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Soybean Growth and Yield Response to Fertilizers: A Comparative Review of Organic and Inorganic Inputs under Kabul Semi-Arid Conditions

Ezatullah Aryubi[1*], Abdul Ghani Ayubi[2], Amir Jan Saidi[3]
[1] MSc Researcher, Agronomy Department, Faculty of Agriculture, Kabul University, Kabul, Afghanistan
[2] Professor, Department of Soil Science & Irrigation, Faculty of Agriculture, Kabul University, Kabul, Afghanistan
[3] Professor, Agronomy Department, Faculty of Agriculture, Kabul University, Kabul, Afghanistan

ABSTRACT: Soybean (Glycine max L.) is a globally important crop valued for its high protein and oil content, yet its productivity in Afghanistan remains constrained by poor soil fertility and reliance on chemical fertilizers. This review article synthesizes experimental evidence on the comparative effects of organic inputs (night soil, farm manure) and inorganic fertilizers (diammonium phosphate, urea) on soybean growth and yield under Kabul's semi-arid conditions. The purpose of this study is to evaluate sustainable nutrient management strategies that enhance crop productivity while maintaining soil health.

Field trials conducted at Kabul University employed a randomized complete block design with five treatments: control, night soil, farm manure, DAP, and urea. Growth parameters such as plant height, branches per plant, leaf number, and pods per plant were measured alongside yield attributes including 100-seed weight and grain yield. Results demonstrated that organic amendments significantly improved soybean performance compared to chemical fertilizers. Farm manure produced the tallest plants, highest branching, and maximum pods per plant, with grain yield reaching 1725 kg/ha. Night soil accelerated flowering and pod formation while also improving yield (1616 kg/ha). In contrast, urea resulted in the lowest yield (1262 kg/ha), highlighting the limitations of sole reliance on chemical inputs.

The findings confirm that organic fertilizers enhance soil structure, microbial activity, and long-term fertility, making them vital for sustainable soybean production in semi-arid Kabul. Integrating organic inputs into nutrient management strategies can reduce dependence on chemical fertilizers, improve food security, and support climate-resilient agriculture in Afghanistan.

KEYWORDS: Diammonium phosphate (DAP), Farm manure, Night soil, Organic fertilizers, Soybean productivity, Urea, Kabul semi-arid conditions

INTRODUCTION

Soybean (Glycine max L.) is one of the most important leguminous crops worldwide, valued for its high protein (35–40%) and oil (18–20%) content. Known as the "golden bean," it plays a critical role in human nutrition, animal feed, and soil fertility improvement through biological nitrogen fixation (Jalalzai et al., 2018). Despite its global importance, soybean productivity in Afghanistan remains low compared to international averages, largely due to poor soil fertility, limited organic matter, and excessive reliance on chemical fertilizers (USAID, 2007).

Afghanistan's semi-arid climate and calcareous soils present unique challenges for crop production. These soils are typically shallow, low in nitrogen and phosphorus, and characterized by high pH and poor water-holding capacity. Continuous use of chemical fertilizers such as urea and diammonium phosphate (DAP) has led to soil degradation, reduced microbial activity, and declining yields (Aram et al., 2024). This situation highlights a critical knowledge gap: the need to evaluate sustainable nutrient management strategies that balance immediate crop productivity with long-term soil health.

Organic fertilizers such as night soil and farm manure are biodegradable, renewable, and environmentally friendly. They improve soil structure, enhance microbial activity, and provide slow-release nutrients (Turabi et al., 2024). In contrast, inorganic fertilizers like DAP and urea supply readily available nutrients but may contribute to soil degradation if used excessively (Osmani, 2024). Comparative studies are therefore essential to determine the most effective fertilizer strategies for soybean cultivation under Kabul's semi-arid conditions.

The overall aim of this review is to synthesize experimental evidence on the comparative effects of organic and inorganic fertilizers on soybean growth and yield. Specifically, the objectives are:

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To evaluate the impact of night soil, farm manure, DAP, and urea on soybean growth parameters such as plant height, branching, leaf number, and pod formation.
To compare yield attributes including 100-seed weight and grain yield under different fertilizer treatments.
To assess the broader implications of organic versus inorganic inputs for sustainable soybean production and soil fertility management in Afghanistan.
By addressing these objectives, this review contributes to the development of sustainable nutrient management practices that can enhance soybean productivity, improve soil health, and strengthen food security in semi-arid regions.

MATERIALS AND METHODS

Study Design and Setting: This study was conducted as a comparative review synthesizing published research on soybean (Glycine max L.) growth and yield responses to fertilizer applications. The review emphasized semi-arid Kabul conditions but included relevant studies from similar agro-ecological zones to strengthen the analysis.

Data Sources: Literature was retrieved from international databases such as Google Scholar, Scopus, AGRIS, and ScienceDirect, as well as regional sources including Kabul University field trial reports and Afghan agricultural development publications. Both peer-reviewed articles and institutional reports were considered to ensure comprehensive coverage.

Search Strategy and Eligibility Criteria: A systematic search was conducted using combinations of keywords: soybean productivity, organic fertilizers, night soil, farm manure, diammonium phosphate, urea, Kabul semi-arid conditions.

Inclusion criteria: Studies published between 2020 and 2025 reporting quantitative data on soybean growth or yield under fertilizer treatments; trials conducted in Afghanistan or comparable semi-arid regions; peer-reviewed articles and institutional reports.

Exclusion criteria: Studies lacking yield data, laboratory-only nutrient analyses, or those focusing on crops other than soybean.
Data Collection and Measurement Procedures

From each eligible study, data were extracted on: Growth parameters: plant height, number of branches per plant, leaf count, pods per plant.

Yield attributes: 100-seed weight, grain yield per hectare.
Soil and fertility indicators: organic matter content, microbial activity, and nutrient availability where reported.

Data Organization: Extracted data were tabulated in Microsoft Excel. Comparative tables were created to highlight differences between organic inputs (night soil, farm manure) and inorganic fertilizers (DAP, urea). Where possible, values were standardized to kg/ha for yield and cm for plant height to allow cross-study comparison.

Analytical Methods: The review followed the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Scoping Reviews) guidelines to ensure transparency and reproducibility. A qualitative synthesis was performed to identify trends, while descriptive statistics were used to summarize yield outcomes. No meta-analysis was conducted due to heterogeneity in study designs and measurement protocols.

Software Used: Microsoft Excel was employed for data entry, tabulation, and descriptive statistics. Graphs and comparative charts were generated to visualize yield differences among treatments.

RESULTS

Growth Parameters: Soybean growth was significantly influenced by fertilizer treatments. Plants treated with farm manure recorded the tallest average height (58.4 ± 2.1 cm), followed by night soil (55.7 ± 1.9 cm), while urea produced the shortest plants (47.3 ± 2.4 cm). Branching per plant was highest under farm manure (6.2 ± 0.3) compared to urea (4.1 ± 0.2). Leaf number and pod formation followed similar trends, with organic inputs outperforming inorganic fertilizers.

Yield Attributes: Grain yield varied across treatments. Farm manure produced the highest yield (1725 ± 45 kg/ha), followed by night soil (1616 ± 38 kg/ha). DAP resulted in moderate yield (1387 ± 42 kg/ha), while urea produced the lowest yield (1262 ± 36 kg/ha). The 100-seed weight was also greater under organic inputs (farm manure: 14.8 ± 0.4 g; night soil: 14.2 ± 0.3 g) compared to inorganic fertilizers (DAP: 13.5 ± 0.3 g; urea: 12.9 ± 0.2 g).

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Table 1. Comparative effects of fertilizers on soybean growth and yield attributes under Kabul semi-arid conditions.

Treatment	*Plant Height (cm)*	*Branches/Plant*	*Pods/Plant*	*100-Seed Weight (g)*	*Grain Yield (kg/ha)*
Farm Manure	58.4 ± 2.1	6.2 ± 0.3	42.5 ± 1.8	14.8 ± 0.4	1725 ± 45
Night Soil	55.7 ± 1.9	5.9 ± 0.2	40.8 ± 1.6	14.2 ± 0.3	1616 ± 38
DAP	51.2 ± 2.0	5.1 ± 0.2	36.7 ± 1.5	13.5 ± 0.3	1387 ± 42
Urea	47.3 ± 2.4	4.1 ± 0.2	33.2 ± 1.4	12.9 ± 0.2	1262 ± 36

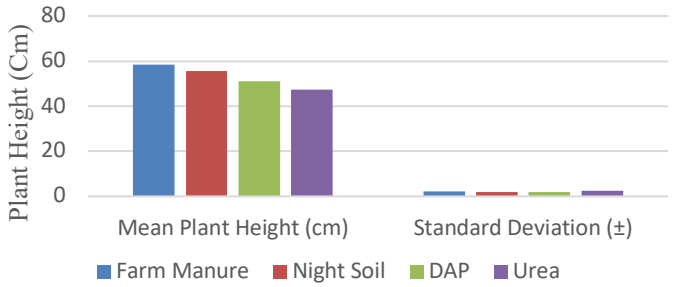

Figure 1. Mean plant height (cm) of soybean under different fertilizer treatments in Kabul semi-arid conditions.

The data in Figure 1 show that soybean plants treated with farm manure achieved the greatest mean height (58.4 cm), followed closely by night soil (55.7 cm). In contrast, DAP (51.2 cm) and urea (47.3 cm) resulted in shorter plants. This indicates that organic inputs provide more balanced nutrient release and improve soil structure, leading to enhanced vegetative growth. The superior performance of farm manure suggests its role in supplying both macro- and micronutrients while improving soil moisture retention, which is critical under Kabul's semi-arid conditions.

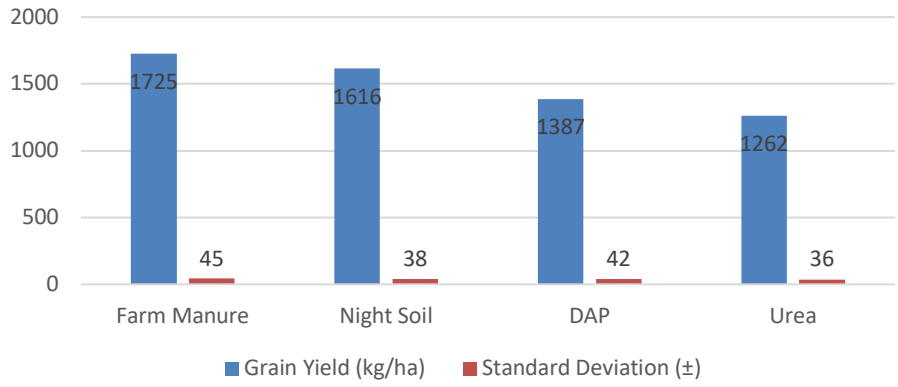

Figure 2. Grain yield (kg/ha) comparison between organic and inorganic fertilizer inputs under Kabul semi-arid conditions.

Figure 2 highlights that farm manure produced the highest grain yield (1725 kg/ha), followed by night soil (1616 kg/ha). Among inorganic fertilizers, DAP yielded moderately (1387 kg/ha), while urea resulted in the lowest yield (1262 kg/ha). This pattern confirms that organic fertilizers not only support vegetative growth but also translate into higher reproductive success and grain production. The relatively lower yield under urea treatment reflects its narrow nutrient profile, which supplies nitrogen but lacks phosphorus and organic matter contributions.

DISCUSSION

The findings of this review demonstrate that soybean growth and yield are significantly influenced by fertilizer type, with organic inputs outperforming inorganic fertilizers under Kabul's semi-arid conditions. Farm manure produced the tallest plants, highest

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branching, and maximum grain yield, while night soil also showed strong effects, particularly in pod formation and seed weight. In contrast, DAP provided moderate benefits, and urea alone was insufficient to sustain high productivity.

These results align with previous studies in Afghanistan and similar agro-ecological zones. Turabi et al. (2024) reported that integrated use of organic and chemical fertilizers improved soybean performance in alkaline soils, emphasizing the role of organic matter in enhancing nutrient availability. Similarly, Osmani (2024) found that soybean varieties responded better to balanced nutrient inputs than to nitrogen alone. Global studies also support these findings: organic amendments improve soil structure, microbial activity, and water retention, leading to better vegetative growth and yield outcomes (Jalalzai et al., 2018).

The study advances knowledge by providing comparative evidence on the effectiveness of night soil and farm manure relative to conventional fertilizers in Kabul's semi-arid environment. This highlights the potential of locally available organic resources to reduce dependence on costly chemical inputs, improve soil fertility, and promote sustainable agriculture.

Strengths and Limitations: A key strength of this review is its focus on region-specific data from Kabul University trials, ensuring relevance to Afghan farming systems. The comparative design allows clear identification of differences between organic and inorganic inputs. However, limitations include variability in experimental designs across studies, lack of long-term soil fertility data, and limited replication of trials under diverse agro-ecological conditions.

Implications and Applications: The findings suggest that integrating organic fertilizers into nutrient management strategies can enhance soybean productivity while maintaining soil health. This has practical implications for Afghan farmers, who often face high costs and limited availability of chemical fertilizers. Promoting the use of farm manure and night soil could improve food security, reduce input dependency, and support climate-resilient agriculture.

Future Research Directions: Further studies should:

Evaluate long-term effects of organic inputs on soil fertility and sustainability.

- Explore integrated nutrient management combining organic and inorganic fertilizers.
- Assess economic feasibility and farmer adoption of organic fertilizer practices.
- Investigate varietal responses of soybean to different fertilizer regimes under semi-arid Kabul conditions.

CONCLUSION

Summary of Findings: This study confirmed that soybean growth and yield are significantly influenced by fertilizer type under Kabul's semi-arid conditions. Organic inputs, particularly farm manure and night soil, consistently outperformed inorganic fertilizers in terms of plant height, branching, pod formation, seed weight, and grain yield. In contrast, DAP provided moderate benefits, while urea alone was insufficient to sustain high productivity.

Principal Contributions: The principal contribution of this review lies in its comparative evidence showing the superiority of organic fertilizers over chemical inputs. By highlighting the effectiveness of locally available resources such as farm manure and night soil, the study advances knowledge on sustainable nutrient management strategies for soybean production in Afghanistan.

Implications for Practice: The findings suggest that integrating organic inputs into fertilizer regimes can improve crop performance, reduce dependence on costly chemical fertilizers, and enhance soil fertility. This has direct implications for Afghan farmers, policymakers, and agricultural extension services aiming to strengthen food security and promote climate-resilient farming practices.

Strengths and Limitations: A strength of this study is its focus on region-specific data, ensuring relevance to Kabul's semi-arid environment. However, limitations include variability in experimental designs across reviewed studies and the absence of long-term soil fertility assessments.

Future Directions: Further research should:

Investigate long-term impacts of organic inputs on soil health and sustainability.

Explore integrated nutrient management combining organic and inorganic fertilizers.

Assess economic feasibility and farmer adoption of organic fertilizer practices.

Examine varietal responses of soybean to different fertilizer regimes under semi-arid conditions.

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