yield (1.35 t/ha), straw yield (2.17 t/ha) and Biological yield (3.52 t/ha) were in phosphorus application of 60 kg p_2o_5/ha, followed by application of 40 kg p_2o_5/ha, 20 kg p_2o_5/ha respectively and the lowest grain yield (0.9 t/ha), straw yield (1.47 t/ha) and Biological yield (2.37 t/ha) were in absolute control plots compared phosphorus fertilized treatments. Our finding supported by the result of *Hanan et al., (2022)* who reported phosphorus application at the rate of 60 p_2o_5/ha revealed the grain yield, Straw yield and Biological yield of mung bean. these findings are corroborated with the findings of *Khaleeq et al., (2023b)* who reported the maximum grain yield and straw yield were in 60 p_2o_5/ha application. *Khaleeq et al., (2023a*) reported using the optimum phosphorus dose was increased the grain yield, straw yield and biological yield common bean, application 60 kg p_2o_5/ha was the maximum grain and straw yield of common bean, *Khaleeq et al., (2023c)* reported phosphorus fertilizer at the rate of 60 kgp2o5/ha was the maximum pod length, 1000 seed weight and pods/plant of mung bean.

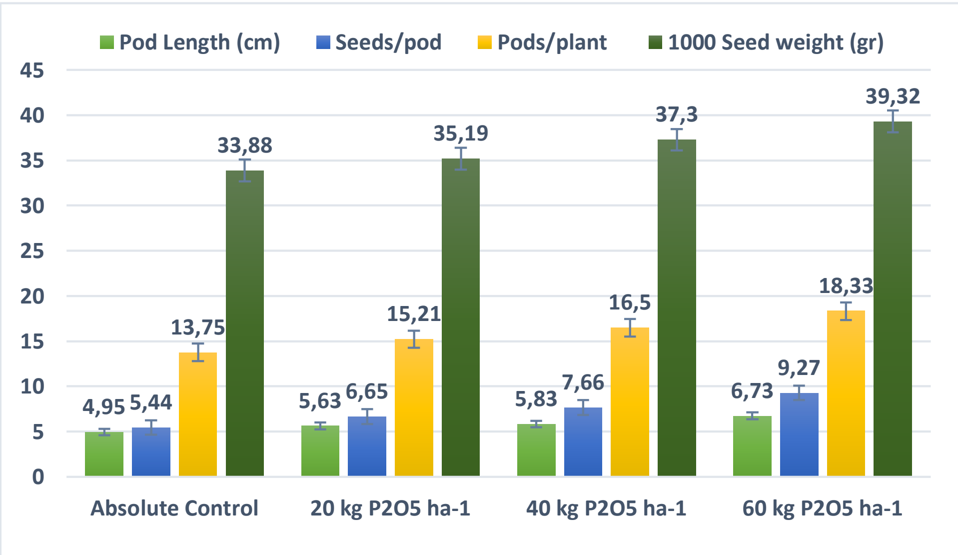

Figure (1): effect of phosphorus on pod length, seeds/pod, pods/plant and 1000 seed weight

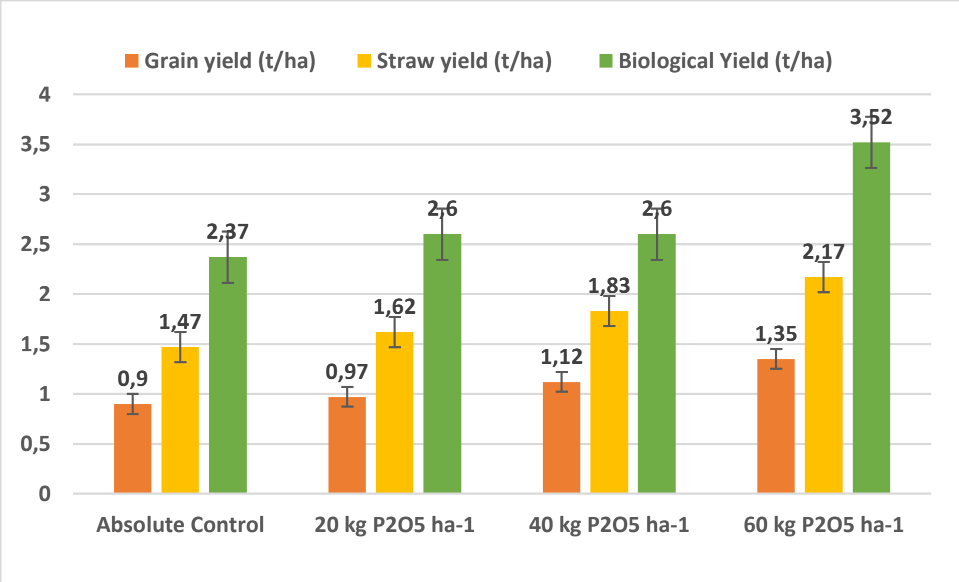

Figure (2): effect of phosphorus on grain yield, straw yield and Biological yield

Conclusion

The results of this study demonstrate that the application of 60 kg p_2o_5/ha of phosphorus fertilizer significantly enhanced the growth and yield of mung bean in the northeast ecology of Afghanistan. The highest values for various growth parameters such as plant height, branches per plant, leaf area index, pod length, as well as yield-related traits including seeds per pod, pods per plant, 1000 seed weight, grain yield, straw yield and biological yield were observed with the application of 60 kg p_2o_5/ha. These findings suggest that optimizing phosphorus fertilizer application can be an effective strategy for improving mung bean productivity in this region. Further research and field trials may be warranted to validate these results and optimize phosphorus management practices for mung bean cultivation in similar agro-ecological zones.

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