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An On-Farm Trial on the Effect of Biofertilizer and Sulphur on Productivity of Sunflower in a Typical Alluvial Soil

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Abstract

A two-year on-farm trial (OFT) was conducted at the Instructional Farm and farmer's field by Krishi Vigyan Kendra, Ashokenagar, North 24 Parganas, West Bengal, India, during the *rabi* seasons of 2020-2021 and 2021-2022 to evaluate the impact of azotobacter inoculation and sulfur application on the growth, yield, and economic returns of a typical alluvial soil crop. The experiment compared three treatments: Farmer's Practice (control), Farmer's Practice + azotobacter + sulphur @ 20 kg/ha, and farmer's practice + azotobacter + sulphur @ 40 kg/ha. Measurements at 50% flowering indicated significant improvements in leaf area index (LAI) and chlorophyll content with increasing levels of azotobacter and sulfur application. Similarly, basal girth and capitulum diameter showed substantial increases as these treatments were escalated. Seed weight per capitulum, yield (t/ha), oil percentage, and crude protein content also exhibited notable enhancements with higher application rates of azotobacter and sulfur. Economic analysis revealed that both azotobacter and sulfur applications at 40 kg/ha significantly increased gross returns, net returns, and benefit-cost ratio compared to the control and the lower application rate, demonstrating their potential economic viability under local farming conditions.

Key words: Azotobacter, Oil content, Sulfur, Sunflower, Yield

Sunflower (*Helianthus annuus* L.) is a significant oilseed crop cultivated worldwide, and its production holds immense economic and agricultural importance. Originating from North America, sunflower has become a widely cultivated crop across temperate, tropical, and subtropical regions, thriving under diverse environmental conditions. Its prominence in agriculture stems from its ability to produce high-quality edible oil and its role as a vital component of the global oilseed industry. In recent years, India has emerged as a prominent player in sunflower cultivation, with an increasing focus on its potential as an oilseed crop. The sunflower's versatility and adaptability to diverse agro-climatic conditions make it an attractive choice for farmers, contributing to the country's efforts to enhance edible oil production and reduce dependence on imports. Sunflower oil, extracted from the seeds, is not only a staple edible oil in the Indian diet but also finds widespread application in the food processing industry, making it a valuable commodity. Its high linoleic acid content makes it a preferred choice for health-conscious consumers, as it is associated with numerous health benefits [1]. Additionally, sunflower seeds can be used in various forms, such as snacks and confectionery, adding to its commercial value. The successful cultivation of sunflower oilseeds requires a balanced ecosystem and the involvement of beneficial microorganisms that play a crucial role in enhancing plant growth and productivity. Among these beneficial microorganisms, azotobacter and sulfur have emerged as key players in promoting sunflower oilseed production. Azotobacter is a free-living, nitrogen-fixing bacterium that forms a symbiotic relationship with sunflower plants. This beneficial association enables azotobacter to convert atmospheric nitrogen into plant-available forms, such as ammonia, which serves as a natural fertilizer for the sunflower crop [2]. By facilitating nitrogen fixation, azotobacter helps improve soil fertility and enhances the overall nutrient uptake by the sunflower plants, leading to increased growth and yield [3]. On the other hand, sulfur is an essential macronutrient required for the synthesis of crucial proteins and enzymes in sunflower plants. It plays a vital role in various metabolic processes, including photosynthesis and nitrogen metabolism [4]. Sulfur acts as a key component of amino acids and vitamins, which are fundamental for the development of healthy sunflower crops. Adequate sulfur availability in the soil significantly influences oil content and quality in sunflower seeds [5]. The combination of azotobacter and sulphur in sunflower cultivation creates a mutually beneficial relationship, where azotobacter supplies nitrogen to the plants, while sulfur supports critical biochemical processes. This synergy results in improved plant growth, enhanced oilseed production, and better oil quality. Considering the significant role of azotobacter and sulphur in sustainable production of oil seed crops, an experiment was conducted to study the effect of biofertilizer and sulphur on growth, yield and oil content of sunflower (*Helianthus annuus* L). This study evaluates the impact of integrating biofertilizers and sulphur application on sunflower productivity in alluvial soil, a widely cultivated but often nutrient-depleted agro-ecological zone. Sunflower (*Helianthus*

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annuus L.), being a vital oilseed crop, requires a balanced nutrient management strategy to optimize growth, yield, and oil content. The on-farm trial aims to address this need by investigating how biofertilizers like azotobacter and varying rates of sulphur supplementation influence key agronomic, physiological, and economic parameters.

MATERIALS AND METHODS

The present field experiment was conducted as on farm trial (OFT) in a typical alluvial soil at the Instructional Farm, Krishi Vigyan Kendra, Ashokenagar, North 24 Parganas, West Bengal, India as well as farmer's field during *rabi* season of 2020- 2021 and 2021-2022. The soil was slightly acidic (pH-5.28), low in available nitrogen (135 kg/ha), phosphorus (17.95 kg/ha), sulphur (7.6 mg/kg), and medium in potassium (142 kg/ha). The variety used in this experiment was 'PAC 361'. The experiment was laid out in randomized block design with three treatments, viz. Farmer's Practice: 80:40:40 kg/ha N:P:K (apply N in to 3 split at 15, 30, 60 DAS), Farmer's Practice + Azotobacter @ 750 g/ha + Sulphur @ 20 kg/ha and Farmer's Practice + Azotobacter @ 750 g/ha + Sulphur @ 40 kg/ha. Oil from the sunflower seeds were extracted with petroleum ether in Soxhlet apparatus. It is then distilled off completely, dried, the oil weighed, and the per cent oil is calculated [6]. Total chlorophyll content was measured adopting the method of Hiscox and Israelstam [7]. The data were analyzed following analysis of variance (ANOVA) technique and mean differences were adjusted by the multiple comparison test [8].

RESULTS AND DISCUSSION

The Leaf Area Index (LAI) is an important parameter used to assess the canopy structure and overall plant growth in crops (Table 1). In this study, the impact of different agricultural practices, including the use of azotobacter and sulphur at varying application rates, on the LAI of sunflower was investigated. Under the farmer's practice, which served as the control group, the measured LAI was recorded at 3.78. This value represents the baseline LAI associated with the traditional farming practices followed by the farmers in the study area. The results showed a noticeable increase in the LAI, reaching 4.12 and 4.30 where sulphur was applied at a rate of 20 and 40 kg/ha respectively, along with azotobacter @ 750 g, in addition to the farmer's practice. The LAI of 4.30 indicates that higher application rates of sulphur appear to have a more pronounced effect on LAI, indicating the potential for improved sunflower growth and productivity. Similarly, the chlorophyll content also shows an increase from 0.55% (farmer's practice) to 0.67% (farmer's practice + azotobacter + sulphur @ 20 kg/ha) and further to 0.73% (farmer's practice + azotobacter + sulphur @ 40 kg/ha). Chlorophyll is essential for photosynthesis, the process through which plants convert light energy into chemical energy, and it plays a critical role in plant growth and development. The observed increase in chlorophyll content suggests that the application of azotobacter and sulphur positively influences the photosynthetic efficiency of sunflower plants, potentially leading to better growth and productivity. This improvement in chlorophyll levels could have positive implications for sunflower crop performance and ultimately contribute to increased oilseed yield and quality [9-10]. Further, it can be observed that the combined application of azotobacter and sulphur has a significant positive impact on both basal girth and capitulum diameter compared to the conventional farmer's practice. The basal girth is a measurement of the circumference of the sunflower stem at the base. In this case, the basal girth increases from 5.54 cm (farmer's practice) to 9.72 cm (farmer's practice + azotobacter + sulphur @ 40 kg/ha). This significant increase indicates a thicker and more robust stem, which can provide better support to the plant and potentially contribute to increased nutrient and water uptake. Likewise, the capitulum diameter shows an increase from 10.87 cm (farmer's practice) to 17.12 cm (farmer's practice + azotobacter + sulphur @ 40 kg/ha). This notable enhancement in diameter suggests larger and more developed flower heads, which are desirable for higher seed production. This improvement in plant morphology can have positive implications for sunflower crop productivity and overall oilseed production.

Table 1 Effect of treatments on growth parameters of sunflower

Treatment	LAI at 50% flowering	Chlorophyll at 50% flowering	Basal girth (cm)	Capitulam diameter (cm)
Farmer's Practice	3.78	0.55	5.54	10.87
Farmer's Practice + Azotobacter + Sulphur @ 20 kg/ha	4.12	0.67	7.26	13.06
Farmer's Practice + Azotobacter + Sulphur @ 40 kg/ha	4.30	0.73	9.72	17.12
CD at 5%	0.009	0.005	0.07	0.107

Table 2 Effect of treatments on yield parameters of sunflower

Treatment	Seeds weight / Capitulam	Yield (t/ha)	Oil (%)	Crude protein (%)
Farmer's Practice	52.97	1.18	36.18	22.52
Farmer's Practice + Azotobacter + Sulphur @ 20 kg/ha	62.97	1.53	37.85	24.68
Farmer's Practice + Azotobacter + Sulphur @ 40 kg/ha	74.93	1.79	39.2	25.79
CD at 5%	0.377	0.011	0.048	0.057

The study found that the application of azotobacter @ 750 g and sulphur at different rates, 20 and 40 kg/ha, significantly improved sunflower seed yield and oil content compared to the conventional farmer's practice. The sunflower seed yield increased from 1.18 (t/ha) to 1.53 (t/ha) with sulphur at 20 kg/ha and 1.79 (t/ha) with sulphur at 40 kg/ha. This indicates that the application of sulphur at different rates contributes to higher sunflower seed production [11]. The sunflower seed oil content increased from 36.18% (farmer's practice) to 37.85% (farmer's practice + azotobacter + sulphur @ 20 kg/ha) and further to 39.2% (farmer's practice + azotobacter + sulphur @ 40 kg/ha). The application of sulphur at 40 kg/ha led to a more significant improvement in sunflower seed oil content compared to both the conventional farmer's practice and the treatment with a lower application rate. This indicates that higher application rates of sulphur further enhance oil accumulation in sunflower seeds. Sulphur application increases oil content due to its role in biosynthesis, forming glucosides, glucosinolates, and activating enzymes, leading to higher seed yield and oil content [12]. Additionally, the results show an increase in crude protein content with the application of azotobacter and sulphur at 40 kg/ha, reaching 25.79%. This suggests that higher nutrient availability, especially nitrogen from azotobacter, might contribute to increased protein synthesis in sunflower seeds [13].

The gross monetary return, net monetary return and benefit cost ratio of different treatments are depicted in (Table 3). The comparison shows that the treatment azotobacter @ 750 g/ha + sulphur @ 40 kg/ha has the highest gross return of Rs. 74,400.00 per hectare and the highest Benefit-Cost (B:C) ratio of 2.57. This suggests that incorporating azotobacter and higher amounts of sulphur in the farming practice provides better returns and is more economically viable compared to the other two treatments [14].

Table 3 Effect of treatments on economics of sunflower cultivation

Treatment	Cost of cultivation (Rs./ha)	Gross return (Rs/ha)	Net return (Rs./ha)	BC ratio
Farmer's Practice	28000.00	57360.00	29360.00	2.05
Farmer's Practice + Azotobacter + Sulphur @ 20 kg/ha	28700.00	62700.00	34000.00	2.18
Farmer's Practice + Azotobacter + Sulphur @ 40 kg/ha	29000.00	74400.00	45400.00	2.57
CD at 5%	Cost of cultivation (Rs./ha)	Gross return (Rs/ha)	Net return (Rs./ha)	BC ratio

CONCLUSION

The integration of Azotobacter inoculation and sulfur application shows promising agronomic benefits in terms of improved growth parameters, yield attributes, and economic returns in the cultivation of the studied crop in alluvial soils. These findings underscore the practical relevance and potential adoption of these practices to enhance agricultural productivity and profitability in similar agro-ecological contexts. Further research and field trials are recommended to optimize the application rates and validate these findings across diverse environments.

LITERATURE CITED

1. Sandhya G, Singh R, Singh E. 2021. Effect of biofertilizers and levels and sources of sulphur on yield and economics of sunflower (*Helianthus annuus* L.). *Pharma Inno. Journal* 10(11): 1822-1825.
2. Singh M, Garg N. 2018. Influence of Azotobacter and nitrogen levels on growth and yield of sunflower (*Helianthus annuus* L.). *Int. Jr. of Chem. Studies* 6(4): 333-336.
3. Sindhu SS, Sharma V. 2019. Role of azotobacter and rhizobium in sustainable agriculture: A review. *Int. Jr. of Curr. Microbiology and App. Science* 8(10): 1506-1515.
4. Yadav RL, Singh JP. 2020. Effect of sulphur levels on yield, nutrient uptake and quality of sunflower (*Helianthus annuus* L.). *Journal of Oil Research* 37(4): 532-535.
5. Gupta S, Kumar S, Lal S. 2019. Sulphur nutrition and sunflower seed oil quality: A review. *Int. Jr. of Current Microbiology and Applied Science* 8(5): 1031-1043.
6. Sadasivam S, Manickam A. 1992. *Biochemical Methods for Agricultural Sciences*. Wiley Eastern Limited, New Delhi, India.
7. Hiscox JA, Israelstam GE. 1979. A method for the extraction of chlorophyll leaf tissue without mecreation. *Canadian Journal of of Botany* 57: 1332-1334.
8. Gomez KA, Gomez AA. 1984. *Statistical Procedures for Agriculture Research*. Jhon Wiley and Sons. New York.
9. Hussain SS, Misger FA, Kumar A, Baba MH. 2011. Effect of nitrogen and sulphur on biological and economical yield of sunflower (*Helianthus annuus* L.). *Res. Jr. of Agril. Sciences* 2(2): 308-310.
10. Kavitha S. 2013. Individual and combined effect of biofertilizer, chemical fertilizer and vermicompost on *Amaranthus tristis*. *Int. Jr. of Pharm. Sci. Rev. and Research* 20(2): 190-195.
11. Sandhya G, Singh R, Singh E. 2021. Effect of biofertilizers and levels and sources of sulphur on growth and yield of sunflower (*Helianthus annus* L). Biolo. *Forum – An International Journal* 13(4): 332-337.
12. Patra P, Pati BK, Ghosh GK, Mura SS, Saha A. 2013. Effect of biofertilizers and sulphur on growth, yield, and oil content of hybrid sunflower (*Helianthus annuus*. L) in a typical lat. *Soil* 2: 603 doi:10.4172/scientificreports.603.
13. Ramamoorthy K, Sudarsan S. 1992. Supply of zinc and boron on yield and seed quality in groundnut. *Annuals of Plant Physiology* 6: 33-38.
14. Khandekar SD, Ghotmukale AK, Dambale AS, Suryawanshi SB. 2018. Growth, yield and economics of sunflower (*Helianthus annuus* L.) as influenced by biofertilizer and fertilizers levels. *International Journal of Current Microbiology and Applied Science* 6: 1564-1571.