

Effect of nitrogen and phosphorus on growth and yield of mungbean



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Summary

Nutrient management and their balance application are crucial for the high productivity of the crops; nitrogen and phosphorus are the essential nutrients, which are often deficient in the soil and must be supplied to the crops through various sources. The excessive application of these nutrients can lead to increased emissions of greenhouse gases and contribute to eutrophication, water pollution, and many other issues. To determine the optimal application rate of these nutrients, a field experiment was conducted in ANASTU research farm, Kandahar, in 2023 to evaluate the effects of different nitrogen and phosphorus levels on the growth and yield of mungbean (*Vigna radiata* L.). Treatments comprised three levels of nitrogen (0, 20, and 40 kg ha⁻¹) and four levels of phosphorous (0, 40, 60 and 80 kg P₂O₅ ha⁻¹). The study was carried out using an RCBD design with three replications. The results showed that 20 kg N ha⁻¹ and 40 kg P₂O₅ ha⁻¹, together and separately, enhanced growth parameters (Plant height, leaf area, dry matter, branches plant⁻¹), yield attributes (Pods plant⁻¹, grains pod⁻¹, 100-grain weight and pod length) and grain, stover and total yield, significantly. Overall, this study indicates that the mungbean should be fertilized with 20 kg N ha⁻¹ and 40 kg P₂O₅ ha⁻¹ in Dand district of Kandahar province.

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Introduction

Afghanistan is predominantly an agricultural country, boasting successful cultivation of various crops such as wheat, rice, maize, pulses, and vegetables. Notably, pulses serve as a vital protein source, especially for the poor population and domestic animals. The stems and leaves of pulse crops contribute to the production of "Bhushi," a protein-rich concentrate feed prepared through chopping and drying stover. Additionally, the husk of the seeds is utilized as feed for cattle (Omran et al. 2018 and 2020). Mungbean (*Vigna radiata* L.) is a short-duration crop which requires only 60-65 days from planting to harvest. It is typically grown between February and May with few inputs or intensive management (Hossain et al. 2023). It holds particular significance as an edible bean with high nutritive value. Beyond their role in human nutrition, mungbeans contribute to soil fertility by effectively fixing atmospheric nitrogen, as highlighted by Sadeghipour et al. 2009 and Yin et al. 2018. This crop is extensively cultivated in tropical and subtropical regions, serving as an excellent source of vegetable protein in Afghanistan. The nutritional profile of mungbeans includes 51% carbohydrates, 26% protein, 10% moisture, 3% minerals,

and 3% vitamins, making them easily adaptable for cooking (Omran et al. 2018). All these benefits make mungbean an unavoidable component of sustainable agriculture in the region.

Nitrogen is the most essential nutrient for crops, and its efficient management can provide higher yields, better quality, and higher incomes for farmers (Fazil et al. 2022). Despite the inherent nitrogen-fixing ability of pulses, nitrogen remains crucial for optimal growth, yield, and quality, serving as a vital component of protein, nucleic acids, and chlorophyll in pulse crops like mungbean (Rana et al. 2016). Similarly, phosphorus plays a pivotal role in mungbean's physiological processes, influencing nutrient uptake, root growth, and nodulation, thereby enhancing pulse productivity (Dass et al. 1997; Balai et al. 2017). Phosphorus deficiency has been implicated as a possible cause of the low yield problem in legumes (Nazir et al. 2022). The importance of balanced nitrogen, phosphorus, and nutrient fertilization is underscored, as their inadequacy or imbalance can impede mungbean growth, development, and overall yield (Yin et al. 2018).

The excessive use of nitrogen and phosphorus in agriculture contributes significantly to climate change through multiple pathways. Nitrogen fertilizers, especially synthetic ones, increase emissions of potent greenhouse gas nitrous oxide (N₂O). Runoff from fields with high nitrogen and phosphorus levels leads to water pollution, algal blooms, and carbon dioxide release during decomposition. The energy-intensive production of these fertilizers adds to carbon emissions. Improper nitrogen and phosphorus management exacerbates greenhouse gas emissions, water pollution, and broader

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environmental challenges linked to climate change. In Afghanistan, due to a lack of awareness and research support, small farmers often apply imbalanced fertilizers, resulting in lower yields, incomes, and increased environmental pollution. This study in Kandahar province aims to identify appropriate nutrient application doses and address these critical issues.

Materials and Methods

The experiment was carried out in the Experimental Research Farm of Afghanistan National Agricultural Sciences and Technology University (ANASTU) in Kandahar, Afghanistan, from June to September 2023. The experiment was conducted using a factorial RCBD with three replications; treatments consisted of three levels of nitrogen (0, 20 and 40 kg ha⁻¹) and four levels of phosphorus (0, 40, 60 and 80 kg P₂O₅ ha⁻¹). Soil texture class was sandy clay loam with soil pH of 8.1, available nitrogen 146 kg ha⁻¹, available phosphorus 8.70 kg ha⁻¹, available potassium 193 kg ha⁻¹, soil EC 2.30 dS m⁻¹ and organic carbon 0.31%. Potassium was applied at the rate of 20 kg ha⁻¹ and animal manure 8-ton ha⁻¹ equally to each plot at the time of sowing. N and P were applied through urea and TSP, respectively. The mungbean

variety (Local variety) was sown in the present study. All the recommended cultural practices were followed.

The statistical analysis of data was done as per the standard method of the OPSTAT online testing program; the significance of treatment effects was tested with the help of the F-test and critical difference (CD) values at P=0.05 were used to determine the significant difference between treatment means.

Results and Discussion

Growth Performance

The data on growth parameters is given in (Table 1). The significantly tallest plant and more dry matter accumulation were recorded with the application of 20 kg N ha⁻¹ among N levels and with 40 kg P₂O₅ ha⁻¹ among P levels over the rest of the treatments at all crop growth stages. As mungbean can fix the atmospheric N into the soil, the crop may not need more than 20 kg ha⁻¹, and this amount is much required and enough to lead its growth. Similar results were found by Chattha et al. 2017; Mainul et al. 2014; Rathore et al. 2007; Nadeem et al. 2004; Malik et al. 2003; Sachin et al. 2019 and Pathan et al. 2023.

The interaction effects between nitrogen and phosphorus were significant at all crop growth stages.

Table 1. Plant height and dry matter accumulation of mungbean at different growth stages

Treatments	Plant height (cm)			Dry matter accumulation (g plant ⁻¹)		
	At 30 DAS	At 60 DAS	At Harvest	At 30 DAS	At 60 DAS	At Harvest
Nitrogen levels						
N ₀	14.1	40	53.8	5.3	10.4	16.4
N ₂₀	15.4	41.6	61.1	6.3	12.4	17.7
N ₄₀	16.1	42	58.4	5.9	12.2	17.4
SEm±	0.12	0.13	0.29	0.04	0.07	0.03
CD (P≤0.05)	0.37	0.37	0.86	0.11	0.20	0.10
P₂O₅ levels						
P ₀	14.5	40	56.3	5.8	11.5	17.2
P ₄₀	15.1	42.3	60.1	6.1	12.2	17.6
P ₆₀	15	40.6	57.3	5.9	11.6	17.0
P ₈₀	15	41	56.8	5.5	11.3	16.7
SEm±	0.14	0.13	0.33	0.04	0.08	0.04
CD (P≤0.05)	0.43	0.43	0.99	0.12	0.23	0.12
Interaction (N x P)						
CD (P≤0.05)	S*	S*	S*	S*	S*	S*

Yield Performance

Data on yield attributes and yield is shown in (Table 2). 20 kg N ha⁻¹ produced significantly more pods plant⁻¹, grains pod⁻¹, pod length and 1000-grain weight over the rest of the treatments. Similarly, these parameters were markedly higher among P levels with the application of 40 kg P₂O₅ ha⁻¹. Grain and biological yields were also significantly higher with the application of 20 kg N ha⁻¹ among N levels and with 40 kg P₂O₅ ha⁻¹ among P levels over the other rates. In contrast, straw yield was higher in N₄₀ among nitrogen levels. Rathore et al. 2007 reported

the same results, and many other researchers like Chattha et al. 2017; Ehsan et al. 2017; Omran et al. 2018; Omran et al. 2020 and Yin et al. 2018 found 60 kg P₂O₅ as a best treatment. Meanwhile, the local variety of mungbean was cultivated, so the nutrient requirements may be less in comparison to hybrid varieties. Therefore, 40 kg P₂O₅ produced higher growth and yield of mungbean in Kandahar province.

The interaction effects between nitrogen and phosphorus were significant in all yield attributes and yields of mungbean.

Table 2. Yield attributes and yield of mungbean

Treatments	Yield attributes				Yield (kg ha ⁻¹)			Harvest index
	Pods plant ⁻¹	Grains pod ⁻¹	Pod length (cm)	1000-grain weight (g)	Grain	Straw	Biological	

Nitrogen levels								
N ₀	17.3	5.7	6	36.4	1246	2109	3355	37.1
N ₂₀	21.1	7.1	7	40.9	1522	2222	3744	40.6
N ₄₀	20.3	6.4	6.8	39.9	1354	2229	3583	36.3
SEm±	0.25	0.14	0.07	0.26	2.28	5.52	8.12	0.14
CD (P≤0.05)	0.75	0.43	0.20	0.77	6.73	16.29	23.9	0.40
P ₂ O ₅ levels								
P ₀	18.3	6.2	6.3	37.7	1273	2155	3428	37.1
P ₄₀	20.2	6.9	6.9	40.4	1353	2203	3556	38.0
P ₆₀	20.1	6.3	6.6	39.3	1305	2195	3500	37.1
P ₈₀	19.8	6.4	6.6	38.7	1298	2193	3491	37.3
SEm±	0.29	0.17	0.08	0.30	2.63	6.37	9.37	0.16
CD (P≤0.05)	0.87	0.49	0.23	0.89	7.78	18.8	27.7	0.46
Interaction (N x P)								
CD (P≤0.05)	S*	S*	S*	S*	S*	S*	S*	S*

Conclusion

The experiment was conducted for one season in Kandahar province, and the treatments were comprised of 0, 20 and 40 kg N ha⁻¹ and 0, 40, 60 and 80 kg P₂O₅ ha⁻¹. 20 kg N ha⁻¹ and 40 kg P₂O₅ ha⁻¹ produced significantly higher growth parameters, yield attributes and yield of mungbean crop.

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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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