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Effect of Micronutrients and Sulphur on Growth and Yield of Sesame

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, 211007, Uttar Pradesh, India during (*kharif* 2022) to study the effect of micronutrients and sulphur on growth and yield of sesame. The treatments consisted of two levels of zinc (10 kg/ha,5 kg/ha), two levels of boron (5 kg/ha, 2.5 kg/ha) and three levels of sulphur (30 kg/ha, 40 kg/ha, and 50 kg/ha) and one control plot was used (the micronutrients were applied through soil application). The experiment was laid out in the Randomized Block Design with ten treatments which are replicated thrice on the basis of, one year experiment. The result showed that growth parameters viz., Plant height (127.57 cm), Plant dry weight (17.47 g plant^{-1}), the application of micronutrients also improve the Crop growth rate (7.94 g/m^2/day), Relative growth rate (0.026 g/g/day), and the yield parameters viz., Number of capsules plant^{-1} (43.37) seeds pod^{-1} (49.40), test weight (3.40 g), stover yield (1.98 t ha^{-1}), grain yield (1.103 t ha^{-1}), Harvest index (23.01%) were recorded significantly higher with application of zinc(5 kg ha^{-1}), boron(2.5 kg ha^{-1}) in combination

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with sulphur (50 kg ha^{-1}). Maximum highest Net return (₹ 56,226 ha^{-1}), Gross return (₹ 86,364 ha^{-1}), and benefit cost ratio (1.86) were also recorded with the treatment 9 i.e., zinc (5 kg ha^{-1}), boron (2.5 kg ha^{-1}) in combination with sulphur (50 kg ha^{-1}).

Keywords: Sesame; zinc, boron; sulphur; economics; growth and yield parameters.

1. INTRODUCTION

"Sesame (*Sesamum indicum* L.) is one of the oil seed crop originated from south west Africa belongs to family Pedaliaceae, chromosome number 2n=26, commonly known as til, ellu, beniseed, simsim in India" [1]. It is one of the important edible oil seed cultivated in India since ancient times. Sesamum is called "Queen of oil seed crop" by virtue of its excellent quality oil [2]. Sesame have highest oil content (46-52%), protein content varies from 18-20%, (Kadamandala et al., 2021). Raja et al. [3] in their study conducted on sandy clay loam soil found that progressive increase in different growth parameters of sesame.

"Worldwide, sesame is grown on 12.52 mha with production of 6.55 mt and productivity of 510 kg ha^{-1}. India is the largest producer and acreage holder of sesame in the world. It is cultivated on 16.2 l ha with production of 7.33 l and productivity of 450 kg ha^{-1}. The crop is extensively cultivated in the states of Gujarat, Karnataka, Uttar Pradesh, Rajasthan and Madhya Pradesh etc", [4]. "The highest productivity and return was obtained through recommended dose of fertilizer with ZnSO4 indicated that NPK fertilizers produce balanced nutrition to realize the potential of the crop. In Uttar Pradesh, sesame is cultivated in an area of 3.29 lha with the total production of 79.78 lt and productivity of 240 kg ha^{-1}. The area of sesame in karnataka is 0.67 lha with an annual production 0.31 lt with a productivity of 500 kg ha^{-1}" [5]. "It is a short-day plant and thrives best on moderately fertile and well-drained soils with pH. 5.5 - 8.0. It was reported that the sesame hulls possess considerable amount of antioxidant activity due to the presence of high level of phenolic compounds" [6]. A two years consecutive study was conducted by [7] at TNAU, Coimbatore during 2007 and 2008 to study the effect of varying levels of Sulphur and boron on sesame.

Micronutrients are important for plant growth, as plants require a proper balance of all the essential nutrients for normal growth and optimum yield. Plant metabolism, nutrient regulation, reproductive growth, chlorophyll synthesis, production of carbohydrates, fruit and seed development, etc., are such effective functions performed by micronutrients [8,9,10,11] an experiment was conducted during April- June 2013 to find out the effect of NPK levels and micronutrients (Khan *et al.,* 2017) Reported that application of micronutrients increases the crop yield and enhance plant resistance to environmental stress by using Zn, B using Mn fertilizer increased capsule length, capsule $plant^{-1}$, seed $plant^{-1}$, test weight, seed weight, and oil content of sesame. It was concluded that micronutrients fertilizer application @ 10 kg ha^{-1} and 5 kg ha^{-1} would enhance yield and yield related trails proper cultivar is selected to other treatment. "These tracer elements when present at adequate level, elevate the healthy growth in plant physiological, biochemical and metabolic characteristics while their deficiency promotes abnormal growth in plants". (Dubey *et al.,* 2015). "Ultimately reduction of grain yield and production but also make sharp impact on agro–based economy" [12,13].

"Zinc plays an important role in biochemical pathways like carbohydrate metabolism, photosynthesis, conversion of sugars to starch, protein metabolism, auxin (Growth regulators) metabolism, pollen formation, infection by certain pathogens" [12,14]. "Zinc has gained macro importance to meet soil fertility needs to enhance productivity. For optimum plant growth and seed yield, adequate supply of zinc is essential" [15]. "In indian soils Zn deficiency is expected to increase 42% in 1970 to 63% in 2025 due to depletion of soil fertility" [16,17,18].

"Application of boron have received a great deal of importance in high responsive oil seed crops during the last five years, because of wide spread occurence of deficiency from different parts of India. Boron is one of the essential nutrient for optimum growth and development, yield, and quality of crops. It performs many important functions in plants and is mainly involved in cell wall synthesis and structural integration. Deficiency of boron causes inhibition of the root elongation leading to death of root tips in sesame". (Shubham Dwivedi et al., 2020) "Sesame is an important oil crops which has good position to increase economic earnings of grower. The study on effect of nitrogen and zinc application to sesame (*Sesamum indicum* L.). Boron also involved in pollen and tube growth further reduction in the crop yield due to severe disturbance in boron involving metabolic process", (Mandal et al., 2009) [19]. The research to increase its cultivation in attention to its high oil content, quality and its utilization for purpose of Application of Boron at flowering and seed formation stages as compared using water spray and untreated seeds i.e., Boron increases yield uptake anti-oxidant activity (AOA) and theoretical oil content (TOC).

"Sulphur is known important element for plant development in metabolism of plants as well as production of Sulphur containing ammonia acids and therefore exerts adverse effects on both seed and oil yield" [3]. "In their study conducted on sandy clay loam soil found that progressive increase in level of Sulphur significantly increased different growth parameters of sesame viz., plant height, Sulphur is crucial for the growth and development, place a significant role in plant metabolism, indispensable for the synthesis of necessary oils and chlorophyll production" [20]. Sulphur is also a component of a number of organic compounds (Shamina et al., 2003), oil storing organs particularly oil glands (Jaggi et al., 2001) and Vitamin B complex (Thirumalaisami et al., 2001). Application of 30-40 kg ha^{-1} Sulphur to groundnut was more beneficial [21].

2. MATERIALS AND METHODS

A field experiment was conducted during *kharif* (June – September 2022), at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India. Which is located at 25^0 39' 42" N latitude, 81^0 67'56" E longitude and 98 m altitude above the mean sea level. This area was situated on the right side of Yamuna river near prayagraj- Rewa Road above 12 km away from the city. The soil was sandy loam textured, with a pH 7.2, organic carbon (0.657%), potassium (247.3 kg ha^{-1}), and phosphorus (36.7 kg ha^{-1}). Electrical conductivity of the soil (0.387 ds m^{-1}). The experiment was laid out in Randomised Block Design with ten treatments and each replicated thrice. The treatment consist of two levels of zinc, two levels of boron, and 3 levels of sulphur with one control plot and analysed of each treatment was completed to determine the best treatment combination. Net weight, benefit cost ratio were computed based on the cost of cultivation, Grain and stover yield with their prevailing market price. The data collected for different parameters were statistically analysed using replication, randomization, Blocking, Data Analysis etc,. Gomez (1976). Randomized block design. The results are presented at (5%) level of significance for making comparison between treatments.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

3.1.1 Plant height

At 80 DAS, has significantly increase the plant height to (127.57 cm) were recorded with application of zinc 5 kg ha^{-1} and boron 2.5 kg ha^{-1} in combination with sulphur 50 kg ha^{-1}, whereas the application of boron 5 kg ha^{-1} and sulphur 40 kg ha^{-1} (116.33 cm) were found statistically at par with the higher. Plant height of sesame was effect by application of micronutrients and sulphur. The higher dose of sulphur had a positive role in metabolism activity, more synthesis of sulphur containing amino acids like methionine and cystine, increase in chlorophyll content in growing regions and improving photosynthetic activity. Ultimately enhance cell division, carbohydrates metabolism and increased growth of meristematic tissue there by increase crop growth (Sarawgi 2004).

3.1.2 Plant dry weight

At 80 DAS, significantly highest plant dry weight (17.47 g $plant^{-1}$) was recorded with the application of zinc 5 kg ha^{-1} and boron 2.5 kg ha^{-1} in combination with sulphur 50 kg ha^{-1} however, with the application of boron 5kg ha^{-1} and sulphur 40 kg ha^{-1} (16.13 g $plant^{-1}$) were found to be statistically at par with the higher. Application of micronutrients and sulphur has significantly increase the total dry matter accumulation. This might be due to more synthesis of amino acids, increase in chlorophyll content in growing regions and improving photosynthetic activity other physiological activities, ultimately increasing cell division. Zinc, boron and sulphur had stimulating effect in the synthesis of chlorophyll and grater photosynthetic efficiency, which resulted in increasing the dry matter yield of plant [22].

Table 1. Effect of micronutrients and sulphur on plant height, plant dry weight, CGR and RGR of sesame

Treatments	80DAS		80-60 DAS	
	Plant height (cm)	Dry weight (g plant $^{-1}$)	Crop growth rate (g/m^2/day)	Relative growth rate (g/g/day)
Zinc 10 kg/ha + sulphur 30 kg/ha	103.90	15.68	4.69	0.013
Zinc 10 kg/ha + sulphur 40 kg/ha	104.37	15.63	4.44	0.013
Zinc 10 kg/ha + sulphur 50 kg/ha	107.23	15.37	5.83	0.014
Boron 5 kg/ha + sulphur 30 kg/ha	114.23	15.80	5.49	0.014
Boron 5kg/ha + sulphur 40 kg/ha	116.33	16.13	7.94	0.026
Boron 5 kg/ha + sulphur 50 kg/ha	117.00	16.60	7.60	0.025
Zinc 5 kg/ha + boron 2.5 kg/ha + sulphur 30 kg/ha	121.93	17.00	7.50	0.025
Zinc 5 kg/ha + boron 2.5 kg/ha + sulphur 40 kg/ha	122.73	17.33	5.49	0.013
Zinc 5 kg/ha + boron 2.5 kg/ha + sulphur 50 kg/ha	127.57	17.47	4.49	0.013
Control R.D.F 40:60:40 kg/ha NPK	112.60	13.53	6.33	0.013
F test	S	S	S	S
SEm(±)	4.16	0.48	1.52	0.002
CD (5%)	12.37	1.44	4.52	0.01

Table 2. Effect of micronutrients and sulphur on yield and yield attributes of sesame

Treatments	Capsules plant $^{-1}$ (No.)	Seed capsule $^{-1}$ (No.)	Test weight (g)	Grain yield (kg ha $^{-1}$)	Stover yield (t ha $^{-1}$)	Harvest index (%)
Zinc 10 kg/ha+ sulphur 30kg/ha	33.33	40.10	2.56	0.940	1.77	34.72
Zinc 10 kg/ha+ sulphur 40kg/ha	39.73	40.67	2.96	0.945	1.80	34..46
Zinc 10 kg/ha+ sulphur 50kg/ha	37.43	42.36	3.06	0.952	1.83	34.26
Boron 5 kg/ha+ sulphur 30kg/ha	33.13	43.40	2.66	0.950	1.79	34.66
Boron 5 kg/ha+ sulphur 40kg/ha	41.97	44.57	2.80	0.954	1.82	34.43
Boron 5 kg/ha+ sulphur 50kg/ha	39.50	46.08	3.10	0.959	1.85	34.14
Zinc 5 kg/ha + boron 2.5 kg/ha + sulphur 30 kg/ha	38.67	46.60	3.00	1.069	1.88	35.81
Zinc 5 kg/ha + boron 2.5 kg/ha + sulphur 40 kg/ha	41.43	47.77	3.06	1.088	1.94	35.97
Zinc 5 kg/ha + boron 2.5 kg/ha+ sulphur 50 kg/ha	43.37	49.40	3.40	1.103	1.98	36.29
Control	34.93	42.60	2.86	0.944	1.78	34.63
F test	S	S	S	S	S	S
SEm(±)	2.22	1.57	0.045	1.03	0.01	0.23
CD (5%)	6.61	4.69	0.13	3.08	0.05	0.70

Table 3. Effect of micronutrients and sulphur on economics of production of Sesame

Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C Ratio
Zinc 10kg/ha + sulphur 30kg/ha	29608	73602	43994	1.48
Zinc 10kg/ha + sulphur 40kg/ha	29958	73993	44035	1.46
Zinc 10kg/ha + sulphur 50kg/ha	30308	74541	44233	1.45
Boron 5 kg/ha + sulphur 30 kg/ha	29268	74385	45117	1.54
Boron 5 kg/ha + sulphur 40 kg/ha	29618	74698	45080	1.52
Boron 5 kg/ha + sulphur 50 kg/ha	29968	75089	45121	1.50
Zinc 5 kg/ha + boron + 2.5 kg/ha and sulphur 30 kg/ha	29438	83702	54264	1.84
Zinc 5 kg/ha + boron + 2.5 kg/ha and sulphur 40 kg/ha	29788	85190	55402	1.85
Zinc 5 kg/ha + boron + 2.5 kg/ha and sulphur 50 kg/ha	30138	86364	56226	1.86
Control R.D.F 40:60:40 kg/ha NPK	26958	73915	46957	1.74

3.2 Yield Attributes and Yield

The record and analysis of data on yield attributes indicates that a significant higher number of capsules plant $^{-1}$ (43.37), number of seeds pod $^{-1}$ (49.40), test weight (3.40 g), grain yield (1.103 t ha^{-1}), straw yield (1.98 t ha^{-1}) and harvest index (36.29%) were recorded with the application of zinc 5 kg ha^{-1} and boron 2.5 kg ha^{-1} in combination with sulphur 50 kg ha^{-1} however, the treatment 3, treatment 7 and treatment 5 were found to be statistically at par with highest. With the application of sulphur and boron might be due to pivotal role amino acid, protein synthesis, fertility improvement and in viability of seed filling and increase in seed yield, stover yield and oil content [23]. The synergistic effect of sulphur application in increasing productivity of sesame, (Chanda 2003). The sulphur, zinc and boron combinedly results in nutrient balance, important in photosynthesis process which directly bearing on plant growth and development [24]. The application of micronutrients cause improvement in soil- physical chemical properties and nutrient availability to crop during vegetative growth, (Sankaran 2001).

4. ECONOMICS

Gross returns (₹86,364 ha^{-1}), Net returns of (₹56,226 ha^{-1}) were found to be highest with application of zinc 5 kg ha^{-1} and boron 2.5 kg ha^{-1} in combination with sulphur 50 kg ha^{-1}, and B:C ratio of (1.86) were recorded with the application of zinc 5 kg ha^{-1} and boron 2.5 kg ha^{-1} with sulphur 50 kg ha^{-1} i.e., treatment 9.

5. CONCLUSION

It was concluded that for obtaining higher yield components with better quality of Sesame application of zinc 5 kg/ha and boron 2.5 kg/ha in combination with sulphur 50 kg/ha (treatment 9) in sesame was recorded significantly higher number of Capsules/plant (43.37), Seeds/ capsules (49.40), seed yield (1.103 t/ha), and benefit cost ratio (1.86) as compared to other treatments. Since, the finding based on the research done in one season.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sakal R, Singh AP, Choudhary BC, Shahi B. Sulphur satus of Ustifluvents and response of crops. Annal of Agriculture and Biology. 2001;24(1):854-50.
2. Thanunathan K, Manickam G, Singharawal R. Studies on the influence of integrated nutrient management on growth, yield parameters and seed yield of sesame crop research. 2002;24(2):309-13.
3. Raja A, Hattab KO, Gurusamy L, Vembu G, Suganya S. Sulphur application on growth, yield and quality of sesame varieties. International Journal of Agriculture Research. 2007;2(7):599-606.
4. Chaurasia SK, Jain N, Jain N. Effect of integrated use of fertilizer, organic manures and micronutrients on productivity of sesame (*Sesamum indicum L*.). Annals of agriculture research. 2009;30(3-4).
5. Anonymous. Boron deficiency in soils of India. Ministry of Agriculture, GOI, New Delhi, 2015;45.
6. Dhaliwal DS, Williams MMII. Optimum plant density for crowding stress tolerance processing in crop 2021;14(9): e0223107.
7. Vaiyapuri V, Amudha A, Sri ramachandra shakaran MV, Imayavaramban V. Effect of sulphur levels and organic on growth and yield of sesame. Adv. Plant Sci. 2009; 17(2):681-685
8. Forno DA, Cock JH, Gomez KA, YoshidaS. laboratory manual for Physiological studies of rice. 3rd Edition, International Rice Research Institute, Manila; 1976.
9. Mondal MMA, Badruddin M, Malek MA, Hossain MB, Puteh AB. Optimization of sulphur requirement of sesame (*Sesamum indicum L.)* genotypes using tracer techniques. Bangladesh J. Bot. 2009; 41(1):7-13.
10. Shanker H, Chandra Bhushan and Lallu. Effect of levels zinc on growth, dry matter and yield of sesame varieties. J. Oilseeds Res. 1999;16(1).
11. Elayaraja D. Response of sesame (*Sesamum indicum L*.) to micronutrients and NPK levels on growth, yield and nutrients uptake in coastal sandy soils. J. Oils seeds Res. 2017;32(2):179-182.
12. Patil SS, Choudhary AA, Goley AV, Rasal SJ. Effect of phosphorus and sulphur on growth yield and economics of linseed. J.Soils.Crops. 2014;24(1):159-164.
13. Fismesaet J, Vong PC, Guckert A, Frossard E. Influence of sulphur on apperant N use efficiency, yield and quality of oilseed rape *(Brassica napus L*.) grown

on a calcareous soil. Euro.j.Agron. 2000; 12(2):127-141.

14. Jaggi R, Rakesh C, Sharma K and Paliyal SS. Sulphur as a second major nutrient in cruciferous oil seed. Indian Fam. 2000; 12:14-18.
15. Alloway BJ. Zinc in soils and crop nutrition; 2008.
16. Singh B, Sharma Y, Rathore BS. Effect of S and Zn on growth, yield and quality of mustard (*Brassica juncea* L.) Research on crops. 2011;13(3):963-969.
17. Tiwari KN, Gupta BR, Sulphur for sustainable high yield agriculture in Uttar Pradesh, Indian J. Fert. 2006;1(11):37-52.
18. Tiwari RK, Nemdeo KN, Girish JA, Jha G. Effect of Nitrogen and Sulphur on growth, yield and quality of sesame (*Sesamum indicum L.)* Varieties. Research on Crops. 2003; z1:163-167.
19. Kumar BR, Rao, SG, Kondababu P. Yield and economics of sesame based cropping system in North coastal zone of Andhra Pradesh. Curr, Agric. Res. 2021;8:2.
20. Scherer HW, Pacyna S, Spoth KR, Schulz M. Low levels of ferredoxin, ATP, and leghemoglobin contribute to limited N fixation of peas (*Pisum sativum L.*) and alfalfa (*Medicago sativa L.*) under S deficiency conditions. Bio-fer soils, 2008; 44:909-906.
21. Patel PK, Viradiya Mz, Kadivala VH, Shind RD. Effect of potassium and Sulphur on yield and quality of summer groundnut under middle Gujarat condition. IJCMAS. 2018;7(9):2268-2273.
22. Kumar B, Sarkar N C, Maity S, Maiti R. Effect of different levels of sulphur and boron on the growth and yield of sesame under red-laterite soils. Research on Crops. 2019;20(3).
23. Choudhary AA, Nikam RR, Patil SS. Effect of phosphorus and sulphur on oil nutrient uptake and yield of Linseed (*Linum usitatissimum L.)* International Journal of Life Science. 2016;A6:33-36.
24. Yadav RA, Tirupathi AK, Yadav AK. Effect of micronutrients in combination with organic manures and production and Net Return of sesame (*Sesamum indicum L.*) Annals of Agriculture Research, 2008; 30(1,2):53-58.

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