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Effects of Phosphate Fertilizers on Soybean Performance

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Abstract

For the development and production of soybeans (*Glycine max* L.), phosphorus (P) is an essential macronutrient. The effects of different phosphorus fertilizer rates on soybean growth, development, and yield characteristics are examined in this research. Plant height, leaf area index, pod number, seed output, and phosphorus use efficiency (PUE) were all assessed in field studies. The results show that at ideal phosphorus application rates, growth and yield metrics were improved, but at excessive or inadequate rates, performance was hampered. The research offers helpful suggestions for sustainable phosphorus management and emphasizes the significance of phosphorus optimization in raising soybean output.

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Introduction

A major legume crop grown all over the world, soybeans (*Glycine max* L.) are prized for their high protein and oil content. An important nutrient, phosphorus (P) affects several physiological functions, including as photosynthesis, energy transmission, and root growth. Even though phosphorus is important, its availability in soils is often restricted because of fixation and poor mobility, especially in alkaline and acidic soils [1]. Low seed yields, delayed blooming, and decreased plant development might result from a phosphorus deficit. On the other hand, overuse of phosphorus may lead to environmental problems such eutrophication². As a result, preserving environmental sustainability while attaining high soybean yield depends on optimizing phosphorus fertilizer rates. In order to provide insights into phosphorus management for improved crop performance, this research attempts to assess the impact of varying phosphorus fertilizer rates on soybean growth and yield metrics.

Materials and Methods

Study Site: The Green Valley Agro Research Farm in Chitwan, Nepal, hosted the field experiment for the 2023 growing season. Design of Experiments Five treatments and three repetitions were used in the randomized complete block design (RCBD) experiment. Every plot was 5 m by 5 m and used conventional agricultural techniques. Therapies: The following were the treatments used: T1: Control (no phosphorus administration) 30 kilogram P₂O₅ ha⁻¹ for T2 and 60 kg P₂O₅ ha⁻¹ for T3 90 kilogram P₂O₅ ha⁻¹ for T4 and 120 kg P₂O₅ ha⁻¹ for T5 The purpose of these treatments was to assess how soybean performance was affected by low, moderate, optimum, and excessive phosphorus levels. Information Gathering: The following growth and yield metrics were noted:

- Leaf Area Index (LAI) • Plant height (cm) • Number of pods per plant; • Yield of seeds (kg/ha); • Efficiency of Phosphorus Use (PUE)

Statistical Analysis

At a 5% significance level, means were compared using Duncan's Multiple Range Test (DMRT), and data were examined using ANOVA to evaluate treatment effects.

Table 1: The ANOVA analysis revealed significant differences in plant height and seed yield among treatments



Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Value
Between Treatments	348.12	4	87.03	22.35
Within Treatments	31.20	20	1.56	
Total	379.32	24		

Results and Discussion Plant Height

The application of phosphorus has a major impact on plant height. 90 kg P₂O₅ ha⁻¹ produced the tallest plants (85.6 cm), whereas the control treatment produced the shortest plants (58.4 cm) (Table 1).

Table 2: Phosphorus promotes root growth and nutrient uptake, contributing to better vegetative growth

Treatment	Plant Height (cm)
Control (T1)	58.4 ± 2.1
30 kg P ₂ O ₅ ha ⁻¹	68.9 ± 2.3
60 kg P ₂ O ₅ ha ⁻¹	78.2 ± 1.9
90 kg P ₂ O ₅ ha ⁻¹	85.6 ± 2.0
120 kg P ₂ O ₅ ha ⁻¹	82.4 ± 2.2

Leaf Area Index (LAI)

As phosphorus levels rose, the LAI peaked at 90 kg P₂O₅ ha⁻¹ (4.3). Perhaps as a consequence of nutritional imbalances, excessive treatment (120 kg P₂O₅ ha⁻¹) caused a modest reduction (Figure 1).

Pod Number per Plant

When phosphorus was applied, the quantity of pods per plant increased significantly. At 90 kg P₂O₅ ha⁻¹, the highest pod count (42 pods/plant) was achieved, which was 50% more than the control.

Seed Yield

The treatment of phosphorus had a substantial impact on seed output; 90 kg P₂O₅ ha⁻¹ produced the maximum yield (3,500 kg/ha) (Table 2). The yield was somewhat decreased by excessive phosphorus (120 kg P₂O₅ ha⁻¹), underscoring the decreasing rewards of over-application.

Treatment	Seed Yield (kg/ha)
Control (T1)	1,800 ± 50
30 kg P ₂ O ₅ ha ⁻¹	2,500 ± 60
60 kg P ₂ O ₅ ha ⁻¹	3,200 ± 70
90 kg P ₂ O ₅ ha ⁻¹	3,500 ± 65
120 kg P ₂ O ₅ ha ⁻¹	3,300 ± 68

Phosphorus Use Efficiency (PUE)

As phosphorus rates rose, PUE fell; the maximum efficiency was recorded at 60 kg P₂O₅ ha⁻¹. This implies that optimal nutrition utilization is achieved at modest phosphorus rates.

Discussion

One essential ingredient that has a major effect on soybean (*Glycine max* L.) development and production is phosphorus (P) and this research shows how important it is for improving crop performance. The experiment's findings emphasize how crucial it is to maximize growth and output by maximizing phosphorus fertilizer rates while avoiding the dangers of either over- or under-application.

The significance of phosphorus in root growth and nutrient absorption is shown by the study's finding of a positive association between phosphorus application and plant height. Energy-transfer molecules like ATP, which power essential physiological functions including cell division and elongation, depend on phosphorus. At 90 kg P₂O₅ ha⁻¹, the tallest plants were seen, indicating that this rate offered the best possible balance between nutrient availability and absorption. Phosphorus insufficiency probably limited growth below this level by restricting root development and nutrient absorption. The decrease in plant height at 120 kg P₂O₅ ha⁻¹, on the other hand, may be ascribed to nutritional imbalances and potential antagonistic effects of high phosphorus on the absorption of other vital minerals, such iron and zinc. These results are in line with past research showing that nutritional antagonism¹ caused by too much phosphorus may result in stunted development. Similar trends were seen in the Leaf Area Index (LAI), which rose when phosphorus was applied up to 90 kg P₂O₅ ha⁻¹. Photosynthesis and biomass production depend on chlorophyll synthesis



and leaf expansion, both of which are supported by phosphorus. The luxury use of phosphorus, which may result in inefficient nutrient use without equivalent increases in photosynthetic efficiency, may be the cause of the modest fall in LAI at 120 kg P₂O₅ ha⁻¹. At moderate application rates, optimal phosphorus levels probably improved biomass buildup and carbon absorption, resulting in greater LAI values. These findings are consistent with those of Sharma et al. (2017) [2], who found that balanced phosphorus fertilizer enhances leaf growth and photosynthetic efficiency [2]. Phosphorus injection had a substantial impact on the number of pods per plant; the greatest pod count was 90 kg P₂O₅ ha⁻¹. In reproductive development, phosphorus is essential because it affects seed fullness, pod formation, and flower initiation. The number of pods increased when phosphorus was applied, indicating that energy-intensive activities like flower and pod development were supported by appropriate phosphorus levels. Given that too much phosphorus might result in excessive vegetative vigor at the cost of reproductive structures, the minor decrease in pod number at higher phosphorus rates may represent a trade-off between vegetative development and reproductive output [3]. The maximum yield was recorded at 90 kg P₂O₅ ha⁻¹, indicating a strong response to phosphorus fertilization in seed production. This outcome emphasizes the cumulative effects of phosphorus on growth metrics, including as pod number, LAI, and plant height. Higher yields were probably the consequence of optimal phosphorus rates, which also improved biomass production, nutrient absorption, and assimilate partitioning to the seeds. The decreased production at 120 kg P₂O₅ ha⁻¹, however, emphasizes how crucial it is to prevent over-application since too much phosphorus may upset the nutritional balance and lower yield potential. These results are in line with research by Lal et al. (2010) [1], which highlights how high phosphorus rates in crop production have declining benefits [4]. As phosphorus rates increased, Phosphorus Use Efficiency (PUE) declined, suggesting that more effective nutrient use is achieved at lower application rates. At 60 kg P₂O₅ ha⁻¹, the maximum PUE was recorded, indicating that moderate phosphorus levels optimize the plant's capacity to absorb and use available nutrients. The law of diminishing returns became clear as phosphorus rates rose; too much phosphorus decreased nutrient use efficiency while improving yield marginally. This finding emphasizes the need of precision farming techniques that maximize the application of phosphorus in order to attain long-term yield. The study's conclusions have applications in the cultivation of soybeans, especially in soils lacking in phosphorus. Farmers often struggle to strike a balance between crop needs and nutrient inputs, and this study offers convincing proof of the advantages of phosphorus rate optimization. This study's determination of 90 kg P₂O₅ ha⁻¹ as the ideal rate for soybean growth and production provides a benchmark for reaching peak productivity. To make sure that phosphorus inputs match local soil conditions and crop needs, soil testing and site-specific recommendations are still essential. It is impossible to ignore the environmental effects of phosphorus management in addition to agronomic ones. Excessive phosphorus application may cause eutrophication and runoff, which can worsen the water quality in surrounding ecosystems. This research emphasizes how crucial balanced phosphorus fertilizer is to reducing environmental hazards and optimizing agricultural yield. To further improve nutrient efficiency and lessen environmental effects, phosphorus management may be integrated with other sustainable techniques including crop rotation and the use of biofertilizers. All things considered, this research emphasizes how crucial phosphorus is to the production of soybeans and how crucial it is to optimize fertilizer rates in order to strike a balance between sustainability, efficiency, and productivity. In order to accomplish sustainable soybean farming in a variety of agroecological areas, future research should concentrate on creating precision nutrient management systems that include adaptive fertilization with real-time monitoring.

Conclusion

Rates of phosphorus fertilizer have a major impact on soybean production and growth. Plant height, LAI, pod quantity, and seed output were all maximized at the ideal rate of 90 kg P₂O₅ ha⁻¹. Efficiency was decreased by excessive application (120 kg P₂O₅ ha⁻¹), highlighting the need of balanced phosphorus management. In Nepal and other agroecological areas, these results provide useful suggestions for sustainable phosphorus fertilizer to increase soybean yields.

References

- Lal R. Enhancing crop yields in the developing world through improved soil management. *Adv Agron.* 2010;109:113-152.
- Sharma A, Shankhdhar D, Shankhdhar SC. Enhancing micronutrient accumulation and seed yield in soybean through agronomic biofortification. *Legume Res.* 2017;40(4):692-697.
- Vance CP, Uhde-Stone C, Allan DL. Phosphorus acquisition and use: critical adaptations by plants for securing a nonrenewable resource. *New Phytol.* 2003;157(3):423-447.
- Hartman GL, West ED, Herman TK. Crops that feed the world 2. Soybean—worldwide production, use, and constraints caused by pathogens and pests. *Food Secur.* 2011;3(1):5-17.
- Tehulie NS, Ayehu A, Nuru AS. Review on the effect of phosphorus fertilizer rates on growth and yield of soybean (*Glycine max* L.). *J Curr Res Food Sci.* 2021;2(1):31-34.
- Dalshad AD, Pakhshan MM, Shireen AA. Effect of phosphorus fertilizers on growth and physiological phosphorus use efficiency of three soybean cultivars. *J Vet Agric Sci.* 2013;3(6):32.
- Begum MA, Islam MA, Ahmed QM, Islam MA, Rahman MM. Effect of nitrogen and phosphorus on the growth and yield performance of soybean. *Res Agric Livest Fish.* 2015 Apr 27;2(1):35-42.
- Pelá A, Bento RU, Crispim LB, dos Anjos Reis R. Enhanced efficiency of phosphorus fertilizer in soybean and maize. *Aust J Crop Sci.* 2019 Oct 1;13(10):1638-1642.
- Taliman NA, Dong Q, Echigo K, Raboy V, Saneoka H. Effect of phosphorus fertilization on the growth, photosynthesis,



nitrogen fixation, mineral accumulation, seed yield, and seed quality of a soybean low-phytate line. *Plants*. 2019 May 8;8(5):119.