E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(11): 179-182
Received: 20-08-2024
Accepted: 26-09-2024

Diksha Singh
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Umesha C
Assistant Professor, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Diksha Singh
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of bio-fertilizer and sulphur on growth and yield of sunflower (*Helianthus annuus* L.)

Diksha Singh and Umesha C

DOI: https://doi.org/10.33545/2618060X.2024.v7.i11Sc.1950

Abstract
A field experiment was conducted during *Rabi* season of 2023 at Crop Research Farm Department of Agronomy. The treatment consisted of three levels of Sulphur (20 kg/ha, 25 kg/ha and 30 kg/ha) and PSB – 20 g/kg, *Azotobacter* – 20 g/kg and PSB + *Azotobacter* – 20 g/kg (0.5%, 1% and 1.5%) along with recommended dose of nitrogen, phosphorus, potassium and control (60:80:60 NPK kg/ha), this experiment was laid out in a Randomized Block Design with ten treatment and replications thrice application Sulphur. The application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (Treatment 9) recorded significantly maximum plant height (135.41 cm), Plant dry weight (49.37 g/plant), seeds/capitulum (307.00), test weight (50.20 g), seed yield (8.56 q/ha), stover yield (31.26 q/ha) and harvest index (26.23%).
It was concluded that for obtaining higher yield components with better quality of Sunflower application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha was recommended.

Keywords: Bio-fertilizer**,** sulphur, sunflower, yield

Introduction
Sunflower (*Helianthus annuus* L.) is an oleaginous species cultivated in many regions of the world, such as Russia, Ukraine, United States, Argentina, and China **[**Kostenkova 2019] [6], due to its wide phenotypic plasticity. The term Helianthus is derived from the Greek helios, meaning sun, and anthos, meaning flower. This crop has high nutritional value and medicinal properties through compounds extracted from seeds fixed in achene (dried fruit) of this oilseed. In addition to the production of edible oil, sunflower has also been used as a raw material in the production of cosmetics, paints, lubricants, and biodiesel [Rocha-Filho 2016] [5]. After the process of extracting oil from the seeds, sunflower bran is also a byproduct used as a protein source for human consumption or as a food supplement for ruminant and non-ruminant feed [Adeleke 2020] [1]. Sunflower oil content varies from 48-53% and it is premium oil with pale yellow in colour used for cooking and margarine. Sunflower is a rich source of linoleic acid (64%) which helps in reducing cholesterol deposition in the coronary arteries of the heart. Oil contains high level of alpha tocopherol, a form of vitamin E. There are two types of sunflowers seed produced, oilseed and confectionery. About 95% of world production is the oil seed type and only 5% the confectionery type. Sunflower contains appreciable quantities of proteins, vitamins A, B, E & K. The sunflower meal is nutritious and can be used to feed the milk cattle, poultry and pigs. In India the sunflower is traditionally cultivated in Karnataka, Maharashtra and Andhra Pradesh. In recent years its cultivation has also been taken up in non-traditional states like Haryana, Punjab, UP, Gujarat, Tamil Nadu, Orissa, MP, and Rajasthan. Among the important sunflower growing states in the country, Karnataka is one where it occupies an area of 9.85 lakh hectares with annual production of 3.62 lakh tones and productivity of 336 kg per hectare.
Azotobacter fixes the atmospheric nitrogen to make available for the plants. It increases the seed germination, plant growth and yield. In certain conditions, they also exhibit antifungal activities and there by fungal disease may be controlled indirectly. It increases the reproductive stage duration, grain filling duration and the total duration of plant growth. Beside this, application of *Azotobacter* effects the grain yield, stalk yield and oil content of the crop (Amutha *et al.*, 2014) [2]. *Azotobacter* are considered as indicates of plant health. It is well established that root exudates produced diverse organic substances important for rhizosphere microbes. *Azotobacter*

stimulate architecture, producing siderophores and lowering ethylene level of non-legumes plants (Chand *et al*., 2006) [4].
The PSB (*Phosphate solubilizing bacteria*) application was able to mobilize P efficiently in the sunflower and improved seed quality and oil yield. It also enhanced the head diameter, 1000 seed weight, kernel ratio and oil content and led to seed and oil yield increases of 15.0 and 24.7% over no application, respectively (Chen *et al.*, 2009) [24].
Sulphur is regarded as a quality nutrient because it affects not only crop yield but also crop quality through its effects on protein metabolism, oil synthesis, and amino acid formation. The average increase in oil content due to sulphur application in major oilseeds is 11.3 percent in groundnut, 9.6% in mustard, 6.0% in linseed and 3.8% in sunflower (Sharma *et al.* 2009) [17]
Sulphur is a mobile element that is quickly lost from the soil. The level of available sulphur reaches below the critical limit and sunflower is bound to suffer sulphur deficiency. Sulphur-deficient soils are unable to provide enough sulphur to satisfy crop demand, resulting in crop sulphur deficiency and suboptimal yield. Sulphur is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium (Tandon and Messick, 2003) [19]. Sulphur plays a predominant role in improving the grain quality of sunflower crop and also the use efficiency of nitrogen and phosphorus (Najer *et al*., 2011) [12].

Materials and Methods

The experiments on the effect of S and B as foliar application with different levels of sulphur along with recommended dose of fertilizers (RDF) on the growth and yield enhancement of sunflower were conducted at *Rabi* season of 2023 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj which is located at 25^0 24 42 N latitude, 81^0 50 56 E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj city. A composite soil sample was collected at a depth of 0-30 cm. It was air dried, crushed, and tested for physical and chemical properties. The soil was sandy clay loam in texture with soil reaction of (pH 7.6), 0.69 organic matter (0.72%), available nitrogen (152.7 kg/ha), phosphorus (10.4 kg/ha), potassium (174.0 kg/ha), Sulphur (7.2 mg/kg), Zn (0.72 mg/kg) and available B (0.56 mg/kg). Experiments were carried out in a randomized block design with ten treatments [T_1- PSB 20 g/kg + Sulphur 20 kg/ha, T_2- PSB 20 g/kg + Sulphur 25 kg/ha - 1%, T_3- PSB 20 g/kg + Sulphur 30 kg/ha, T_4- *Azotobacter* 20 g/kg + Sulphur 20 kg/ha, T_5- *Azotobacter* 20 g/kg + Sulphur 25 kg/ha, T_6- *Azotobacter* 20 g/kg + Sulphur 30 kg/ha, T_7- (PSB 20 g + *Azotobacter* 20 g) + Sulphur 20 kg/ha, T_8- (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha, T_9- (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha, T_{10} - Control (60-80-60) NPK kg/ha]. Experimental plots consisted of three levels of Sulphur (20 kg/ha, 25kg/ha and 30 kg/ha) as soil application and Bio-fertilizer [PSB (*Phosphate solubilizing bacteria*) - 20 g/kg, *Azotobacter* - 20 g/kg, PSB -20 g + *Azotobacter*- 20 g/kg] as seed treatments and control *i.e.*, recommended N, P and K (60:80:60 kg/ha) alone as soil application. All the treatments were applied by balancing to the initial soil test values and crop requirements to justify the crop response to the supplied nutrients in both years.

Results and Discussion

Plant Height: Highest plant height (135.41 cm) was recorded with the application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha (T_9), at 80 DAS there was significant difference among the treatments. Whereas treatment (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (131.63 cm) was found to be statistically at par with T_9, and minimum was reported in control (125.76 cm). According to Tisdale *et al.*, 2003 [20] in addition to its high N fixation and biofertilizers is known to synthesize growth substances such as IAA and other auxines and vitamins B which might have also helped in growing the plant height.

Plant Dry Weight: Highest plant dry weight (48.09 gm) was stated with the application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha (T_9), whereas treatment (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (47.78 gm) was found to be statistically at par with T_9, and minimum was reported in control (41.07 gm). Biofertilizers not only provide nitrogen but also produces a variety of growth- promoting substances, among them indole acetic acid, gibberellins, and B-vitamins this might have helped in the hike in no. of leaves. These findings are similar to that of Kavitha (2013) [9]; Vaghasia and Kahanpara (2008) [21]; Rani *et al.*, (2009) [14]; Hussain *et al.*, (2011) [7]; Basavaraju (1999) [3].

Crop growth rate: During 60 – 80 DAS interval treatment with (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha (6.91 g/m^2/day) was recorded higher, and minimum was reported in (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (5.46 g/m^2/day) over all the treatments and there was no significant difference between the treatments.

Relative growth rate: Highest Relative growth rate (0.710 g/g/day) was reported with the treatments (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha. Whereas minimum Relative growth rate (0.593 g/g/day) PSB 20 g + *Azotobacter* 20 g + Sulphur 25 kg/ha and also reported by other treatments and there was no significant difference between the treatments. This might be due to reduced uptake of nutrients and water as the roots start getting suberized after completion of active vegetative growth (Russell 1952) [16].

Seeds per capitulum: Maximum seeds/capitulum (307.00) was observed with the treatment of application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha over all the treatments, minimum was recorded in Control (290.00) However, the treatments (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (300.33) which was found to be statistically at par with T_9. Vessey (2003) [22] reported that Azotobacter and *Azotobacter* increase the available nitrogen in the soil which could enhance the grain number. Grain yield was significantly influenced with different combinations of biofertilizers with chemical fertilizers.

Test weight: Significantly maximum test weight (g) (50.20 g) was observed with the treatment of application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha (T_9) over all the treatments, minimum was recorded in Control (42.85 g) However, the treatments (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (49.89 g) which was found to be statistically at par with T_9.

Seeds yield (q/ha): Significantly maximum seed yield (8.56 q/ha) was recorded with the treatment of application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha (T_9) over all the treatments, minimum was recorded in Control (6.90 q/ha). However, the treatments (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (8.56 q/ha) which was found to be statistically

at par with T_9. The increase in yield and yield attributing parameters might due to the application of the combined use of inorganic fertilizers, organic manures and bio fertilizers can enhance the inherent nutrients supplying capacity of the soil with respect to both macro- and micronutrients (Jayabal and Chelliah, 2000) [8] and also improve the physical properties of the soil, which promote better rooting, higher nutrient uptake by the crop and increase in seed yield.

Stover yield (q/ha): Significantly Maximum stover yield (31.26 q/ha) was observed with the treatment of application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha over all the treatments, minimum was recorded in Control (28.35 q/ha) However, the treatments (PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha (30.91 q/ha) which was found to be statistically at par with T_9.

Harvest index (%): Significantly Maximum harvest index (26.60%) was observed with the treatment of application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha over all the treatments, minimum was recorded Control (26.05%). Similar results have also been reported by Ramu and Reddy (2003) [15] and Shekhawat and Shivay (2009) [18].

Table 1: Effect of sulphur and biofertilizer on yield attributes and yield of Sunflower

S No	Treatments	Seeds/capitulum	Test weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
1.	PSB 20 g/kg +Sulphur 20 kg/ha	295.00	44.83	7.34	28.97	26.51
2.	PSB 20 g/kg + Sulphur 25 kg/ha	296.67	46.78	7.71	29.79	26.30
3.	PSB 20 g/kg + Sulphur 30 kg/ha	296.00	46.42	7.63	29.50	26.45
4.	*Azotobacter* 20 g/kg + Sulphur 20 kg/ha	297.33	47.28	7.80	30.32	26.05
5.	*Azotobacter* 20 g/kg + Sulphur 25 kg/ha	294.00	43.78	7.15	28.53	26.60
6.	*Azotobacter* 20 g/kg + Sulphur 30 kg/ha	296.00	45.90	7.54	29.32	26.09
7.	(PSB 20 g + *Azotobacter* 20 g) + Sulphur 20 kg/ha	294.00	44.46	7.26	28.71	26.45
8.	(PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha	300.33	49.89	8.32	30.91	26.60
9.	(PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha	307.00	50.20	8.56	31.26	26.23
10.	Control (RDF): 60:80:60 NPK kg/ha	290.00	42.85	6.90	28.35	26.54
	F – Test	S	S	S	S	NS
	SE m (±)	2.77	0.58	11.43	5.80	0.517
	CD (p=0.05)	8.23	1.73	35.05	1.08	1.536

Table 2: Effect of sulphur and biofertilizer on growth attributes of Sunflower

S. No.	Treatment combinations	At 80 DAS			During 40 – 60 DAS
		Plant Height (cm)	Dry Weight (gm/plant)	Crop Growth Rate (g/m^2/day)	Relative Growth Rate (g/g/day)
1.	PSB 20 g/kg +Sulphur 20 kg/ha	129.15	43.05	6.38	1.148
2.	PSB 20 g/kg + Sulphur 25 kg/ha	130.10	45.00	6.52	1.174
3.	PSB 20 g/kg + Sulphur 30 kg/ha	129.63	44.64	6.43	1.158
4.	*Azotobacter* 20 g/kg + Sulphur 20 kg/ha	130.18	45.50	6.55	1.179
5.	*Azotobacter* 20 g/kg + Sulphur 25 kg/ha	128.29	42.00	6.04	1.087
6.	*Azotobacter* 20 g/kg + Sulphur 30 kg/ha	130.26	44.12	6.45	1.162
7.	(PSB 20 g + *Azotobacter* 20 g) + Sulphur 20 kg/ha	128.63	42.68	6.21	1.118
8.	(PSB 20 g + *Azotobacter* 20 g) + Sulphur 25 kg/ha	131.63	47.78	6.70	1.212
9.	(PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha	135.41	48.09	6.73	1.205
10.	Control (RDF): 60:80:60 NPK kg/ha	125.76	41.07	6.06	1.091
	F- test	S	S	S	NS
	S.Em(±)	1.20	0.77	0.14	0.04
	CD (p=0.05)	3.57	2.29	0.41	-

Conclusion

It was concluded that for obtaining higher yield components with better quality of Sunflower application of (PSB 20 g + *Azotobacter* 20 g) + Sulphur 30 kg/ha was recorded significantly higher as compared to other treatments. Since, the finding based on the research done in one season.

Acknowledgement

I am grateful to my advisor as well as all the faculty members of Department of Agronomy for their unwavering support and advice throughout the entire experimental research study.

Competing Interests

Authors have declared that no competing interests exit.

References

1. Adeleke BS, Babalola OO. The endosphere microbial communities, a great promise in agriculture. Int Microbiol. 2020;24:1-17.
2. Amutha R, Karunakaran S, Dhanasekaran S. Isolation and mass production of biofertilizer (Azotobacter and Phosphobacter). Int J Latest Res Sci Tech. 2014;3:79-81.
3. Basavaraju MN. Effect of Azotobacter inoculation on growth and yield of radish. M.Sc. (Agri) thesis. University of Agricultural Sciences, Bangalore, Karnataka, India; c1999.
4. Chand H, Meena M, Sharma K. Microbial biodiversity and bioremediation assessment through omics approaches. Front Environ Chem. 2006;1:570326.
5. Da Rocha-Filho PA, Maruno M, Ferrari M, Topan JF. Liquid crystal formation from sunflower oil: long term stability studies. Molecules. 2016;21(6):680.
6. Kostenkova EV, Bushnev AS, Vasilko VP. The study of *Helianthus annuus* L. of domestic breeding in arid Crimea. In: Innovations in Agricultural and Rural Development. IOP Conf Ser Earth Environ Sci. 2019;341:012011.

7. Hussain SS, Misger FA, Kumar A, Baba MH. Effect of nitrogen and sulphur on biological and economical yield of sunflower (*Helianthus annuus* L.). Res J Agric Sci. 2011;2(2):308-310.
8. Jayabal A, Palayyappan SP, Chelliah S. Effect of integrated nutrient management techniques on yield attributes and yields of sunflower (*Helianthus annuus* L.). Indian J Agron. 2000;45(2):384-386.
9. Kavitha S. Individual and combined effect of biofertilizer, chemical fertilizer and vermicompost on *Amaranthus tristis*. Int J Pharm Sci Rev Res. 2013;20(2):190-195.
10. Krishnamurthy VV, Mathan KK. Effect of sulphur on yield of groundnut. Madras Agric J. 1996;83:640-642.
11. Messick DL. Sulphur fertilizers: A global perspective. In: Proceedings of TSI-FAI-IFA Workshop. Sulphur in balanced fertilization; c2003. p. 1-7.
12. Najar GR, Singh SR, Akthar F, Hakeem SA. Influence of sulphur levels on yield, uptake and quality of soybean (Glycine max) under temperate conditions of Kashmir valley. Indian J Agric Sci. 2011;81(4):340-343.
13. Naser A, Anjum S, Sarvajeet G, Umar I, Ahmed C, Armando D, *et al*. Improving growth and productivity of oleiferous Brassica under changing environment: significance of nitrogen and sulphur nutrient and underlying mechanisms. Sci World J. 2012;12.
14. Rani KU, Sharma KL, Nagasri K, Srinivas K, Muthy TV, Maruthi GR, *et al*. Response of sunflower to sources and levels of sulphur under rainfed semiarid tropical conditions. Commun Soil Sci Plant Anal. 2009;40:2926-2944.
15. Reddi Ramu Y, Maheswara Reddy P. Growth and yield of sunflower as influenced by nitrogen and sulphur nutrition. Indian J Dryland Agric Res Dev. 2003;18(2):192-195.
16. Russell EJ. The development of plant root in soil. In: Soil Conditions and Plant Growth. 8th ed. London: Congmans Green & Co. Ltd.; c1952. p. 421-432.
17. Sharma A, Sharma P, Brar MS, Dhillon NS. Comparative response to sulphur application in raya (*Brassica juncea*) and wheat (*Triticum aestivum*) grown on light textured alluvial soils. J Indian Soc Soil Sci. 2009;57(1):62-65.
18. Shekhawat K, Shivay YS. Effect of nitrogen sources, sulphur and boron levels on productivity, nutrient uptake and quality of sunflower (*Helianthus annuus*). Indian J Agron. 2009;53(2):129-134.
19. Tandon HLS, Messick DL. Practical Sulphur Guide. Washington, D.C.: Sulphur Institute; c2003.
20. Tisdale SL, Nelson WL, Beaton JD, Havlin JL. Soil Fertility and Fertilizers. 5th ed. New Delhi: Prentice-Hall of India; c2003.
21. Vaghasia PM, Khanpara VD. Response of groundnut (*Arachis hypogaea* L.) to moisture conservation practices and sulphur nutrition under rainfed conditions. Int J Agric Sci. 2008;4(2):523-526.
22. Vessey JK. Plant growth promoting rhizobacteria as biofertilizers. Plant Soil. 2003;255:571-586.
23. Wani MA, Agha FA, Malik MA, Rather ZA. Response of sunflower to sulphur application under Kashmir conditions. Appl Biol Res. 2001;3:19-22.
24. Chen YP, Rekha PD, Arun AB, Shen FT, Lai WA, Young CC. Phosphate solubilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities. Appl Soil Ecol. 2009;34:33-41.