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Response of inorganic and organic fertilizer on growth and yield of sesame (*Sesamum indicum* L.)

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Abstract

A field experiment titled “Response of inorganic and organic fertilizer on growth and yield of Sesame (*Sesamum indicum* L.)” was conducted at the Research Farm of the Department of Agronomy, School of Agriculture Science, Technology & Research, Sardar Patel University, Balaghat (M.P.). The study aimed to determine the optimal doses of inorganic and organic fertilizers to maximize yield and to evaluate the economic viability of different fertilization treatments. The experiment was laid out in a randomised block design with three replications and consisted of eight treatments, including control, organic, and inorganic fertilizers applied to Sesamum cv. Jawahar Til-12 (PKDS 12).

The results indicated that the application of both inorganic and organic fertilizers significantly improved yield compared to the control. Among the treatments, NPK @ 60:25:25 kg/ha emerged as the most effective, providing the highest yield and best economic returns. This treatment demonstrated the optimal balance of essential nutrients, leading to superior plant growth and productivity. Within the organic treatments, Vermicompost @ 5 t/ha was found to be the most effective, surpassing FYM in enhancing soil health and crop yield, although it was less economically viable compared to the inorganic options. Economic analysis highlighted that the NPK @ 60:25:25 kg/ha treatment offered the best gross return, net return, and B:C ratio, making it the most economically sound choice.

In conclusion, the study underscores the importance of nutrient supplementation in improving sesame yield, with inorganic fertilizers proving most effective in terms of both yield and economic returns. However, Vermicompost presents a strong organic alternative, particularly for those prioritizing sustainable agricultural practices, despite its lower economic returns.

Keywords: Organic, branches, bio-fertilizers, grains, capsul, seed index, straw yield

Introduction

Oilseeds are a primary source of fat and protein, especially for vegetarians. In the Indian economy, oilseeds account for a significant portion of the gross cropped area and contribute substantially to the GDP and global edible oil consumption (Anonymous, 2024). Sesame (*Sesamum indicum* L.), also known as gingelly or Til, is one of the earliest domesticated edible oilseeds. It is cultivated across various environments, from semi-arid tropics and subtropics to temperate regions.

Sesame is an essential oilseed crop, second only to groundnut and rapeseed-mustard. The oil content in sesame ranges from 46 to 52%, and protein from 18 to 20% (Anonymous, 2024). Approximately 73% of its oil is used for edible purposes, 14.5% for domestic uses like making sweet candies, and 8.3% for hydrogenation. The remaining 4.2% is used industrially, including in the manufacture of paints, perfumed oils, pharmaceuticals, and insecticides. Sesame oil is also popular in soap, cosmetic, and skincare industries due to its anti-bacterial, antiviral, antifungal, and antioxidant properties, and its cholesterol-free nature makes it recommended for heart patients.

Globally, sesame is cultivated on millions of hectares, producing substantial yields with varying productivity across regions. In India, major producing states include Gujarat, West Bengal, Tamil Nadu, Maharashtra, Karnataka, and Rajasthan (Anonymous, 2024).

Nutrient management is crucial for achieving high sesame yields. Essential nutrients like nitrogen (N), phosphorus (P), potassium (K), and sulfur (S) play vital roles in plant growth and development. Nitrogen is a key component of amino acids, proteins, and chlorophyll, essential

for vegetative growth and photosynthesis. Phosphorus forms energy-rich phosphate bonds and is critical for nucleic acids, proteins, and several co-enzymes (Mian *et al.*, 2011) ^[12]. Potassium regulates water balance, enzyme activation, and photosynthesis, while sulfur is a component of amino acids and vitamins, vital for protein synthesis and chlorophyll formation (Tisdale *et al.*, 1993).

The response of sesame to organic and inorganic fertilizers significantly impacts yield potential. Inorganic fertilizers provide readily available nutrients that can be quickly absorbed by plants, leading to immediate improvements in growth and yield. For instance, nitrogen application can significantly enhance vegetative growth, while phosphorus and potassium are crucial for root development and seed quality (Brady & Weil, 2008) ^[3]. Sulfur also plays a critical role, particularly in oilseed crops like sesame, by enhancing oil content and quality (Jamal *et al.*, 2010) ^[5]. On the other hand, organic fertilizers such as farmyard manure (FYM) and vermicompost improve soil structure, enhance microbial activity, and increase nutrient availability, contributing to sustainable soil health and crop productivity. Combining organic and inorganic fertilizers can lead to better yield outcomes due to the complementary benefits they provide (Lal, 2004) ^[10].

Balanced nutrient management in sesame cultivation is important. Balanced NPKS fertilization leads to higher yields and better crop quality. Nitrogen is essential for robust vegetative growth, phosphorus promotes root development and flowering, potassium improves disease resistance and drought tolerance, and sulfur is crucial for protein synthesis and oil content in sesame seeds. Organic fertilizers provide a slow-release source of nutrients and improve soil properties. Combining both types of fertilizers can enhance nutrient availability and utilization, leading to improved yields. Integrated nutrient management, which combines organic and inorganic fertilizers, results in better crop performance compared to the use of either type alone.

Combining FYM and vermicompost with inorganic fertilizers improves yield, enhances soil fertility and microbial biomass, leading to sustainable agricultural practices. The integrated use of organic and inorganic fertilizers improves soil nutrient status, increases nutrient uptake by plants, and enhances the efficiency of nutrient use, thereby improving the overall productivity and sustainability of sesame cultivation.

The importance of nitrogen (N), phosphorus (P), potassium (K), and sulfur (S) in sesame cultivation cannot be overstated. Nitrogen is fundamental for the synthesis of amino acids and proteins, playing a critical role in the growth and development of plants. Phosphorus is vital for the formation of ATP, which plants use for energy transfer, and it is also crucial for the development of roots and seeds. Potassium enhances the plant's ability to resist diseases and aids in water regulation, while sulfur is necessary for the synthesis of certain amino acids and vitamins (Brady & Weil, 2008; Jamal *et al.*, 2010) ^[3, 5]. These nutrients, when supplied in the right balance, can significantly enhance the yield and quality of sesame crops.

Inorganic fertilizers, such as urea, diammonium phosphate (DAP), and muriate of potash (MOP), provide a concentrated and immediate supply of these essential nutrients. However, the overuse of inorganic fertilizers can lead to soil degradation, nutrient imbalances, and environmental pollution (Khurana *et al.*, 2017) ^[7]. Hence, there is a growing interest in supplementing inorganic fertilizers with organic sources like FYM and vermicompost to mitigate these negative impacts and promote sustainable farming practices

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 inorganic and organic 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 treatments were control (T₁), NPK @ 60:25:25 kg/h (T₂), NPK @ 50:20:20 kg/ha (T₃), NPK @ 40:15:15 kg/ha (T₄), FYM @ 7.5 t/ha (T₅), FYM @ 10 t/ha (T₆), Vermicompost @ 3.75 t/ha (T₇), Vermicompost @ 5 t/ha (T₈). The gross and net plot size was 4.00 m x 3.60 m and 3.40 m x 2.70 m, respectively. The fertiliser grades were applied as per the 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

Yield attributing characters like test weight, seed yield, straw yield, biological yield and harvest index were markedly improved with the level of NPK @ 60:25:25 kg/ha. as compared to other treatments. Higher test weight was observed in plant with NPK @ 60:25:25 kg/ha. The application of higher rates of NPK leads to the differentiation of tissue to the reproductive part from the vegetative part, meristematic activity and development of floral primordium which increases the number of flower production and capsule formation. Higher level of NPK led to the translocation of photosynthesis from leaves through the stem to sink (capsule). Sharma *et al.* (2018) ^[17], Kaur *et al.* (2015) ^[6], Yadav *et al.* (2016) ^[22] and Mehta *et al.* (2018) ^[11] observed similar result.

Application vermicompost @ 5 t/ha. markedly enhanced yield-related traits, including test weight, seed yield, straw yield, biological yield, and harvest index, when compared to other treatments. The use of Vermicompost not only increased test weight but also enriched the soil with organic matter, improving soil structure, aeration, and moisture retention. The higher organic content facilitated the differentiation of tissues from vegetative to reproductive stages by enhancing root growth and nutrient availability. This stimulated meristematic activity and the development of floral primordia, leading to an increase in flower and capsule formation. Additionally, Vermicompost contributed to the gradual release of nutrients, supporting sustained plant growth and better translocation of photosynthates to the reproductive parts. These findings align with the observations of Ramesh *et al.* (2013) ^[14], Kumar *et al.* (2015) ^[9], Thakur *et al.* (2016) ^[21], Jain *et al.* (2018) ^[4], and Singh *et al.* (2019) ^[19].

The incorporation of FYM @ 10 t/ha significantly improved yield-contributing factors, such as test weight, seed yield, straw yield, biological yield, and harvest index, outperforming other treatments FYM @ 7.5 t/ha. The higher test weight observed in FYM-treated plants can be attributed to the enhanced soil fertility resulting from the increased organic matter content. FYM not only enriched the soil with essential nutrients but also enhanced microbial activity, which improved nutrient cycling and availability. The elevated levels of FYM promoted a healthy root system, leading to better uptake of water and nutrients, which facilitated the transition from vegetative to reproductive phases. This enhanced meristematic activity and the development of floral primordia, resulting in more flowers and capsules. Moreover, the slow release of nutrients from FYM

ensured a steady supply, aiding in the efficient translocation of photosynthates from the leaves to the sink (capsule). Similar findings were reported by Singh *et al.* (2014)^[20], Banerjee and Saha (2015)^[1], Rao *et al.* (2016)^[15], Bose *et al.* (2017)^[2], Krishnan *et al.* (2017)^[8], and Sharma *et al.* (2023)^[16].

A comparative analysis of inorganic and organic fertilizer treatments on yield and its contributing factors demonstrates that the inorganic treatments significantly outperformed the organic alternatives. This superiority of inorganic fertilizers can be attributed to their higher nutrient availability, which is immediately accessible to plants. As a result, plants absorb these nutrients more efficiently, leading to accelerated growth and substantially higher yields. The quick-release nature of inorganic fertilizers provides an immediate boost to plant development, optimizing yield potential.

On the other hand, when comparing the organic treatments, Vermicompost proved to be more effective than FYM in enhancing seed yield and associated growth parameters. Vermicompost, with its rich organic matter content and

beneficial microbial activity, promotes better nutrient uptake and soil structure, which in turn supports more robust plant growth and higher yields compared to FYM. This suggests that while organic options are beneficial, Vermicompost offers a more potent impact on yield improvement within organic farming practices.

The results revealed that different nutrient application on treatment influenced the economics of sesame. The cost of cultivation was different due to different amount of organic and inorganic fertilizer application which incurred different amount of production cost.

The Maximum cost of production was reported in highest application of nutrient *i.e.* NPK @ 60:25:25 kg/ha. The increasing amount of nutrient application increases yield of seed and stover of sesame, which lead to improvement in gross return, net returns, and benefit cost ratio up to the highest level among all treatments. Mishra *et al.* (2023)^[13] and Sharma and Singh, (2023)^[18].

Table 1: Response of inorganic and organic fertilizer on growth and yield of Sesame (*Sesamum indicum* L.)

Treatment	Seed weight (kg/ha)	Straw weight (kg/ha)	Test weight (g)	Biological yield / plant (g)	HI (%)	GMR (₹ ha ⁻¹)	NMR (₹ ha ⁻¹)	B: C ratio
Control	550.33	1820.00	2.14	2511.00	21.98	49486.40	33670.40	3.13
NPK @ 60:25:25 kg/ha.	907.00	2020.67	2.67	2975.33	30.52	78622.01	61583.81	4.61
NPK @ 50:20:20 kg/ha.	834.00	1990.33	2.58	2912.00	28.71	72690.99	55746.49	4.29
NPK @ 40:15:15 kg/ha.	799.00	2005.67	2.50	2830.67	28.27	69937.01	53261.21	4.19
FYM @ 7.5 t/ha.	661.33	1860.00	2.17	2611.33	25.41	58486.40	35170.40	2.51
FYM @ 10 t/ha.	714.00	1913.33	2.19	2556.67	28.06	62859.99	37043.99	2.43
Vermicompost @ 3.75 t/ha.	766.67	1920.33	2.37	2687.00	28.53	67094.59	32528.59	1.94
Vermicompost @ 5 t/ha.	794.00	1951.00	2.48	2814.67	28.23	69373.00	28557.00	1.70
S.Em±	18.05	39.83	0.04	99.15	1.05	1493.30	1493.30	0.07
C.D. (P=0.05)	74.75	120.82	0.12	300.74	3.19	4529.44	4529.44	0.22

Conclusion

Based on the experiment's findings, it is clear that the application of fertilizers, particularly inorganic options, significantly enhances crop yield and its contributing factors. Among the treatments, NPK @ 60:25:25 kg/ha proved to be the most effective, offering the highest yield, economic returns, and overall agronomic benefits. This indicates the superior nutrient availability in inorganic fertilizers, leading to enhanced plant growth and productivity. In the realm of organic treatments, Vermicompost @ 5 t/ha outperformed FYM, demonstrating its potential for improving soil health and crop yield, although its economic returns were lower than those of the inorganic treatments. FYM @ 10 t/ha also showed positive results but was less effective than Vermicompost. Overall, while inorganic fertilizers provide the greatest yield benefits, Vermicompost stands out as a strong organic alternative, especially for those focusing on sustainable agriculture practices.

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