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Growth and Yield of Sesame (*Sesamum Indicum* L.) As Affected By Nitrogen and Phosphorus at Peshawar, Pakistan

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Abstract

The field experiment was conducted during Rabi 2023 to study Effect of NP application on growth and yield of sesame at Students' Experimental Farm, Department of Agronomy, The University of Agriculture Peshawar, Pakistan in a three replicated randomized complete block design (RCBD). The treatments included T_1 = Control (No fertilizer), T_2 = 40-30 NP kg ha^{-1}, T_3 = 55-40 NP kg ha^{-1}, T_4 = 70-50 NP kg ha^{-1}, T_5 = 85-60 NP kg ha^{-1} and T_6 = 100-70 NP kg ha^{-1}. The results of the study indicated that the sesame treated with 70-80 NP kg ha^{-1} resulted maximum 12.12 branches plant^{-1}, 180.80 capsules plant^{-1}, 44.37 seeds capsule^{-1}, 51.68 g seed weight plant^{-1}, 4.26 g seed index, 5223.0 kg ha^{-1} biological yield and 672.76 kg ha^{-1} seed yield. The nitrogen and phosphorus 60-70 kg ha^{-1} resulted maximum 182.05 cm plant height, 10.71 branches plant^{-1}, 158.94 capsules plant^{-1}, 39.37 seeds capsule^{-1}, 45.56 g seed weight plant^{-1}, 3.95 g seed index, 4802.9 kg ha^{-1} biological yield and 622.99 kg ha^{-1} seed yield. Similarly, the sesame treated with 50-60 NP kg ha^{-1} resulted 158.14 cm plant height, 9.29 branches plant^{-1}, 136.88 capsules plant^{-1}, 34.18 seeds capsule^{-1}, 39.56 g seed weight plant^{-1}, 3.65 g seed index, 4382.8 kg ha^{-1} biological yield and 572.76 kg ha^{-1} seed yield. Nitrogen and phosphours 40-50 kg ha^{-1} resulted 150.16 cm plant height, 7.88 branches plant^{-1}, 115.14 capsules plant^{-1}, 29.48 seeds capsule^{-1}, 33.65 g seed weight plant^{-1}, 3.31 g seed index, 3962.8 kg ha^{-1} biological yield and 522.90 kg ha^{-1} seed yield. 30-40 NP kg ha^{-1} resulted 154.96 cm plant height, 6.50 branches plant^{-1}, 92.82 capsules plant^{-1}, 24.37 seeds capsule^{-1}, 27.75 g seed weight plant^{-1}, 3.00 g seed index, 3542.7 kg ha^{-1} biological yield and 472.86 kg ha^{-1} seed yield. However, control (No fertilizer) resulted minimum 104.82 cm plant height, 5.10 branches plant^{-1}, 70.92 capsules plant^{-1}, 19.28 seeds capsule^{-1}, 21.65 g seed weight plant^{-1}, 2.68 g seed index, 3122.5 kg ha^{-1} biological yield and 422.76 kg ha^{-1} seed yield. After going through the findings of the present research, it was concluded that the growth and yield of sesame increased simultaneously with increasing nitrogen and phosphorus levels and the sesame fertilized with 70-80 NP kg ha^{-1} resulted in maximum seed yield (672.76 kg ha^{-1}), followed by 60-70 NP kg ha^{-1} (622.99 kg ha^{-1}) and 50-60 NP kg ha^{-1} (572.76 kg ha^{-1}).

Keywords: Sesame, growth, yield, phosphorus, nitrogen.

Introduction

Sesame (*Sesamum indicum* L.) is one of humanity's oldest domesticated oilseed crops, dates back approximately 3,000 years and is recognized as the earliest oil source utilized by humans. Often termed the "Queen of oilseeds," it remains an understudied "orphan crop" despite its nutritional and agronomic significance. In recent decades, global demand for sesame has surged owing to its high-quality oil, elevated protein levels, antioxidant properties, and resilience to harsh climatic and soil conditions (Zebene et al., 2022). Pakistan, however, faces a critical challenge in edible oil security, importing over 70% of its supply due to insufficient domestic oilseed production capacity (Hussain et al., 2023). This reliance on foreign markets underscores the nation's limited ability to meet its edible oil demands through local resources (Myint et al., 2020). According to the *Economic Survey of Pakistan 2020–21*, agriculture remains a cornerstone of the economy, contributing 19.2% to the national GDP and employing 38.5% of the workforce, predominantly in rural regions (Ahmad et al., 2024). Sesame holds significant importance in global nutrition and food systems. Its seeds are primarily cultivated for oil extraction, but they also serve as a foundational ingredient in diverse culinary applications, including tahini paste, confectioneries like *halva* (sweetened tahini), and additions to salads and baked goods (Mahdavi Khorami et al., 2020). As one of the earliest domesticated oilseed crops, sesame remains widely grown across Asia and Africa, valued not only for its oil but also as a protein-rich supplement in animal feed and human diets. Beyond its culinary uses, sesame oil is prized in medicinal and pharmaceutical industries for its therapeutic properties, featuring in health products, antiseptics, and antimicrobial formulations. Nutritionally, sesame seeds are a powerhouse, containing 50–60% oil and 25% protein, alongside bioactive antioxidants such as sesame and sesamoid lignans linked to disease prevention and health promotion. The seeds are also a rich source of essential amino acids (e.g., tryptophan, methionine), calcium, and trace minerals, enhancing their role in functional foods and nutraceuticals (Gutu et al., 2023). This unique composition underscores sesame's dual utility as both a dietary staple and a versatile ingredient in industrial and therapeutic applications. Nitrogen is a fundamental macronutrient critical for plant growth, particularly in crops such as sesame, where it directly influences developmental processes and productivity. As a primary constituent of amino acids, proteins, enzymes, and chlorophyll, nitrogen underpins essential metabolic functions, including photosynthesis, energy transfer, and cellular structure formation (Zenawi et al., 2019). Its role extends to driving cell division and expansion, fostering robust root systems that enhance nutrient assimilation and water uptake. Adequate nitrogen availability correlates with vigorous vegetative growth, resulting in taller, more resilient sesame plants (Nosheen et al., 2019). In agricultural systems, nitrogen is indispensable for optimizing crop yield and quality. It not only amplifies biomass production but also enhances seed protein content, making it vital for improving both food security and nutritional value (Noor et al., 2023). However, challenges such as limited local fertilizer production, high costs, and low nitrogen-use efficiency necessitate innovative agronomic strategies to maximize fertilizer efficacy (Nourzadeh et al., 2025). Precision in nitrogen application is particularly crucial for sesame cultivation, where calibrated dosing is key to achieving high yields without compromising resource sustainability (Muhammadamin et al., 2023). Phosphorus is a vital macronutrient central to plant growth and physiological processes, particularly in crops like sesame. It serves as a cornerstone for energy transfer and storage mechanisms (e.g., ATP synthesis), nucleic acid formation, and enzymatic activation, all of which drive cellular metabolism and structural development. Crucially, phosphorus strengthens root architecture, fostering extensive root branching and elongation in sesame plants. This robust root system enhances nutrient uptake efficiency and improves access to deeper soil moisture, bolstering drought resilience a critical trait in water-scarce environments (Amare et al., 2019). Beyond structural benefits, phosphorus directly influences sesame seed quality. It regulates enzymes involved in lipid biosynthesis, thereby elevating oil content and refining oil composition in seeds.

Optimal phosphorus levels are thus linked to superior oil yield and functional properties, enhancing both market value and nutritional utility (Thuc et al., 2023).

Material and Methods

The field experiment was carried out to assess during 2022 at the experimental students farm department of Agronomy at The University of Agriculture Peshawar, Pakistan. The experiment was set up using a Randomized Complete Block Design with a plot size of 3 x 4 12 m^2. Examined treatments, Sesame to study the effect of NP oil application on growth and yield of sesame. It's advisable to plant sesame in full sunlight, leaving a spacing of 2-3 feet between plants to support their robust growth. Once it takes root, sesame has the ability to flourish in elevated temperatures with minimal water requirements.

Weed Managements

Sesame is vulnerable to weed competition in the initial 15-35 days after sowing (DAS). To maintain a relatively weed-free field, it is necessary to have at least two weddings, one on 15 DAS and another on 35 DAS. When the crop is row-seeded, it allows for the use of blade harrows for intercoalition. Employing this method, two intercoalition sessions on 15 DAS and 35 DAS, followed by one round of hand weeding, effectively ensures a weed free field.

Climate Required

The sesame plant thrives under relatively high temperatures throughout its growth stages. Typically, the ideal temperature range for its life cycle falls between 25 to 35 degrees Celsius. When the temperature exceeds 40 degrees Celsius and is accompanied by hot winds, the oil content of the sesame seeds diminishes.

Soil Analysis

The pH range falls between 5.5 to 8.0

Sources of Supply

Sources of supply through urea (Nitrogen level) = , T_1 = Control (No fertilizer), T_2 = 30-40 NP kg ha^{-1}, T_3 = 40-50 NP kg ha^{-1}, T_4 = 50-60 NP kg ha^{-1}, T_5 = 60-70 NP kg ha^{-1}, T_6 = 70-80 NP kg ha^{-1} at the time of maturity five plant was selected in each experimental plots and the units to measure, Plant height (cm), Branches $plant^{-1}$, Capsules $plant^{-1}$, Seed $capsules^{-1}$, Seed weight $plant^{-1}$ (g), Seed index (1000-seed wt., g), Biological yield (kg ha^{-1}), Seed yield (kg ha^{-1}) were recorded.

IPM

The Jassid, also referred to as the leafhopper, represents a significant pest for sesame crops and is notorious for its ability to transmit phyllody disease. This pest remains active throughout the entire growth cycle, spanning from the vegetative phase to the capsule stage.

Harvesting

The optimal time for harvesting a sesame crop is when approximately 90-95% of the leaves have fallen, and the lower three-quarters of the plants and pods have turned yellow, just before the pods start to open.

Statistical analysis

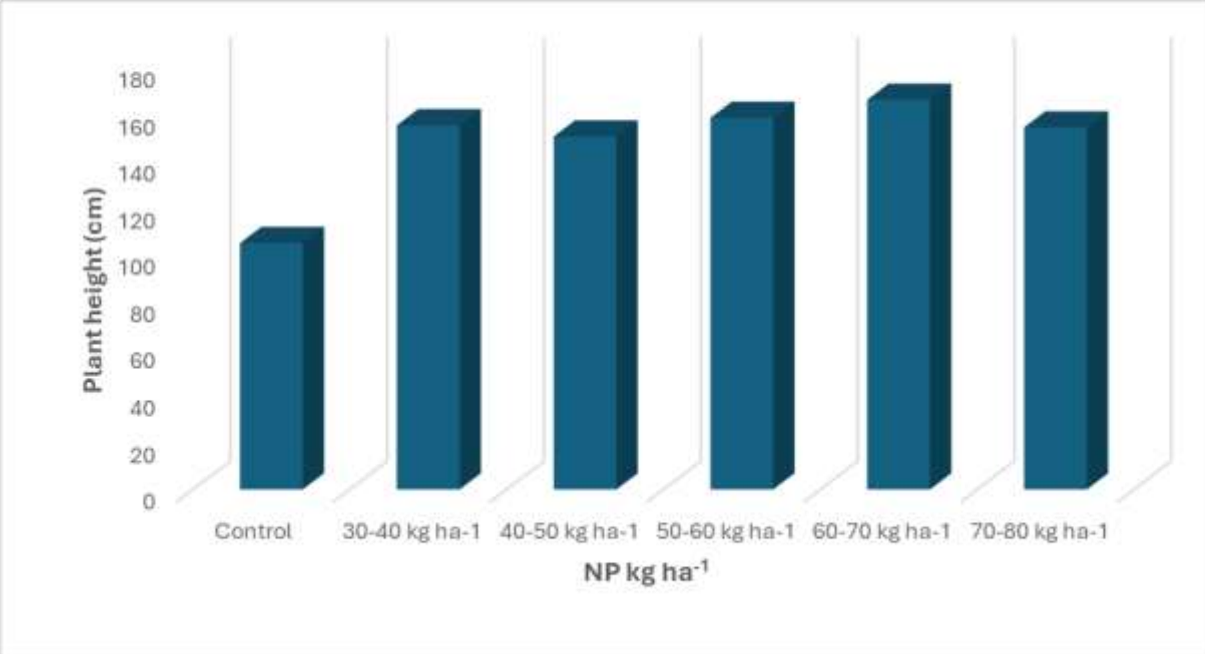
Using the Statistix-8.1 software, an ANOVA was performed on the gathered data (Statistix, 2006). Tests were used when needed to evaluate the effectiveness of various treatments.

RESULTS

Plant height (cm)

The study revealed significant variations in sesame plant height (cm) under different nitrogen-phosphorus (NP) application rates. The highest plant stature, 165.83 cm, was recorded with the optimal NP dose of 60-70 kg ha^{-1}, demonstrating the positive correlation between nutrient availability and vegetative growth. Suboptimal doses of 70–80 kg ha^{-1} and 50–60 kg ha^{-1} produced progressively shorter plants, averaging 154.05 cm and 158.14 cm, respectively. Further reductions in NP application to 40–50 kg ha^{-1} resulted in stunted growth, with plant height declining sharply to 150.16 cm. The lowest NP treatment (30–40 kg ha^{-1}) severely restricted plant development, yielding an average height of 154.96 cm, while the unfertilized control group exhibited the most pronounced growth inhibition at 104.82 cm. These findings underscore the critical role of balanced NP fertilization in maximizing sesame plant height, a key determinant of overall crop productivity.

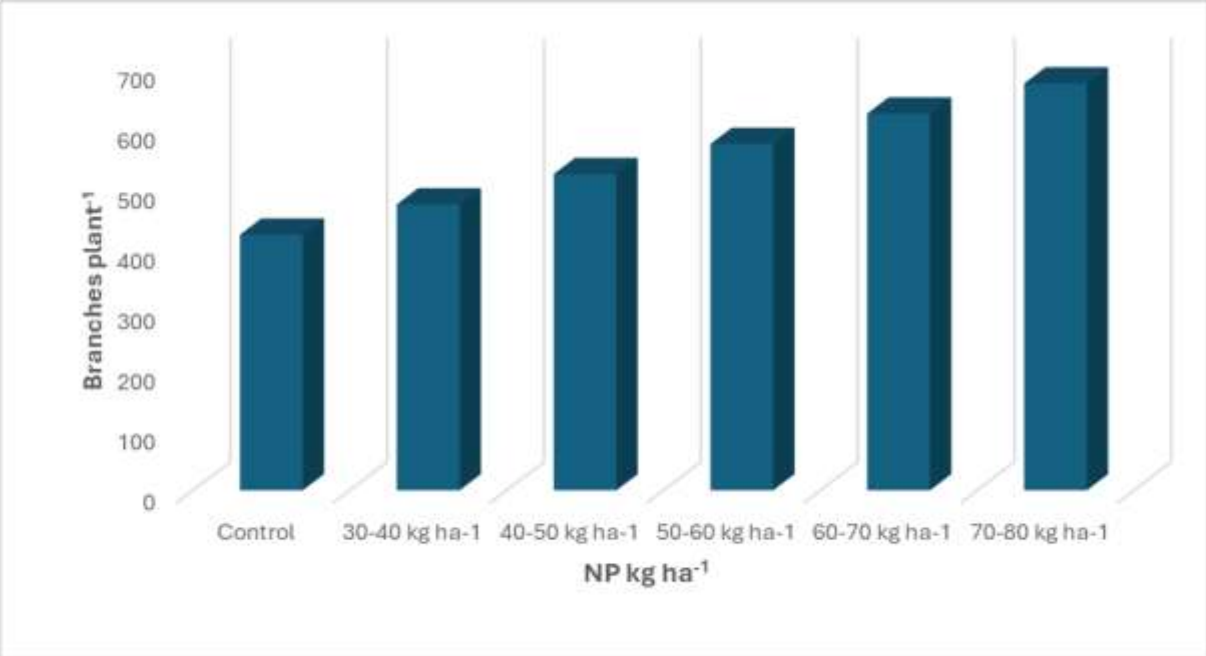
Table 4.1 Plant height (cm) of sesame crop as influenced by different nitrogen and phosphorus levels



Branches plant^{-1}

The study demonstrated a pronounced influence of nitrogen-phosphorus (NP) fertilization on branch development in sesame plants. The highest branch count, 12.12 branches per plant, was observed under the optimal NP application rate of 70–80 kg ha^{-1}, highlighting the role of balanced nutrition in enhancing vegetative growth. Progressively lower NP doses of 60–70 kg ha^{-1} and 50–60 kg ha^{-1} yielded diminishing returns, with average branch numbers declining to 10.71 and 9.29 branches per plant, respectively. Further reductions to 40–50 kg ha^{-1} resulted in a marked drop to 7.88 branches per plant, while the lowest NP treatment (30–40 kg ha^{-1}) severely restricted branching, producing only 6.50 branches per plant. Notably, the unfertilized control group exhibited the weakest performance, with a minimal 5.10 branches per plant. These results underscore the direct correlation between NP nutrient availability and lateral branch proliferation, a critical factor in optimizing sesame canopy architecture and yield potential.

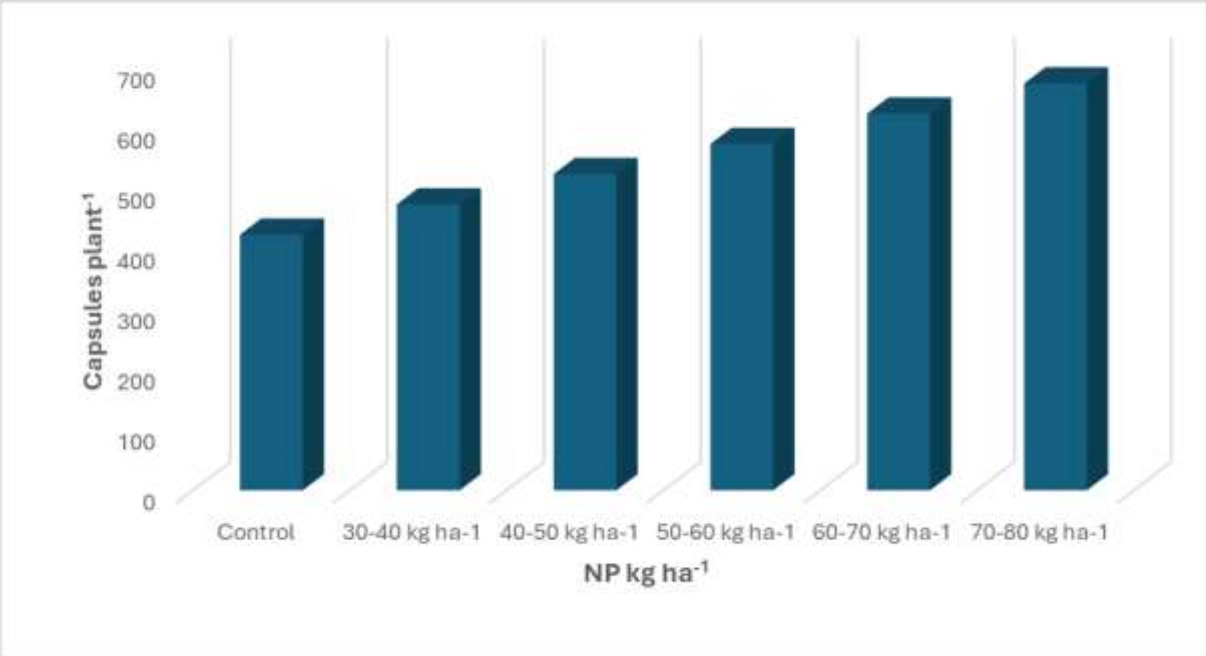
Table 4.2 Branches plant^{-1} of sesame crop as influenced by different nitrogen and phosphorus levels



Capsules plant^{-1}

Nitrogen-phosphorus (NP) fertilization significantly influenced capsule production in sesame plants, with the highest yield of 180.80 capsules per plant achieved at the optimal NP application rate of 70–80 kg ha^{-1}. Suboptimal doses of 60–70 kg ha^{-1} and 50–60 kg ha^{-1} resulted in progressively fewer capsules, averaging 158.94 and 136.88 capsules per plant, respectively. A sharp decline was observed at lower NP levels: 40–50 kg ha^{-1} produced 115.14 capsules per plant, while 30–40 kg ha^{-1} further reduced capsule numbers to 92.82 per plant. The unfertilized control group exhibited the poorest performance, with a minimal 70.92 capsules per plant. These findings highlight the dose-dependent relationship between NP nutrient availability and reproductive success in sesame, emphasizing the critical role of balanced fertilization in maximizing pod formation key determinant of overall crop yield.

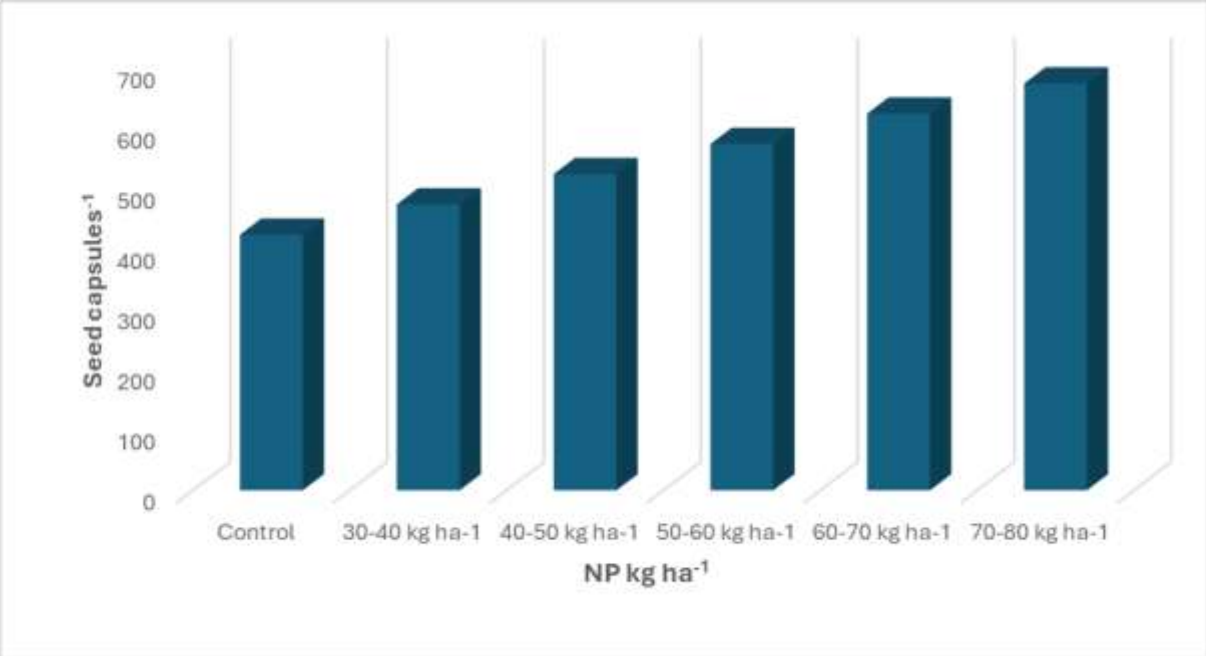
Table 4.3 Capsules plant-1 of sesame crop as influenced by different nitrogen and phosphorus levels



Seeds capsule^{-1}

The study revealed a strong correlation between nitrogen-phosphorus (NP) fertilization and seed production per sesame capsule. The highest seed count, 44.37 seeds per capsule, was recorded under the optimal NP application rate of 70–80 kg ha^{-1}, underscoring the importance of balanced nutrient availability for reproductive success. Progressive reductions in NP doses yielded fewer seeds: 60–70 kg ha^{-1} and 50–60 kg ha^{-1} resulted in averages of 39.37 and 34.18 seeds per capsule, respectively. Further declines were observed with lower NP levels, as 40–50 kg ha^{-1} produced 29.48 seeds per capsule, while 30–40 kg ha^{-1} generated only 24.37 seeds per capsule. The unfertilized control group exhibited the lowest seed output, with a minimal 19.28 seeds per capsule. These results emphasize the critical role of NP fertilization in enhancing seed set a pivotal factor in sesame yield potential and highlight the cascading impact of nutrient deficiency on reproductive efficiency.

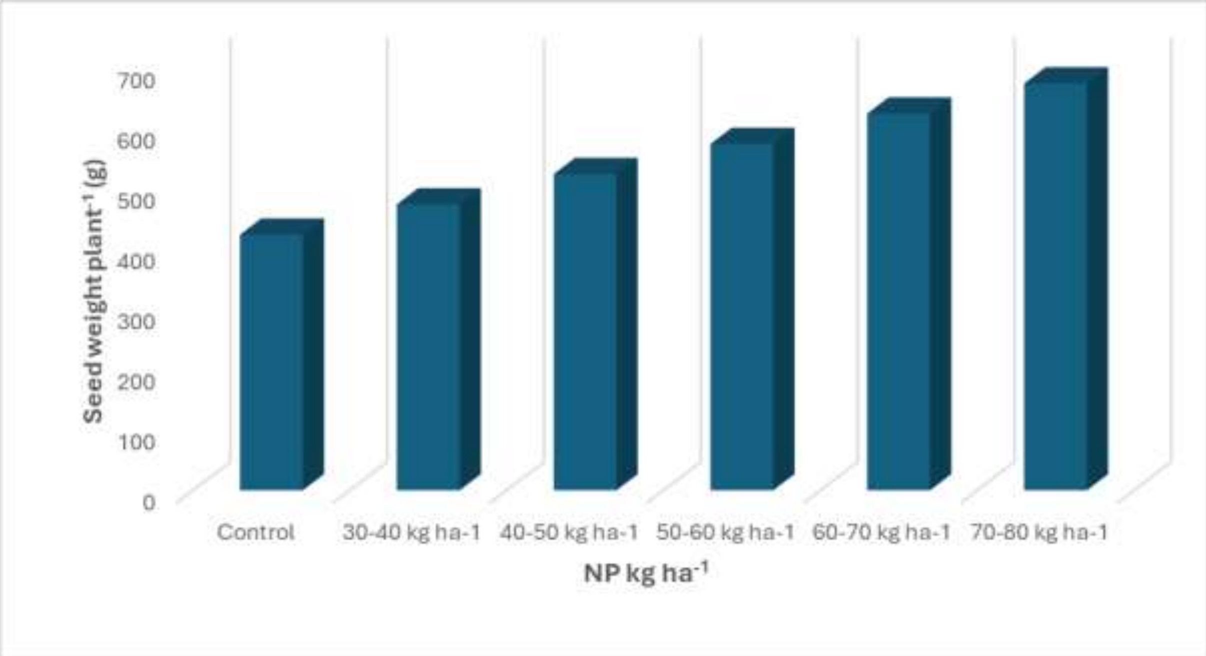
Table 4.4 Seed capsules^{-1} of sesame crop as influenced by different nitrogen and phosphorus levels



Seed weight plant^{-1} (g)

Nitrogen-phosphorus (NP) fertilization significantly influenced seed yield per sesame plant, with the highest seed weight of 51.68 g plant^{-1} achieved at the optimal NP application rate of 70–80 kg ha^{-1}. Suboptimal NP doses of 60–70 kg ha^{-1} and 50–60 kg ha^{-1} resulted in progressively lower yields, averaging 45.56 g and 39.56 g per plant, respectively. A sharp decline occurred at reduced NP levels: 40–50 kg ha^{-1} produced 33.65 g plant^{-1}, while 30–40 kg ha^{-1} yielded only 27.75 g plant^{-1}. The unfertilized control group exhibited the poorest performance, with a minimal seed weight of 21.65 g plant^{-1}. These findings demonstrate a dose-dependent relationship between NP nutrient availability and seed development, underscoring the necessity of balanced fertilization to maximize sesame productivity and economic returns.

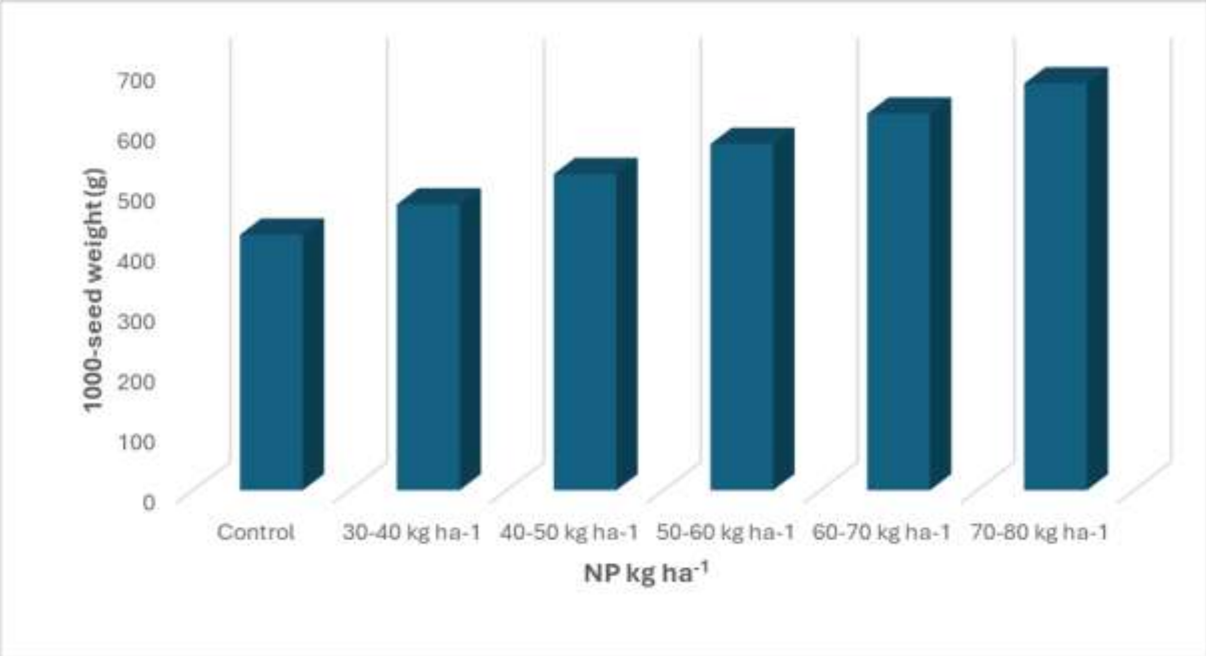
Table 4.5 Seed weight plant^{-1} (g) of sesame crop as influenced by different nitrogen and phosphorus levels



Seed index (1000-seed wt., g)

Nitrogen-phosphorus (NP) fertilization significantly influenced sesame seed index (1000-seed weight, g), with the highest value of 4.26 g recorded under the optimal NP application rate of 70–80 kg ha^{-1}. Subsequent treatments showed diminishing returns: 60–70 kg ha^{-1} and 50–60 kg ha^{-1} yielded progressively lower seed indices of 3.95 g and 3.65 g, respectively. A marked decline occurred at reduced NP levels, as 40–50 kg ha^{-1} produced a seed index of 3.31 g, while 30–40 kg ha^{-1} resulted in 3.00 g. The unfertilized control group exhibited the lowest seed index at 2.68 g, reflecting severe nutrient limitation. These findings highlight the critical role of balanced NP fertilization in enhancing seed size and uniformity key determinants of sesame marketability and yield potential and underscore the adverse effects of suboptimal nutrient management on seed quality.

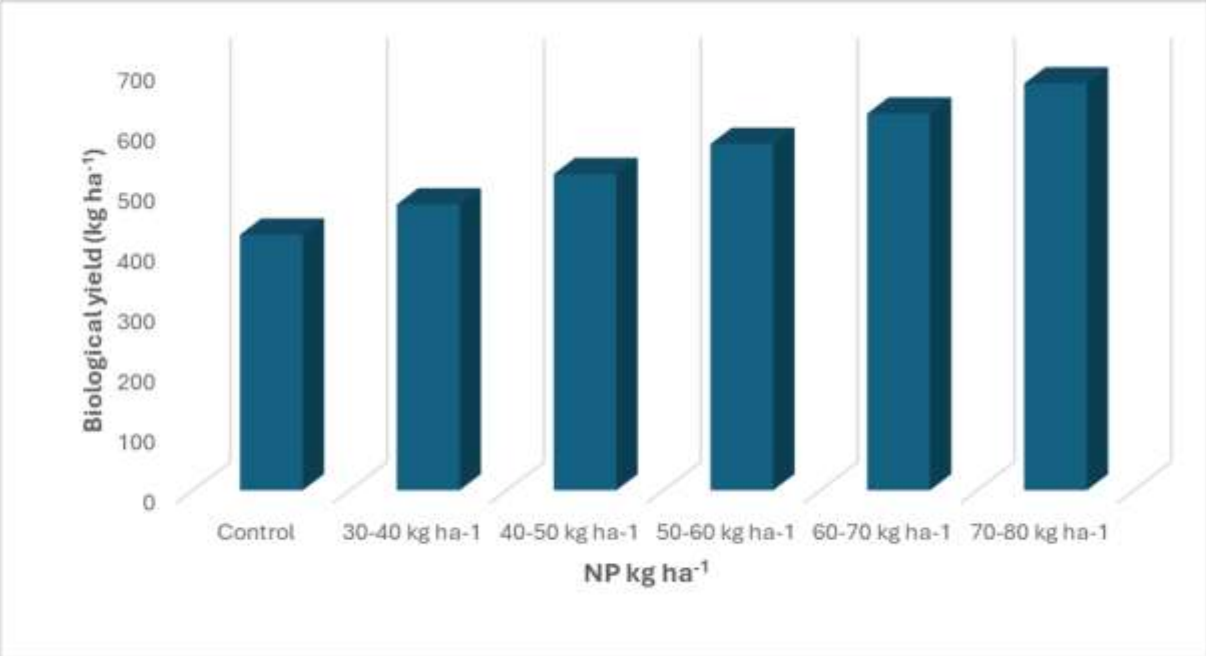
Table 4.6 Seed index (1000-seed wt., g) of sesame crop as influenced by different nitrogen and phosphorus levels



Biological yield (kg ha^{-1})

Nitrogen-phosphorus (NP) fertilization exerted a pronounced impact on sesame biological yield (total biomass production), with the highest output of 5,223.0 kg ha^{-1} achieved under the optimal NP application rate of 70–80 kg ha^{-1}. Suboptimal NP doses of 60–70 kg ha^{-1} and 50–60 kg ha^{-1} yielded progressively lower biological yields, averaging 4,802.9 kg ha^{-1} and 4,382.8 kg ha^{-1}, respectively. Further reductions in NP levels led to significant declines: 40–50 kg ha^{-1} produced 3,962.8 kg ha^{-1}, while 30–40 kg ha^{-1} resulted in a biological yield of 3,542.7 kg ha^{-1}. The unfertilized control group exhibited the lowest biomass accumulation at **3,122.5 kg ha^{-1}**, underscoring the detrimental effects of nutrient deficiency. These results highlight the critical role of balanced NP fertilization in maximizing sesame biomass a key indicator of overall crop vigor and productivity and reinforce the necessity of tailored nutrient management for sustainable agricultural output.

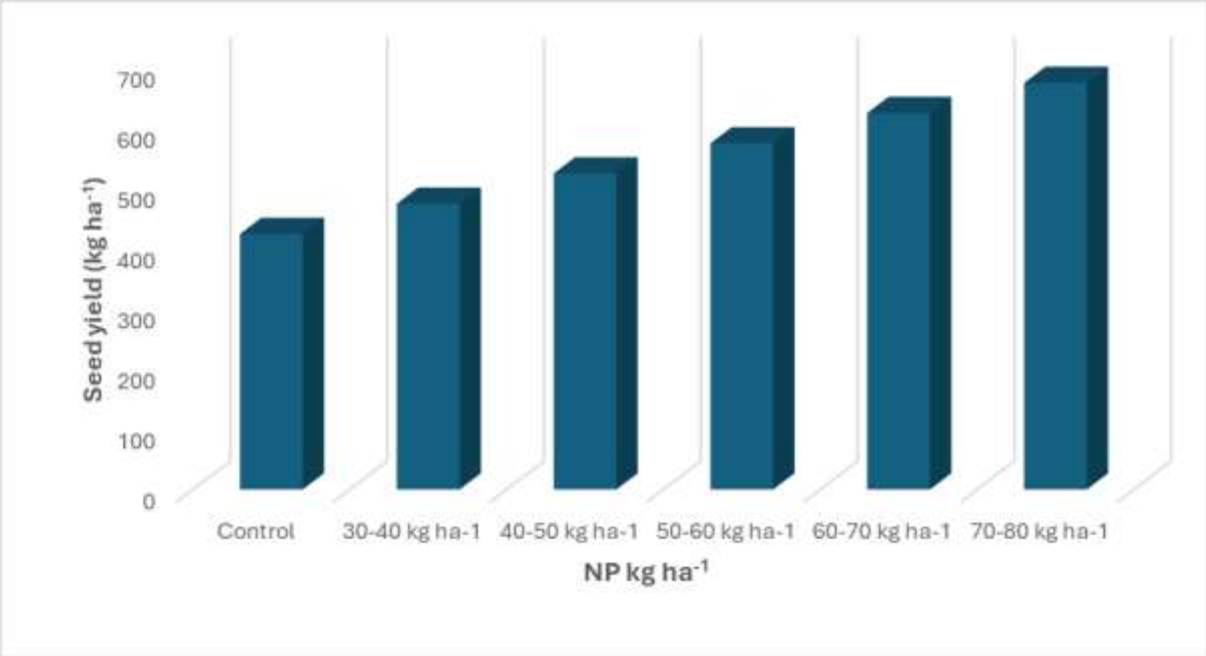
Table 4.7 Biological yield (kg ha^{-1}) of sesame crop as influenced by different nitrogen and phosphorus levels



Seed yield (kg ha^{-1})

Nitrogen-phosphorus (NP) fertilization significantly influenced sesame seed yield, with the highest production of 672.76 kg ha^{-1} achieved under the optimal NP application rate of 70–80 kg ha^{-1}, underscoring the importance of balanced nutrient management. Suboptimal doses of 60–70 kg ha^{-1} and 50–60 kg ha^{-1} yielded progressively lower seed outputs, averaging 622.99 kg ha^{-1} and 572.76 kg ha^{-1}, respectively. A sharp decline was observed at reduced NP levels: 40–50 kg ha^{-1} produced 522.90 kg ha^{-1}, while 30–40 kg ha^{-1} resulted in 472.86 kg ha^{-1}. The unfertilized control group exhibited the poorest performance, with a minimal seed yield of 422.76 kg ha^{-1}, highlighting the detrimental impact of nutrient deficiency. These findings demonstrate a clear dose-response relationship between NP availability and sesame productivity, emphasizing the necessity of tailored fertilization strategies to maximize economic returns and agricultural sustainability.

Table 4.8 Seed yield (kg ha^{-1}) of sesame crop as influenced by different nitrogen and phosphorus levels



DISCUSSION

Sesame (*Sesamum indicum* L.), a globally significant oilseed crop, is prized for its economic and nutritional contributions to agriculture and food systems. As modern farming practices advance, maximizing both yield and crop quality has emerged as a critical priority to meet rising demand and ensure food security. Among the factors driving sesame productivity, nitrogen (N) and phosphorus (P) stand out as indispensable macronutrients, orchestrating foundational physiological and biochemical processes that underpin plant growth. Their synergistic roles from stimulating root architecture and photosynthetic efficiency to regulating enzyme activity and biomass accumulation have spurred extensive research into optimizing their application in sesame cultivation. The present study showed that the sesame treated with 70-80 NP kg ha^{-1} resulted maximum 12.12 branches plant^{-1}, 180.80 capsules plant^{-1}, 44.37 seeds capsule^{-1}, 51.68 g seed weight plant^{-1}, 4.26 g seed index, 5223.0 kg ha^{-1} biological yield and 672.76 kg ha^{-1} seed yield. The nitrogen and phosphorus 60-70 kg ha^{-1} resulted maximum 182.05 cm plant height, 10.71 branches plant^{-1}, 158.94 capsules plant^{-1}, 39.37 seeds capsule^{-1}, 45.56 g seed weight plant^{-1}, 3.95 g seed index, 4802.9 kg ha^{-1} biological yield and 622.99 kg ha^{-1} seed yield. Similarly, the sesame treated with 50-60 NP kg ha^{-1} resulted 158.14 cm plant height, 9.29 branches plant^{-1}, 136.88 capsules plant^{-1}, 34.18 seeds capsule^{-1}, 39.56 g seed weight plant^{-1}, 3.65 g seed index, 4382.8 kg ha^{-1} biological yield and 572.76 kg ha^{-1} seed yield. Nitrogen and phosphours 40-50 kg ha^{-1} resulted 150.16 cm plant height, 7.88 branches plant^{-1}, 115.14 capsules plant^{-1}, 29.48 seeds capsule^{-1}, 33.65 g seed weight plant^{-1}, 3.31 g seed index, 3962.8 kg ha^{-1} biological yield and 522.90 kg ha^{-1} seed yield. 30-40 NP kg ha^{-1} resulted 154.96 cm plant height, 6.50 branches plant^{-1}, 92.82 capsules plant^{-1}, 24.37 seeds capsule^{-1}, 27.75 g seed weight plant^{-1}, 3.00 g seed index, 3542.7 kg ha^{-1} biological yield and 472.86 kg ha^{-1} seed yield. However, control (No fertilizer) resulted minimum 104.82 cm plant height, 5.10 branches plant^{-1}, 70.92 capsules plant^{-1}, 19.28 seeds capsule^{-1}, 21.65 g seed weight plant^{-1}, 2.68 g seed index, 3122.5 kg ha^{-1} biological yield and 422.76 kg ha^{-1} seed yield After going through the findings of the present research, it was concluded that the growth and yield of sesame increased simultaneously with increasing nitrogen and phosphorus levels; and the sesame fertilized with 70-80 NP kg ha^{-1} resulted in maximum seed yield (672.76 kg ha^{-1}), followed by 60-70 NP kg ha^{-1} (622.99 kg ha^{-1}) and 50-60 NP kg ha^{-1} (572.76 kg ha^{-1}). The results are further compared with the study of Nourzadeh et al., (2025) indicated that leaf area index was increased with an increasing level of N rates up to 80 kg ha^{-1} and decreased with further increase in the N rate. Increasing level of N up to 150 kg ha^{-1} increased the leaf area. Gebremariam, (2015) compared the effects of poultry manure with N.P.K. (15, 15, 15) rates on sesame in rivers state, southern rainforest of Nigeria. The PM and NPK rates per seedling per pot were 0, 5, 10, and 20g. Results indicate that NPK initially developed taller plants, but with time over NPK, PM increased growth rate. Taller sesame plants at 10 WAP over NPK rates were provided by PM at 5, 10 and 20 g. The number of leaves between plants that obtained PM and NPK did not differ significantly, while NPK affected greater LA. With doses of both fertilizers, diameter of head, head weight and seed weight increased, 20 g PM produced the widest diameter sesame plants and the weightiest seeds. This was still lower than the highest number of seeds fertilized with 20 g PM produced by sesame plants. For sesame development in the southern rainforest, Nigeria, twenty (20 g) PM application rates per seedling are recommended (Gholamhoseini et al., 2022). Similarly, the study of Shakeri et al. (2016) reported that nitrogen is an imperative macronutrient that is demanded in large amounts for sesame production. But nitrogen deficiency and low nitrogen use effectively negatively affect the sesame growth and yield (Desoky et al., 2023). In the current study the LAI, CGR and time series TDM were highest with neem-coated urea fertilization at N increment N100 (148 kg ha^{-1}) in comparison to all other SRNF at N increment N100 (148 kg ha^{-1}). These results were correlated with higher availability of nitrogen and the imperious role of N in improving all the plant functions by the production of protein, enzymes, hormones, chlorophyll, and vitamins which ultimately resulted in higher LAI, CGR, and time series TDM. Furthermore, higher values of LAI, CGR, and time series TDM were because of the more availability of (N) by reducing the losses of (N) in the form of runoff, nitrate leaching, and ammonia volatilization; hence, continuous availability of (N) due to the slow release of (N) from neem-coated urea (Fang et al., 2023). The increase in LAI was attributed due to the more expansion of leaves as the plants were using their whole (N) requirement that is why the growth of these plants treated with coated fertilizers was more effective. With this factor, all the other growth parameters were also enhanced as these are correlated with each other (Brima et al., 2021). A similar investigation has found that the application of slow-release fertilizers and biochar sources promotes the growth and development of sesame significantly and enhances the nitrogen (N) supply in the whole growth periods; it is because of lesser N losses in the different forms (Wacal et al., 2019). It's essential to consider local conditions, soil characteristics, and specific varieties of sesame when planning nitrogen fertilization to maximize growth and yield while maintaining environmental sustainability. Proper nitrogen management in sesame cultivation can have a significant impact on both the quantity and quality of the harvested seeds (Salam et al., 2020). Similarly, higher values of net leaf photosynthetic rates, net transpiration rates, stomatal conductance, and chlorophyll content might be due to the slow and successive discharge of N from neem-coated urea Oloniruha et al. (2021) which corresponded well to the N requirements at critical growth stages of sesame. The increase in net photosynthetic rate may be due to the more chlorophyll contents of the sesame leaves as the more production of proteins supports the increase in leaves area and chlorophyll contents as well. Similarly, the more leaf size and more leaf area will have a greater number of stomata which are the main contributors of the transpiration in plants. Stomatal conductance also increases with the better growth of the sesame plants (Berhe et al., 2024). The high nitrogen with neem-coated source obtained maximum harvest index in comparison to low N applied and coating with other nitrogen sources. Markedly high harvest index for sesame might be attained due to appropriate availability of N by using coated sources. The gap between the highest and lowest harvest index of sesame crop attained at different SRNF and N levels was statistically significant. The effects of SRNF showed improvements in the yield components studied because of the slow release of N from SRNF which matched well to the demand of sesame crop. High NUE is directly related to less N losses like leaching, volatilization, runoff, and denitrification (Wu et al., 2024). Nitrogen use efficiency was observed maximum with the use of slow-release fertilizer as compared to simple urea (Wang et al., 2024). Adequate phosphorus levels contribute to larger seed size, which is desirable in the sesame market (Latifi et al., 2018). Moreover, phosphorus enhances oil synthesis within the seeds, leading to higher oil content, which is a critical factor for commercial value. The impact of phosphorus on sesame yield may vary depending on various factors such as soil conditions, climate, and management practices. Conducting soil tests and following recommended phosphorus application rates based on the specific requirements of sesame cultivation will help optimize yield and maximize the benefits of phosphorus fertilization (Khan et al., 2024).

Conclusion

After going through the findings of the present research, it was concluded that the growth and yield of sesame increased simultaneously with increasing nitrogen and phosphorus levels; and the sesame fertilized with 70-80 NP kg ha^{-1} resulted in maximum seed yield (672.76 kg ha^{-1}), followed by 60-70 NP kg ha^{-1} (622.99 kg ha^{-1}) and 50-60 NP kg ha^{-1} (572.76 kg ha^{-1}).

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