



Impact of biofertilizer combinations on yield and economics of sesame (*Sesamum indicum* L.) under organic rainy-season management

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Summary

The present study was conducted to evaluate the impact of various organic nutrient combinations on crop yield and the economics of sesame cultivation. The experiment was conducted during the 2023-24 kharif season at the Organic Research Farm, Karguanji, Department of Agronomy, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh. The experiment was laid out in a Randomized block design with 8 treatments and 3 replications. A total of eight treatments were formulated viz., T₀ (RDF-Control); T₁ (FYM + PSB); T₂ (FYM + Mycorrhiza); T₃ (FYM + SSB); T₄ (FYM + PSB + Mycorrhiza); T₅ (FYM + PSB + SSB); T₆ (FYM + Mycorrhiza + SSB); T₇ (FYM + PSB + Mycorrhiza + SSB). From the above experimental findings, it may be concluded that the treatment T₇ (FYM + PSB + Mycorrhiza + SSB) was found to be best in terms of yield of sesame, having the highest number of capsules per plant and grains per capsule (53.90 capsules and 66.70 grains); seed yield (15.63 q/ha), even better than T₁ (RDF-Control). The highest benefit-cost ratio was found in T₇ (FYM + PSB + Mycorrhiza + SSB) and T₅ (FYM + PSB + SSB) with (2.00:1). Therefore, for sesame cultivation using farmyard manure as an organic source and PSB, SSB and Mycorrhiza as biofertilizers can be beneficial to get better yield and return.

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Introduction

The rising demand for edible oil is driven by population growth, improved living standards, rapid industrialisation, and the use of oilseed crops for biofuel synthesis. To meet this demand, large imports are filling the gap between supply and demand. Sesame [*Sesamum indicum* (L.)] is one of the oldest oilseed crops, domesticated over 3,000 years ago, with a chromosome number of 2n=26. The genus *Sesamum* includes several species, most of which are wild and native to sub-Saharan Africa (Bedigian, 2015). Sesame oil consists of several fatty acids, including linoleic acid (41%), oleic acid (39%), palmitic acid (8%), and stearic acid (5%), with smaller amounts of others. Sesame seeds provide 17.7 g of protein, 23.4 g of carbohydrates, 11.8 g of dietary fibre, and 49.7 g of fat per 100 g. They are also rich in vitamins like A and B9, as well as minerals such as calcium (975 mg), iron (14.6 mg), zinc (7.8 mg), sodium (11 mg), potassium (468 mg), phosphorus (629 mg), and magnesium (351 mg). In 2020, global sesame production reached 7 million metric tons, with Sudan, Myanmar, and Tanzania leading output. White and lighter-coloured sesame genotypes are commonly found in Europe, America, West Asia, and the Indian subcontinent, while black and darker varieties are mainly grown in China and

Southeast Asia. It is a high-value oilseed crop, with Japan being the largest importer, where sesame oil, especially from roasted seeds, is a staple in cooking. China, the second-largest importer, mainly imports oil-grade sesame while exporting lower-cost food-grade seeds, especially to Southeast Asia. Other key importers include the United States, Canada, the Netherlands, Turkey, and France. It accounts for nearly 45% of the total oilseed area in India. India ranks among the world's leading sesame producers, contributing 18.33% of global hectares and 9.68% of production. However, its average productivity remains stagnant at 413 kg/ha, much lower than the global average of 1,208 kg/ha (Directorate of Oilseed Development, Ministry of Agriculture and Farmers Welfare, 2020-21). Key sesame-producing states in India include West Bengal, Madhya Pradesh, Rajasthan, Uttar Pradesh, Gujarat, Andhra Pradesh, and Telangana. On average, well-decomposed farmyard manure (FYM) contains 0.5% nitrogen (N), 0.2% phosphate (P₂O₅), and 0.5% potassium (K₂O). FYM also enhances soil phosphorus availability. Besides increasing soil phosphorus content, FYM can influence the solubility and potential availability of applied phosphorus when used alongside fertilizer phosphorus. It is widely acknowledged that neither organic manure alone nor chemical fertilizers can sustain yields under modern intensive farming systems (Mohanty et al. 2022). The integrated use of nutrients from organic manures and biofertilizers is considered the most efficient approach to supplying plant nutrients for sustained crop productivity and

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improved soil fertility (Dhadge and Satpute, 2014; Vala et al., 2018). Integrated Nutrient Management (INM) aims to optimise nutrient supply by utilising all available sources in a coordinated manner, INM is an essential tool for sustainable agriculture, contributing to the Sustainable Development Goals (SDGs) by promoting sustainable consumption and production patterns. The use of biofertilizers supports the cultivation of healthy plants, improving soil health and contributing to sustainability. Although they cannot fully replace synthetic fertilizers and pesticides, biofertilizers are expected to reduce their reliance. Previous studies show that biofertilizers enhance nutrient accumulation and availability (Rosa et al. 2020; Nagar et al. 2017), improve stress tolerance (such as drought and salinity), increase plant vigour, boost chlorophyll content, and enhance stomatal conductance (Bulegon et al. 2017; Dawlatzay et al. 2022). Additionally, biofertilizers have been linked to significant increases in grain productivity (Galindo et al. 2019).

Materials and Methods

The present study was conducted during the *Kharif* season of 2023 at the Karguanji Organic Research Farm, which is part of the Department of Agronomy at the Institute of Agricultural Sciences, Bundelkhand University, located in Jhansi, U.P. The research utilised a Randomized Block Design (RBD) featuring three replications and eight distinct treatments. Data analysis was performed using the Fisher and Yates method from 1967, with OPSTAT software facilitating the statistical evaluation. The sesame variety employed in this investigation was Surbhi 2222. Before sowing, the seeds underwent treatment with Phosphorus Solubilizing Bacteria (PSB) culture at a dosage of 200 grams per 10 kilograms of seeds. The treated seeds were then placed in a shaded environment for approximately 24 hours to allow for drying. Following this, the seeds were sown in designated plots according to the treatment scheme, ensuring a spacing of 40 centimetres between rows and 10 centimetres between individual plants, with the aid of a *kudal*. During the sowing process, mycorrhizal fungi were mixed with farmyard manure (FYM) in the plots, applied at a rate of 10 kilograms per hectare in granular form. This bacterium, known as Sulphur Solubilizing Bacteria (SSB), is recognized for its ability to produce active cells that grow, multiply, and mobilize the insoluble sulphur present in the soil, thereby increasing the oil content in oilseed crops, with an application rate ranging from 1 to 3 litres per acre. The details of treatments comprised of T₀ (RDF-Control)); T₁ (FYM + PSB); T₂ (FYM + Mycorrhiza); T₃ (FYM + SSB); T₄ (FYM + PSB + Mycorrhiza); T₅ (FYM + PSB + SSB); T₆ (FYM + Mycorrhiza + SSB); T₇ (FYM + PSB + Mycorrhiza + SSB). The length of the capsule was measured by scale, and the average length per capsule was calculated. The same plants used to record plant height and branches were also utilized for counting the number of capsules per plant at harvest, and their average was calculated. At harvest, capsules were randomly selected from each plant, and the total grains were counted to determine the average number of grains per capsule. Capsules

from three randomly selected plants were plucked and weighed using an electric balance, and the mean capsule weight per plant was recorded in grams. One thousand grains were randomly counted from the winnowed and cleaned produce of each plot, and their weight was recorded as the test weight. After threshing, winnowing, and cleaning, the produce from each plot was weighed in kg/plot and converted to grain yield in kg/ha. Straw yield (kg/ha) was calculated by subtracting the grain yield from the biological yield. The harvest index, representing the ratio of economic (seed) yield to total biological yield (seed + straw), was expressed as a percentage. It estimates the partitioning of dry matter between seed and straw and was calculated as follows:

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Results and Discussion

On analysing data for the number of capsules per plant and grains per capsule, a significant difference was recorded among different combinations of organic sources. The highest number of capsules per plant and grains per capsule (53.90 capsules and 66.70 grains, respectively) was observed in T₇ (FYM + PSB + Mycorrhiza + SSB), followed by T₅ (FYM + PSB + SSB) with 50.40 capsules and 63.30 grains recorded. T₂ (FYM + Mycorrhiza) recorded the lowest number of capsules per plant (38.70 capsules), while in T₁ (FYM + PSB), the lowest number of grains per capsule (53.00 grains) was observed. The increased number of capsules per plant and grains per capsule in sesame, observed with the treatment combination of FYM, PSB, Mycorrhiza, and SSB, can be attributed to the synergistic effects of these inputs on soil fertility and plant health. Farmyard Manure (FYM) enhances soil structure, boosts nutrient availability, and raises organic matter content, thereby fostering vigorous plant growth. Phosphate-solubilizing bacteria (PSB) aid in transforming insoluble phosphate into forms that plants can readily absorb, thus enhancing phosphorus uptake. Mycorrhizae establish symbiotic relationships with plant roots, expanding the root system and improving the absorption of water and nutrients, particularly phosphorus. Sulphur Solubilising Bacteria (SSB) facilitate the conversion of soil sulphur into forms that are accessible to plants, which is crucial for protein synthesis and overall plant metabolism. The collective action of these biofertilizers, along with FYM, ensures optimal nutrient availability and uptake, leading to healthier plants that exhibit more efficient photosynthesis and growth. This ultimately results in increased flowering and fruiting, as demonstrated by a greater number of capsules per plant and grains per capsule. In contrast, other combinations of biofertilizers and the control Recommended Dose of Fertilizer (RDF) may not achieve the same level of comprehensive nutrient management and soil enhancement, resulting in lower productivity levels. The findings were consistent with those of Raj et al., (2014), who observed that the combination of *Rhizobium* and PSB resulted in an increased number of pods and consequently a higher seed yield in chickpeas. Additionally, Kumar and Singh (2016), in their study on black gram, concluded that the application of 75% RDF along with *Rhizobium*, PSB, and

VAM inoculation led to the highest number of pods per plant in the black gram crop.

A thorough analysis of the length of capsule and the weight of capsules per plant revealed non-significant differences. The treatment T₇ (FYM + PSB + Mycorrhiza + SSB) achieved the highest length of capsules with 2.40 cm and weight of capsules per plant (17.67 grams), followed by T₅ (FYM + PSB + SSB), which recorded 2.37 cm for capsule length and 17.33 grams for weight of capsules per plant. In contrast, T₁ (FYM + PSB) exhibited the lowest length of capsule (2.07 cm), while T₂ (FYM + Mycorrhiza) weighted 14.33 grams for the weight of capsules per plant. The enhancement in the length of capsules, capsule weight per plant, and the number of grains per capsule in sesame can be attributed to the synergistic effects of the treatment combination of FYM, PSB, Mycorrhiza, and SSB. This combination significantly boosts plant growth and nutrient absorption. Farmyard Manure (FYM) enriches the soil with organic matter, enhances soil structure, and increases nutrient availability, resulting in healthier plants with improved growth potential. Phosphate-solubilising bacteria (PSB) increase phosphorus availability, which is essential for root development and energy transfer, thereby promoting optimal capsule growth. Mycorrhizae expand the root system, enhancing water and nutrient uptake, which further supports capsule development. Sulphur Solubilising Bacteria (SSB) facilitates the availability of sulphur, crucial for protein synthesis and overall plant health. The combined action of FYM, PSB, Mycorrhiza, and SSB leads to improved nutrient uptake and metabolic efficiency, resulting in longer capsules, greater weight per capsule, and a higher number of grains per capsule. This integrated approach offers superior benefits compared to other biofertilizer combinations and the control RDF (Recommended Dose of Fertilizer), which may not provide the same level of comprehensive nutrient and soil management, ultimately leading to suboptimal plant growth and capsule development. Jagadeesha (2008) reported that biofertilizer (*Azospirillum* and P Solubilizing Bacteria 2.5kg/ha) had a greater weight of fruits per plant and radial diameter of fruit in tomato.

In the analysis of seed yield, straw yield and biological yield of sesame per hectare across various organic treatments, a striking and statistically significant variation emerged. Treatment T₇ (FYM + PSB + Mycorrhiza + SSB) achieved the highest seed yield of 15.63 q/ha. Following closely by T₅ (FYM + PSB + SSB)

with 13.40 q/ha, both significantly outperform T₁ (FYM + PSB), which recorded the lowest yield of 10.57 q/ha. Similarly, when examining the straw yield, a significant difference was also noted. T₇ again led the way with the highest straw yield of 57.81 q/ha. T₅ followed with 54.15 q/ha, while T₁ lagged with the lowest straw yield of 37.29 q/ha. The highest biological yield was observed in T₇ (FYM + PSB + Mycorrhiza + SSB) with 73.44 q/ha, followed by T₅ (FYM + PSB + SSB) with 67.55 q/ha and T₁ (FYM + PSB) with the lowest biological yield of 47.86 q/ha. The synergistic blend of FYM, PSB, Mycorrhiza, and SSB significantly boosts seed yield, straw yield, and overall biological yield in sesame, thanks to its profound effects on soil fertility and plant vitality. Farmyard Manure (FYM) enriches the soil with organic matter, enhancing its structure, moisture retention capacity, and nutrient availability. This solid foundation fosters robust plant growth and maximizes yield potential. Phosphate-solubilising bacteria (PSB) play a crucial role in making phosphorus more accessible, a vital nutrient for energy transfer and root development, which directly impacts plant productivity. Mycorrhizae establish beneficial partnerships with plant roots, expanding the root network and improving the absorption of nutrients and water, thereby enhancing overall plant health and yield. Sulphur Solubilising Bacteria (SSB) further contribute by ensuring adequate sulphur availability, essential for protein synthesis and plant growth. The combined action of these biofertilizers and FYM creates an ideal growing environment that optimises nutrient uptake, boosts plant vigour, and increases both seed and straw production. This integrated approach outperforms other biofertilizer combinations and the control RDF (Recommended Dose of Fertilizer), which may lack the same nutrient synergy and soil enhancement. Consequently, this treatment combination results in superior seed, straw, and biological yields due to its comprehensive support for plant health and productivity. Marimuthu et al., (2022) reported that application of both organic (*Rhizobium*, phosphorus bacteria and Arbuscular Mycorrhiza) and inorganic phosphorus resources is better for effective utilisation of applied phosphorus for good yield per hectare. Marko et al., (2013) reported that application of sulphur up to 60 kg/ha and *Rhizobium* + PSB applied to blackgram cv. Jawahar Urad-2 proved the most beneficial with respect to enhancing all the growth and yield-attributing characters, seed yield and quality, uptake of nutrients and net income per hectare.

Table 1. Effect of organic sources and biofertilizers on the different yield parameters of the Sesame

Treatment Notation	Treatment details	Capsule Plant ⁻¹	Grains Capsule ⁻¹	Length of capsule (cm)	Weight of capsule/plant (g)	Seed yield (q/ha)	Straw yield (q/ha)
T ₀	RDF-Control	43.1	62.8	2.27	16.67	11.87	47.55
T ₁	FYM + PSB	38.9	53.0	2.07	14.67	10.57	37.29
T ₂	FYM + Mycorrhiza	38.7	53.7	2.17	14.33	11.17	43.52

T ₃	FYM + SSB	39.6	53.3	2.30	14.67	10.83	40.29
T ₄	FYM + PSB + Mycorrhiza	48.1	61.1	2.33	16.00	12.70	53.63
T ₅	FYM + PSB + SSB	50.4	63.3	2.37	17.33	13.40	54.15
T ₆	FYM + Mycorrhiza + SSB	44.9	56.7	2.30	17.00	12.17	48.84
T ₇	FYM + PSB + Mycorrhiza + SSB	53.9	66.7	2.40	17.67	15.63	57.81
SE. m (±)		3.10	2.40	0.11	1.11	0.86	4.10
CD _{0.05}		9.40	7.20	NS	NS	2.64	12.28

Table 2. Effect of organic sources and biofertilizers on the biological yield, harvest index and economic parameters of the Sesame

Treatment Notation	Treatment details	Biological yield (q/ha)	Harvest index (%)	Cost of cultivation (Rs/ha)	Gross Return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T ₀	RDF-Control	59.42	20.10	51000	65840	14840	1.29
T ₁	FYM + PSB	47.86	22.16	52320	103256	50936	2.00
T ₂	FYM + Mycorrhiza	54.68	20.87	52100	99125	47025	1.90
T ₃	FYM + SSB	51.13	21.77	52500	104585	37700	1.66
T ₄	FYM + PSB + Mycorrhiza	66.33	19.23	54740	96380	41640	1.76
T ₅	FYM + PSB + SSB	67.55	19.84	53320	92820	51680	1.96
T ₆	FYM + Mycorrhiza + SSB	61.01	19.96	55430	91340	35910	1.64
T ₇	FYM + PSB + Mycorrhiza + SSB	73.44	21.22	55720	105000	52085	2.00
SE. m (±)		4.19	1.76	-			
CD _{0.05}		12.84	NS				

The highest percentage for harvest index was observed in T₁ (FYM + PSB) with 22.16% followed by T₃ (FYM + SSB) with 21.77% and T₄ (FYM + PSB + Mycorrhiza) with the lowest harvest index of 19.23%. Moreover, treatments showed a statistically nonsignificant difference. Maximum net return was obtained in T₇ (FYM + PSB + Mycorrhiza + SSB) with Rs 52085 per hectare followed by T₅ (FYM + PSB + SSB) with Rs 51680 per hectare and the lowest in Rs 14840 in T₀ (RDF-Control). While highest benefit cost ratio was found in T₇ (FYM + PSB + Mycorrhiza + SSB) and T₅ (FYM + PSB + SSB) with (2.00:1) and lowest in T₀ (RDF-Control) with (1.29:1). Similar findings were recorded by Mishra and Dash (2014) working with *Azolla* in rice and revealed that the growth, yield and cost benefit ratio was higher in use of *Azolla* than chemical fertilizer.

Conclusion

From the above experimental findings, it may be concluded that the treatment T₇ (FYM + PSB + Mycorrhiza + SSB) was found to be best in terms of yield of sesame, having highest number of capsules per plant, grains per capsule (53.90 capsules, 66.70 grains) and, seed yield (15.63 q/ha). The highest benefit-cost ratio was found in T₇ (FYM + PSB + Mycorrhiza + SSB)

and T₅ (FYM + PSB + SSB) with (2.00:1). Therefore, for sesame cultivation using farmyard manure as an organic source and PSB, SSB and Mycorrhiza as biofertilizers can be beneficial to get better yield.

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Reference

1. Bedigian D. 2015. Systematics and evolution in Sesame (Pedaliaceae), part 1: Evidence regarding the origin of sesame and its closest relatives. *Webbia. University of Florence*. 70(1): 1–42.
2. Bulegon LG, Guimaraes VF, Klein J, Battistus AG, Inagaki AM, Offemann LC, et al. 2017. Enzymatic activity, gas exchange and production of soybean co-inoculated with '*Bradyrhizobium japonicum*' and '*Azospirillum brasilense*. *Australian Journal of Crop Science*, 11: 888–896.
3. Dawlatzay Z, Kumar S, Kumar P, Kumar P & Satpal. 2022. Influence of nitrogen and phosphorus levels on phenology, growth and yield of bed planted

- wheat under varying irrigation levels in semi-arid conditions. *Journal of Agriculture and Ecology*, 13: 131-140. <https://doi.org/10.53911/JAE.2022.13113>
4. Dhadge SM & Satpute NR. 2014. Effect of integrated nutrient management on growth, yield, and quality of summer groundnut (*Arachis hypogaea* L.). *International Journal of Agricultural Sciences*, 10(1): 314-316.
 5. Fisher RA & Yates F. 1967. The Design of Experiments: Statistical Principles for Practical Applications. New York: Hafner Publishing Company.
 6. Forni C, Duca D & Glick BR. 2017. Mechanisms of plant response to salt and drought stress and their alteration by rhizobacteria. *Plant Soil*, 410: 335–356.
 7. Galindo FS, Teixeira Filho MCM, Buzetti S, Santini JMK, Alves CJ, Nogueira LM et al. 2016. Corn yield and foliar diagnosis affected by nitrogen fertilization and inoculation with *Azospirillum brasilense*. *Revista Brasileira de Ciência do Solo*, 40: e015036.
 8. Hedge DM & Dwivedi BS. 1992. Nutrient management in rice-wheat cropping system in India. *Fertilizer News*. 37: 27-41.
 9. Ismail I, Blevins RL & Frye WW. 1994. Long-term no-tillage effects on soil properties and continuous corn yields. *Soil Science Society of America Journal*, 58: 193-198.
 10. Jagadeesha. 2008. Effect of organic manures and biofertilizers on growth seed yield and quality in tomato (*Lycopersicon esculentum* Mill.) cv. Megha. M. Sc (Agri) Thesis. Univ. Agric. Sci., Dharwad, Karnataka
 11. Kumar S & Singh TB. 2016. Effect of sulphur with and without *Rhizobium* on yield and biochemical composition of Blackgram. *Annals of Plant and Soil Research*, 11(1): 58-59.
 12. Marimuthu S, Gnanachitra M, Prabu Kumar G & Surendran U. 2022. Effect of organic and inorganic sources of phosphorus for enhancing productivity. *Industrial Crops and Products*, 43: 606-611.
 13. Marko GS, Kushwaha HS, Singh S, Namdeo KN & Sharma RD. 2013. Effect of sulphur and biofertilizers on growth, yield and quality of blackgram. *Crop Research*, 45 (1, 2& 3): 175-178.
 14. Mishra P & Dash DP. 2014. Rejuvenation of Biofertilizer for Sustainable Agriculture and Economic Development in Rice Cultivation. *The Journal of Sustainable Development*, 11(1): 41-61.
 15. Mohanty P, Pany BK, Sahu G, Mohapatra S & Nayak BK. 2022. Effect of integrated nutrient management on growth, yield attributes, yield and quality parameters of groundnut (*Arachis hypogaea*) in an acidic upland of Odisha. *Indian Journal of Ecology*, 49 (1): 118-122.
 16. Munareto JD. 2016. Aspects physiological seed, wheat grain productivity applied nitrogen doses, inoculation and *Azospirillum brasilense* of foliar application. 55 f. Dissertação (Mestrado em Agronomia). Federal University of Santa Maria, Santa Maria, Brazil. Available online at: <http://repositorio.ufsm.br/handle/1/5171> (accessed February 23, 2020).
 17. Nagar M, Soni AK, Sarolia DK & Saini HR. 2017. Effect of organic manures and different levels of npk on growth and quality of bottle gourd [*Lagenaria Siceraria* (Mol.) Standl.]. *Journal of Agriculture and Ecology*, 4: 44-50. <https://saaer.org.in/journals/index.php/jae/article/view/120>.
 18. Pankiewicz VCS, Amaral FP, Santos KFDN, Agtuca B, Xu Y, Schueller MJ et al. 2015. Robust biological nitrogen fixation in a model grass-bacterial association. *Plant Journal*, 81: 907–919.
 19. Raj PK, Singh SB, Namdeo KN, Singh Y, Pariha, SS & Ahirwar MK. 2014. Effect of dual biofertilizers on growth, yield, economics, and uptake of nutrients in chickpea genotypes. *Annals of Plant and Soil Research*, 16(13): 246- 249.
 20. Rosa PAL, Mortinho ES, Jalal A, Galindo FS, Buzetti S, Fernandes GC., et al. 2020. Inoculation with growth-promoting bacteria associated with the reduction of phosphate fertilization in sugarcane. *Frontiers Environment and Science*, 8: 1–32.
 21. Vala FG, Vaghasia PM, Zala KP & Akhtar N. 2018. Response of integrated nutrient management on nutrient uptake, economics, and nutrient status of soil in bold-seeded summer groundnut. *International Journal of Current Microbiology and Applied Sciences*, 7(1): 174-180.