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Effect of Different Levels of Diammonium Phosphate (DAP) Fertilizer on Growth and Yield of Chickpea (Cicer arietinum L.) Variety Flip 94

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ABSTRACT: Chickpea (Cicer arietinum L.) is an important pulse crop valued for its nutritional quality and role in sustainable agriculture. However, productivity is often constrained by low soil fertility and poor nutrient management, particularly phosphorus deficiency. A field experiment was conducted during the 2025 growing season at the Research Farm of the Faculty of Agriculture, Kabul University, Afghanistan, to evaluate the effect of different levels of diammonium phosphate (DAP) fertilizer on growth and yield of chickpea variety Flip 94. The experiment was arranged in a Randomized Complete Block Design (RCBD) with five DAP levels (0, 50, 100, 150, and 200 kg ha^{-1}) and three replications. Results showed that DAP application significantly influenced all growth and yield parameters, while replication effects were non-significant. Treatment 3 (100 kg ha^{-1} DAP) consistently performed best, recording the highest plant height (34.23 cm), number of branches per plant (4.92), number of pods per plant (37.47), grains per pod (1.93), and grain yield (5.52 t ha^{-1}). In contrast, the control treatment recorded the lowest values for all studied traits. The improved performance under optimal DAP application is attributed to enhanced nutrient availability, better root development, increased nodulation, and improved photosynthetic efficiency, which collectively supported stronger vegetative growth and reproductive development. In conclusion, application of DAP fertilizer significantly improves chickpea growth and yield under Kabul agro-climatic conditions. Treatment 3 (100 kg ha^{-1} DAP) was identified as the most effective dose for maximizing productivity of chickpea variety Flip 94.

KEYWORDS: Chickpea, Diammonium phosphate (DAP), Fertilizer levels, Phosphorus, Yield components

INTRODUCTION

Chickpea (Cicer arietinum L.) is one of the most important pulse crops cultivated worldwide and belongs to the family Fabaceae. It is widely grown in Asia, Africa, Europe, Australia, and the Americas, playing a major role in global food and nutritional security. Among pulses, chickpea is highly valued for its adaptability to dryland and low-input farming systems, where it can produce relatively stable yields under unfavorable conditions[1,2]. The crop is mainly cultivated in semi-arid and subtropical regions, with the Indian subcontinent contributing a major share of global production. Chickpea is considered an important component of sustainable agriculture due to its low production cost, drought tolerance, and ability to improve soil fertility.

In Afghanistan, chickpea is cultivated in several provinces under both rain fed and irrigated conditions. It is grown primarily for human consumption and serves as a vital source of protein for rural populations. With increasing population growth and limited access to animal protein, pulse crops have become essential for food and nutritional security. Chickpea seeds contain approximately 18–24% protein, along with carbohydrates, dietary fiber, vitamins, and essential minerals such as iron, zinc, calcium, and magnesium[3,4]. Because of its rich nutritional composition, chickpea is considered an affordable food source for low-income communities. Regular consumption has been associated with improved digestion, glycemic control, and reduced risk of chronic diseases.

Beyond its nutritional value, chickpea contributes to sustainable farming systems through biological nitrogen fixation. Like other legumes, chickpea forms a symbiotic relationship with Rhizobium bacteria in root nodules, converting atmospheric nitrogen into plant-available forms. This reduces dependence on synthetic nitrogen fertilizers and improves soil fertility for subsequent crops[5,1]. Inclusion of chickpea in cereal-based rotations enhances soil structure, increases organic matter, improves nutrient cycling, and supports sustainable production systems. However, nitrogen fixation efficiency depends strongly on soil fertility and nutrient availability, particularly phosphorus.

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Phosphorus is an essential macronutrient required for plant growth and development. It plays a central role in energy transfer, root development, nodulation, flowering, seed formation, and overall metabolism. In legumes, phosphorus is especially critical because nitrogen fixation is energy-demanding[6,7]. Deficiency restricts root growth, reduces nodulation, limits nitrogen fixation, and decreases productivity. Poor phosphorus availability often results in stunted growth, delayed maturity, fewer pods, and lower yield. In many agricultural soils, especially calcareous and alkaline soils, phosphorus availability is naturally low due to fixation with soil minerals. To overcome this, farmers commonly apply phosphorus fertilizers, with diammonium phosphate (DAP) being one of the most widely used sources as it supplies both nitrogen and phosphorus. DAP is typically applied at sowing to promote early root development and vigorous growth. However, efficiency is often low because much of the applied phosphorus becomes fixed, reducing use efficiency and increasing production costs[8,9].
The response of chickpea to DAP depends on soil fertility, environmental conditions, crop variety, and application rate. Appropriate phosphorus application improves root growth, nodulation, vigor, pod formation, and yield. Insufficient application results in poor performance, while excessive use may cause nutrient imbalance and economic loss. Determining the optimum DAP rate is therefore essential for improving productivity and maintaining soil fertility.
Recent studies show that integrated nutrient management, combining chemical fertilizers, organic amendments, and biofertilizers, can significantly improve chickpea growth and yield. Rhizobium inoculation and phosphate-solubilizing bacteria increase nutrient availability, nodulation, and yield components[5,10]. Organic amendments such as farmyard manure and compost improve soil structure, water-holding capacity, microbial activity, and nutrient cycling, supporting long-term fertility. Despite these advances, DAP remains the most commonly used phosphorus fertilizer due to its availability and ease of application.
In Afghanistan, limited research has been conducted to determine appropriate DAP levels for chickpea under local agro-climatic conditions. Farmers often rely on traditional practices rather than scientific recommendations, leading to under- or over-application. This reduces efficiency, limits productivity, and increases costs.
Therefore, this study was conducted to assess the effect of different levels of DAP on chickpea growth, yield, and yield components under Kabul conditions. The objective was to identify the optimum DAP level for improving vegetative growth, pod formation, grain yield, and phosphorus use efficiency. The findings are expected to provide practical recommendations for farmers, enhance productivity, improve soil fertility, and support sustainable agriculture in Afghanistan.

MATERIALS AND METHODS

Study Site and Climate: The experiment entitled "Effect of Different Levels of Diammonium Phosphate (DAP) Fertilizer on Growth, Yield, and Phosphorus Use Efficiency of Chickpea (Cicer arietinum* L.) Variety Flip 94"* was conducted during the 2025 growing season at the Research Farm of the Faculty of Agriculture, Kabul University, Afghanistan (34.3104°N, 69.0823°E; 1809 m above sea level). Kabul has a cold semi-arid climate with cold winters and hot, dry summers. During 2025, the average annual temperature was 12.1°C, and rainfall was approximately 332 mm, mostly received in March and April[1].

Soil Characteristics: Soil samples (0–30 cm depth) were analyzed before sowing. The soil was sandy loam, slightly alkaline (pH 7.8), with 0.9% organic matter, 0.03% total nitrogen, and 1.83 ppm available phosphorus. Calcium carbonate content was 12%, and cation exchange capacity (CEC) was 16.4 meq 100 g^{-1}, indicating moderate nutrient-holding capacity but generally poor fertility[2].

Plant Material and Sowing: The chickpea variety Flip 94 was used. Certified seeds with ~90% germination were sown manually in early March, two seeds per hill, later thinned to one healthy plant per stand. Germination began five days after sowing, with >90% emergence observed within a week[3].

Treatments and Experimental Design: Five levels of diammonium phosphate (DAP) fertilizer were tested:

- T_1 = 0 kg ha^{-1}
- T_2 = 50 kg ha^{-1}
- T_3 = 100 kg ha^{-1}
- T_4 = 150 kg ha^{-1}
- T_5 = 200 kg ha^{-1}

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DAP was applied as a basal dose during final land preparation. The experiment followed a Randomized Complete Block Design (RCBD) with three replications. Each plot measured 2 m × 2 m, with 20 cm row spacing. RCBD is widely used in agronomic trials to minimize experimental error and improve reliability[4].

Crop Management: Land preparation included ploughing, harrowing, residue removal, and leveling. Thinning was done at 15 days after sowing. Hand weeding was performed as needed to reduce competition. Irrigation was applied weekly depending on crop requirements and soil moisture status.

Harvesting and Data Collection: Harvesting was completed in August–September. Border rows were excluded, and ten plants per plot were sampled. Plant samples were dried, cleaned, and weighed.

Parameters Recorded

Data were collected on:

- Plant height (cm)
- Number of leaves per plant
- Number of branches per plant
- Number of pods per plant
- Number of grains per pod
- Grain yield (t ha^{-1})

Grain yield was calculated from net plot yield and converted to tons per hectare.

Statistical Analysis: Data were analyzed using Analysis of Variance (ANOVA) in STAR software. Treatment means were compared using the Least Significant Difference (LSD) test at 5% probability level[5].

RESULTS

The data on plant height, number of branches per plant, number of pods per plant, grains per pod, and grain yield is presented in Tables 1–5. The analysis of variance indicated that treatments had a significant effect on all studied parameters except replication effects, which were non-significant.

The highest plant height was recorded under Treatment 3 (34.23 cm), while the lowest was observed in Treatment 2 (31.27 cm). Treatments 4 and 5 showed intermediate values (32.90 cm and 32.87 cm, respectively), and were statistically at par with each other.

The number of branches per plant was significantly affected by treatments. The highest number of branches was recorded under Treatment 3 (4.92), while the lowest was observed under Treatment 1 (2.70). Treatments 2, 4, and 5 showed intermediate values and were statistically similar in some cases.

Similarly, the number of pods per plant varied significantly among treatments. The highest pods per plant were observed under Treatment 3 (37.47), while the lowest was recorded under the control treatment (19.80). Treatments 5, 4, and 2 showed intermediate values and did not differ significantly from each other in some cases.

Grains per pod also showed a significant response to treatments. The highest value was recorded under Treatment 3 (1.93), while the lowest was observed under Treatment 1 (0.85). Treatments 2, 4, and 5 were statistically at par and showed intermediate values.

Grain yield showed significant variation among treatments. The highest yield was recorded under Treatment 3 (5.52 t ha^{-1}), while the lowest yield was observed under Treatment 1 (2.20 t ha^{-1}). Treatments 4, 2, and 5 showed intermediate grain yields (4.29, 3.83, and 3.31 t ha^{-1}, respectively), with some treatments being statistically at par.

DISCUSSION

The data on plant height, number of branches per plant, number of pods per plant, grains per pod, and grain yield are presented in Figure 1–5. Analysis of variance indicated that treatments had a significant effect on all studied parameters, while replication effects were non-significant.

Plant Height: The highest plant height was recorded under Treatment 3 (34.23 cm), while the lowest was observed in Treatment 2 (31.27 cm). Treatments 4 and 5 showed intermediate values (32.90 cm and 32.87 cm, respectively), and were statistically at par with each other. Similar findings on phosphorus fertilization improving vegetative growth have been reported in chickpea by Mehrotra et al. (2023) and Arriagada et al. (2022)[1,2].

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Number of Branches per Plant: The number of branches per plant was significantly affected by treatments. The highest number was recorded under Treatment 3 (4.92), while the lowest was observed under Treatment 1 (2.70). Treatments 2, 4, and 5 showed intermediate values. These results are consistent with earlier studies highlighting phosphorus's role in branching and nodulation[3].
Number of Pods per Plant: The number of pods per plant varied significantly among treatments. The highest pods per plant were observed under Treatment 3 (37.47), while the lowest was recorded under the control treatment (19.80). Treatments 5, 4, and 2 showed intermediate values. Similar pod formation responses to phosphorus fertilization have been documented by Pandao et al. (2025)[4].

Grains per Pod: Grains per pod also showed a significant response to treatments. The highest value was recorded under Treatment 3 (1.93), while the lowest was observed under Treatment 1 (0.85). Treatments 2, 4, and 5 were statistically at par and showed intermediate values.

Grain Yield: Grain yield showed significant variation among treatments. The highest yield was recorded under Treatment 3 (5.52 t ha^{-1}), while the lowest yield was observed under Treatment 1 (2.20 t ha^{-1}). Treatments 4, 2, and 5 showed intermediate yields (4.29, 3.83, and 3.31 t ha^{-1}, respectively). These findings align with previous reports that phosphorus fertilization enhances chickpea yield and phosphorus use efficiency[5].

CONCLUSION

The present study demonstrated that different diammonium phosphate (DAP) fertilizer treatments had a significant effect on all growth and yield parameters of chickpea (Cicer arietinum L.), while replication effects were non-significant. This confirms that the observed differences among treatments were primarily due to fertilizer application rather than field variability.
Among all treatments, Treatment 3 (100 kg ha^{-1} DAP) consistently performed best, recording the highest plant height, number of branches per plant, pods per plant, grains per pod, and grain yield. The superior performance under this treatment highlights the importance of balanced nutrient availability, which enhanced root development, nodulation, photosynthetic efficiency, and assimilate partitioning. These physiological improvements collectively supported stronger vegetative growth and reproductive development, leading to higher yield.
Other treatments showed moderate improvements, while the control treatment consistently recorded the lowest values, underscoring the critical role of phosphorus fertilization in chickpea production. The findings align with earlier studies that emphasized phosphorus as a limiting nutrient in legumes, directly influencing nodulation, nitrogen fixation, and yield potential[1–3].
In conclusion, proper DAP fertilizer management is essential for improving chickpea productivity under Kabul agro-climatic conditions. The study identified 100 kg ha^{-1} DAP as the optimum dose for maximizing growth and yield of chickpea variety Flip 94. Adoption of this recommendation can help farmers achieve higher productivity, reduce production costs, and improve phosphorus use efficiency. Furthermore, integrating DAP application with organic amendments and biofertilizers may provide additional long-term benefits for soil fertility and sustainability, as suggested by recent nutrient management studies[4,5].

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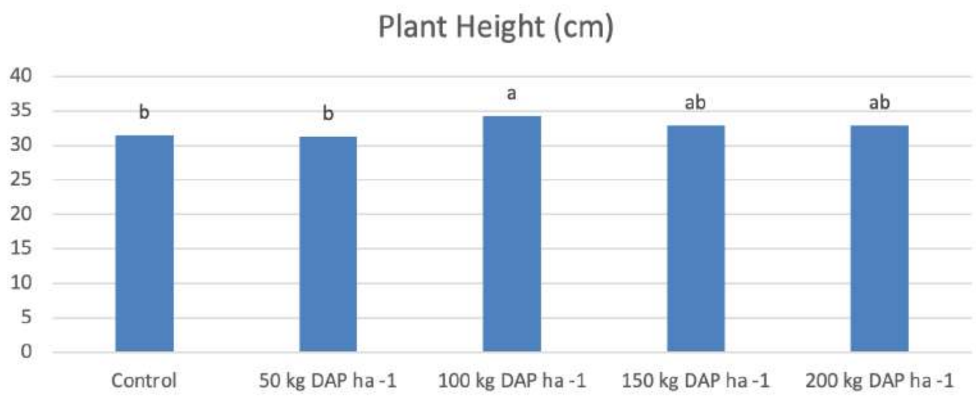

Figure 1. Plant height (cm)

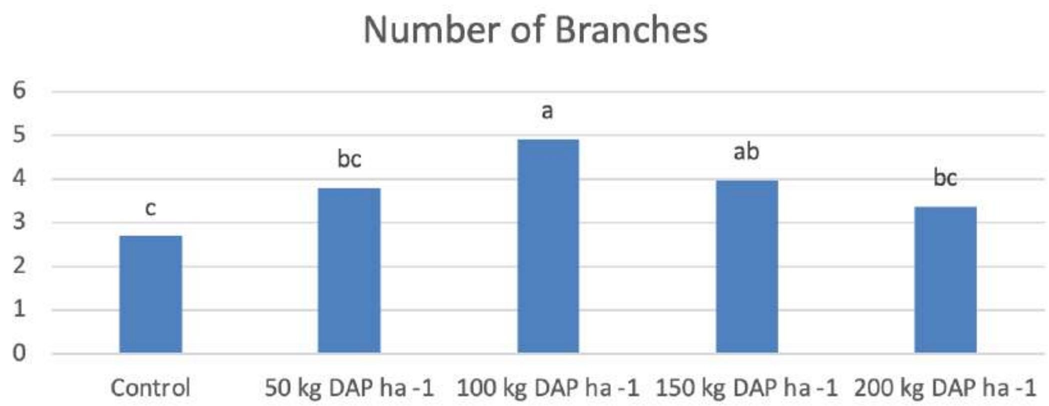

Figure 2. Number of Branches per plant

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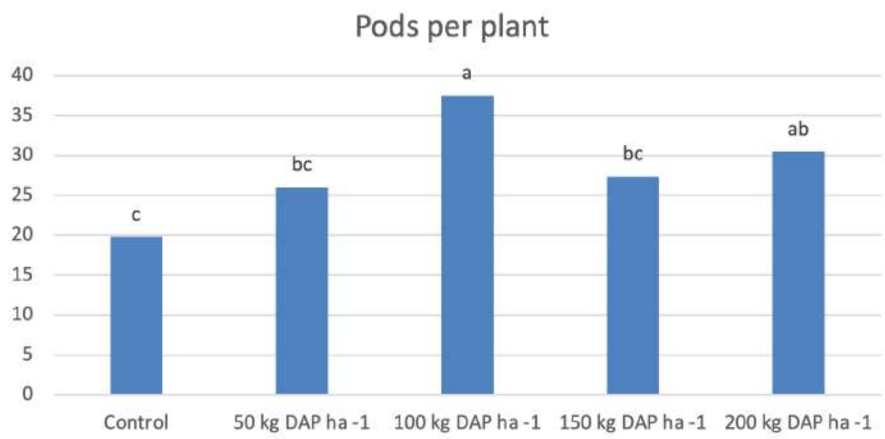

Figure 3. Number of Branches per plans

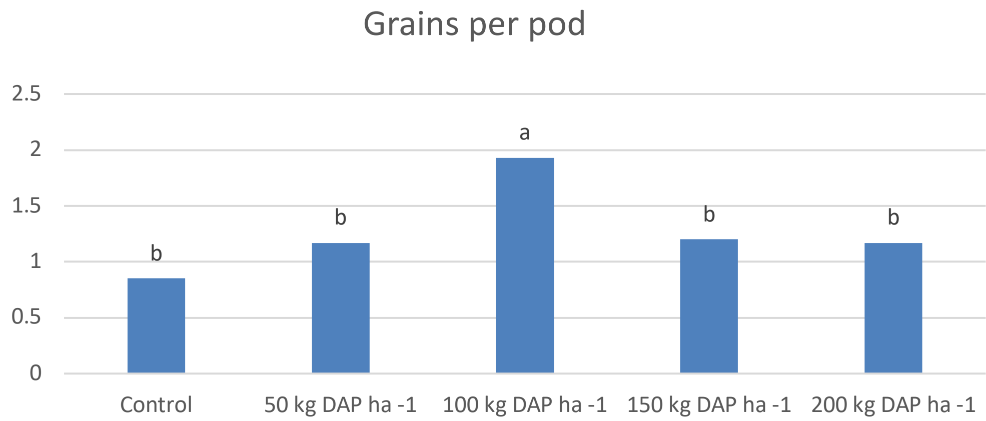

Figure 4. Number of Grains per pod

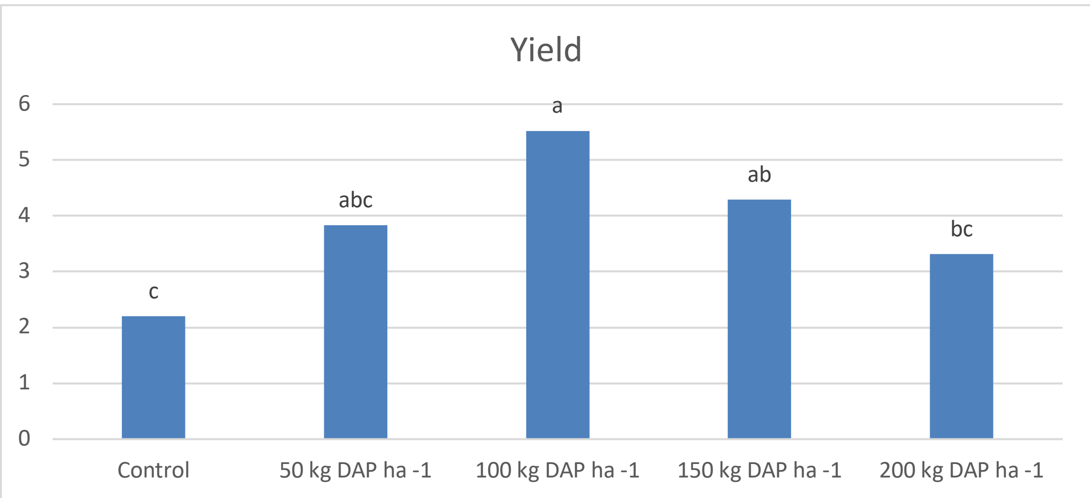

Figure 5. Yield t per hectare