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Impact of different levels of potash on growth and yield of sesame (*Sesamum indicum* L.)

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Abstract

Based on the findings from your experiment on the impact of different levels of potash on the growth and yield of sesame, it is evident that potassium plays a significant role in enhancing the crop's performance. The application of higher levels of potash, particularly in the form of SOP, resulted in notable improvements in various growth parameters such as plant height, number of branches, and number of capsules.

Among the treatments, the application of K₂O at 150 kg/ha as SOP through soil and fertigation (T₈) proved to be the most effective, consistently providing the highest values for plant height, number of branches, capsules, and seed weight per plant. This suggests that the higher potassium availability from SOP significantly boosted plant growth, capsule formation, and seed development. Additionally, the increased potash levels positively influenced seed quality, as indicated by the higher test weight observed in T₈.

In terms of yield and productivity, treatments with 150 kg/ha K₂O as MOP (T₅) also showed strong results, with significant improvements across the observed parameters compared to the control. However, the SOP treatments demonstrated slightly superior performance in terms of both growth and yield.

Economically, while both SOP and MOP at higher levels provided substantial yield benefits, the use of SOP appeared to offer an edge in terms of overall productivity and plant health. The results of your research clearly demonstrate that the strategic application of potash, especially through SOP, can significantly enhance the growth, yield, and quality of sesame, making it a viable practice for optimising sesame production.

Keywords: Organic, sesame, capsule, seed index, significantly, fertigation

Introduction

Sesame (*Sesamum indicum* L.) is widely regarded as one of the oldest cultivated oilseeds in human history, tracing its roots back thousands of years. Often referred to as the "Queen of Oilseeds," sesame holds a prominent position due to its exceptional nutritional value and versatility in agricultural production. This ancient crop, belonging to the Pedaliaceae family, has maintained its significance across cultures and civilisations, both for its nutritional profile and its contribution to agriculture (Rahman *et al.*, 2019) ^[14]. In contemporary agriculture, sesame continues to be a vital component of food systems around the globe, contributing to both human nutrition and economic livelihoods, particularly in developing countries.

Sesame seeds are prized for their high oil content, ranging from 48% to 55%, making them one of the richest oil-producing seeds. The protein content in sesame seeds, which averages between 20% and 28%, also adds to their value as a nutritious food source. These seeds are rich in essential amino acids such as methionine and tryptophan, both of which play critical roles in human health. In addition, sesame seeds are a rich source of minerals such as calcium, phosphorus, and magnesium, along with vitamins like niacin, making them highly beneficial for human consumption (Kumar and Singh, 2018) ^[9]. This combination of oil, protein, and essential nutrients makes sesame an important crop not only for its direct nutritional value but also for its economic importance in food and oil industries.

India plays a crucial role in global sesame production, ranking as the largest producer and cultivator of sesame worldwide. The country has around 19.47 lakh hectares dedicated to sesame cultivation, which yields approximately 8.66 lakh tonnes annually (Bhatt *et al.*, 2021) ^[2]. Despite India's leadership in sesame production, the average productivity stands at only 413 kg per

hectare, which is far below the crop's potential yield. This discrepancy highlights the challenges that exist in terms of improving agronomic practices to enhance productivity. To address this productivity gap, a focus on better nutrient management, among other factors, becomes imperative for maximising yield potential.

The cultivation of sesame across different seasons—kharif, summer, and post-kharif—presents unique challenges and opportunities for farmers. Summer cultivation typically shows higher productivity compared to other seasons, yet overall yields remain suboptimal across all growing periods (Deshmukh *et al.*, 2020) ^[4]. This highlights the need for improved agricultural practices, including optimised nutrient management strategies, to bridge the gap between current yields and the potential productivity of sesame. A central component of this effort is the effective management of potassium, a macronutrient that plays a critical role in plant growth and yield formation.

Potassium is essential for various physiological functions in plants, including enzyme activation, protein synthesis, photosynthesis, and water-use efficiency. In sesame cultivation, potassium plays a particularly vital role in influencing key yield components such as plant height, branching, capsule formation, and seed weight (Patel and Kumar, 2017) ^[13]. Studies have shown that adequate potassium supply can significantly enhance these yield parameters, suggesting that potassium deficiency could be one of the limiting factors in maximising sesame productivity.

There is an ongoing scientific debate regarding the precise role of potassium in sesame cultivation, particularly in regions where soil fertility is already compromised. In the past, fertilization practices in sesame were not always emphasised, especially in areas with nutrient-rich soils. However, contemporary research increasingly points to the importance of balanced fertilization, especially in regions with marginal or depleted soil fertility (Shehu *et al.*, 2010) ^[16]. Given that a substantial amount of sesame cultivation in India takes place on marginal lands, where soil fertility is often suboptimal, the application of potassium and other essential nutrients is crucial for maintaining healthy crop growth and achieving higher yields.

In regions such as Madhya Pradesh, where soil fertility is a persistent issue, sesame cultivation faces significant challenges related to nutrient deficiencies. Studies have highlighted that potassium is one of the most critical macronutrients for sesame in these regions, with deficiencies often resulting in stunted plant growth and reduced yields (Singh and Pal, 2021) ^[19]. Sesame plants, particularly their capsules, tend to maintain a high potassium content even at maturity, underscoring the crop's consistent potassium requirement throughout its growth cycle. This makes it essential to address potassium deficiencies through proper nutrient management practices.

The economic viability of sesame cultivation is another critical factor that influences how nutrient management strategies are applied. Fertilizer inputs, particularly potassium, represent a significant portion of production costs. Farmers must strike a balance between maximizing yield and minimising input costs to ensure that sesame cultivation remains economically sustainable (Verma *et al.*, 2019) ^[22]. Research has shown that optimizing potassium application not only enhances crop productivity but also improves the overall profitability of sesame farming. Therefore, developing cost-effective fertilization strategies that optimize potassium use efficiency is a key priority for both researchers and farmers.

Materials and Methods

The experiment was carried out at the Research Farm of the Department of Agronomy, School of Agriculture Science, Technology & Research, Sardar Patel University, Balaghat (M.P.). The experiment was conducted in a randomised complete block design with three replications. Different organic and bio-fertilisers will be allocated to the plots as per treatments. The seed rate used as 5 kg/ha for sowing with 45.0 x 10.0 cm row-to-row and plant-to-plant distance. The experiment comprised eight treatments designed to study the effect of different potassium sources and levels on crop performance. The treatments included: T₁ - Control (only nitrogen and phosphorus applied, without potassium); T₂ - GRDF (100:50:50 kg N:P:K per hectare along with 20 t/ha FYM); T₃ - K₂O 50 kg/ha supplied through muriate of potash (MOP) applied via soil and fertigation; T₄ - K₂O 100 kg/ha (MOP) through soil and fertigation; T₅ - K₂O 150 kg/ha (MOP) through soil and fertigation; T₆ - K₂O 50 kg/ha (SOP) through soil and fertigation; T₇ - K₂O 100 kg/ha (SOP) through soil and fertigation; and T₈ - K₂O 150 kg/ha (SOP) through soil and fertigation. This treatment structure allowed a comprehensive comparison between two potassium sources—MOP and SOP—at three graded levels (50, 100, and 150 kg K₂O/ha), alongside a control and recommended fertilizer practice, to evaluate their influence on growth, yield, and soil nutrient dynamics. The gross and net plot size was 4.00 m x 3.60 m and 3.40 m x 2.70 m, respectively. The fertilizer grades were applied as per treatments. All the other agronomic practices were applied uniformly to all the treatments. The experiment will consist of the following factors, along with their respective levels.

Results and Discussion

The experiment revealed that the application of higher levels of potash significantly improved plant height in sesame. Treatment T₈ (K₂O 150 kg/ha applied as SOP through soil and fertigation) resulted in the tallest plants at 95 cm, an 18.8% increase over the control, highlighting the positive role of potassium in enhancing growth. This can be attributed to the increased availability of potassium, which promotes cell elongation and better nutrient translocation, as observed by Syed *et al.* (2000) ^[20] and Ojikpong *et al.* (2009) ^[11]. Similarly, treatments with 150 kg/ha of K₂O applied as MOP (T₅) also recorded a notable plant height of 93 cm, supporting findings by Khan *et al.* (2020) ^[8], where potassium improved growth parameters.

The number of branches per plant was significantly influenced by potassium levels, with the highest number recorded in T₈ (6.3 branches per plant), showing a 90.9% increase over the control. This suggests that higher potassium levels, particularly through SOP application, support better branch formation by enhancing nutrient transport and hormonal balance in the plant, as discussed by Hafiz *et al.* (2012) ^[6] and Shehu *et al.* (2010) ^[17].

The number of capsules per plant was markedly increased by the application of potassium, with T₈ (K₂O 150 kg/ha as SOP) producing the highest number of capsules (74), representing a 45.1% increase over the control. This highlights potassium's role in enhancing reproductive growth, a result that aligns with Jadhav *et al.* (2010) and Khan *et al.* (2020) ^[8], who noted improved capsule formation with higher potassium levels.

The application of higher potassium levels resulted in a significant increase in capsule length, with T₈ (K₂O 150 kg/ha as SOP) achieving the longest capsule length (3.4 cm), showing a 45.9% increase over the control. This demonstrates the crucial

role of potassium in promoting reproductive organ development, as previously observed by Rajiv *et al.* (2012)^[15] and Singh *et al.* (2021)^[19], where potassium enhanced seed and fruit characteristics.

The number of seeds per capsule was significantly influenced by different sources and levels of potash (K). Treatment T₈, which received the highest application of K₂O at 150 kg/ha as SOP through soil and fertigation, resulted in the maximum number of seeds per capsule (76), a substantial 35.7% increase over the control. This improvement can be attributed to the enhanced translocation of nutrients, particularly potassium, to reproductive tissues, leading to better seed formation. Similar findings were reported by Syed *et al.* (2000)^[20], who observed that increased levels of NPK improved yield components such as the number of seeds per capsule in sunflower. Additionally, Singarav *et al.* (2002)^[18] and Jadhav *et al.* (2010) observed a significant increase in the number of seeds per capsule with potassium application in their respective studies on sesame and other crops, reinforcing the positive impact of higher potassium levels on reproductive growth.

Seed weight per plant was also positively influenced by potassium application. The highest seed weight of 7.0 g was recorded in treatment T₈ (150 kg/ha K₂O as SOP), representing a 34.6% increase over the control. The higher potassium levels contributed to improved photosynthetic efficiency and nutrient allocation to seeds, resulting in increased seed weight, which is consistent with the findings of Ojikpong *et al.* (2009)^[11], who noted significant increases in sesame seed yield with incremental NPK levels. The results from Hafiz *et al.* (2012)^[6] also confirm that higher potassium application enhances seed weight in sesame, as potassium aids in nutrient mobilisation to the developing seeds.

Test weight was another yield attribute significantly influenced by potassium application. The highest test weight of 3.6 g was recorded in treatment T₈ (150 kg/ha K₂O as SOP), a 44.0% increase over the control. This improvement in seed quality is likely due to the enhanced uptake of potassium, which plays a critical role in enzyme activation and seed filling. These results are in line with Patel *et al.* (2020)^[12], who reported a significant increase in test weight with higher potassium applications in sesame. Similarly, Chowdhury *et al.* (2021)^[3] and Gupta *et al.* (2022)^[5] observed that potassium application significantly improved test weight and seed quality in sesame, indicating that potassium not only enhances yield but also improves the physical characteristics of the seeds.

Biological yield per plant is a crucial indicator of a plant's overall biomass production, which encompasses all parts of the plant contributing to growth. In the present study, biological yield per plant was significantly influenced by varying levels and sources of potassium (K). The highest biological yield was recorded in treatment T₈, where K₂O was applied at 150 kg/ha as SOP, which led to a notable increase of 32.7% over the control treatment (T₁). This increase can be attributed to the enhanced nutrient uptake and overall growth vigour due to optimal potassium application, which plays a key role in photosynthesis, enzyme activation, and osmoregulation. Similarly, treatments T₅ (150 kg/ha of MOP) and T₇ (100 kg/ha of SOP) also showed substantial improvements in biological yield, reflecting the positive impact of potassium on biomass accumulation. Comparable results were observed by Jadhav *et al.* (2010) and Ahmad *et al.* (2018)^[1], who reported a significant increase in biomass yield with increased potassium application, highlighting its role in promoting robust plant growth.

The harvest index, a ratio of economic yield (seed yield) to biological yield, provides insights into the plant's efficiency in allocating biomass to the seeds. In this study, the harvest index increased notably with higher potassium levels. Treatment T₈ (150 kg/ha of SOP) recorded the highest harvest index, showing a 29.5% improvement over the control. This suggests that increased potassium supply enhances the translocation of assimilates from the vegetative parts to the reproductive organs, leading to improved seed development and higher yield efficiency. Similarly, T₅ (150 kg/ha of MOP) and T₇ (100 kg/ha of SOP) also recorded significant improvements in the harvest index, reflecting potassium's vital role in optimising energy distribution within the plant. These findings are consistent with Thakur *et al.* (2015)^[21] and Nayek *et al.* (2014)^[10], who reported a positive correlation between potassium application and harvest index, emphasising the importance of balanced potassium nutrition in enhancing seed production efficiency.

In the present study, treatments involving higher potassium levels, particularly T₈ (K₂O 150 kg/ha as SOP), generated the highest gross and net monetary returns, with increases of 34.6% and 32.4%, respectively, over the control. The application of SOP at this rate clearly demonstrated its superior influence on both growth and yield components of sesame. The results of T₅, with K₂O 150 kg/ha as MOP, also produced substantial increases, confirming the positive role of potassium in maximizing economic returns.

Table 1: Impact of different levels of potash on growth and yield of Sesame (*Sesamum indicum* L.)

Treatment	Plant height (cm)	Number of Branches/plant	Number of capsules/plant	Capsule length (cm)	Number of seed/capsule	Seed weight/plant	Test weight (g)	Grain yield (Kg/ha.)	B:C ratio
T ₁	80	3.3	51	2.3	56	5.2	2.5	608.67	1.53
T ₂	90	5.0	70	3.1	71	6.5	3.3	681.00	1.75
T ₃	85	4.0	65	2.8	66	6.0	3.0	645.00	1.72
T ₄	88	4.3	68	3.0	68	6.3	3.2	677.33	1.71
T ₅	93	5.7	72	3.3	74	6.8	3.5	701.00	1.85
T ₆	86	4.3	66	2.9	68	6.1	3.1	665.00	1.65
T ₇	90	5.0	70	3.2	71	6.6	3.4	690.00	1.80
T ₈	95	6.3	74	3.4	76	7.0	3.6	714.333	1.90
S. Em±	18.05	7.05	1.73	0.11	2.11	13.83	0.04	15.09	0.069
C.D. (P=0.05)	74.75	14.75	5.27	0.35	6.40	29.82	0.12	45.78	0.210

Conclusion

Based on the experimental findings, it is evident that the application of different levels and sources of potash significantly enhances the growth and yield of *Sesamum indicum*

L.). The treatment with K₂O at 150 kg/ha applied as SOP through soil and fertigation exhibited the highest plant height, number of branches, and seed yield, demonstrating the vital role of potash in promoting plant development and productivity.

Moreover, increased capsule length and number of seeds per capsule were observed in this treatment, highlighting its positive impact on overall yield components. The economic analysis further supports the benefits of utilizing appropriate potash levels, emphasizing the importance of optimizing nutrient management for improved agricultural outcomes.

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