Environment and Ecology 41 (3B) : 1674—1679, July—September 2023
Article DOI: https://doi.org/10.60151/envec/YNKC2792
ISSN 0970-0420

Response of Sulfur and Zinc on Growth and Yield of Sesame (*Sesamum indicum* L.)

Patlolla Ruchitha, Umesha C., Gandreti Ashok

Received 19 March 2023, Accepted 9 June 2023, Published on 21August 2023

ABSTRACT

The field experiment was entitled " Response of Sulfur and Zinc on growth and yield of Sesame (*Sesamum indicum* L.) during *Zaid* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (UP). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.3), low in organic carbon (0.57%), available N (230 kg/ha), available P (32.10 kg/ha) and available K (235 kg/ha). The treatments consist of three levels of Sulfur and three levels of Zinc foliar application. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The result showed that viz: Plant height (130.82 cm), number of branches per plant (4.89) and dry weight (13.41 g/plant) were recorded significantly higher with application of Sulfur 25 kg/ha + Zinc 0.5% foliar spray. Whereas, crop growth rate (10.93 g/m^2/day) at 40-60 DAS interval and relative growth rate (0.106 g/g/day) at 20-40 DAS interval recorded significantly higher with application of Sulfur 25 kg/ha + Zinc 0.5% foliar spray. Number of capsules per plant (28.25), number of seeds per capsule (46.88), test weight (2.80), seed yield (1235.01 kg/ha), stalk yield (2195.21 kg/ha) and harvest index (36.00%) were recorded significantly higher with the application of Sulfur 25 kg/ha + Zinc 0.5% foliar spray. Higher gross returns (98801INR/ha), net return (69555 INR/ha) and benefit cost ratio (2.37) was also obtained with application of Sulfur 25 kg/ha + Zinc 0.5% foliar spray.

Keywords Sesame, Sulfur, Zinc, Growth parameter, Seed yield, Economics.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important oilseed crop in India next to groundnut and rapeseed-mustard. Sesamum indicum. It is also called as Gingelly or til. Sesame oil has excellent nutritional, medicinal, cosmetic and cooking qualities for which it is known as 'the queen of oils and content 46-64% oil with it is a rich source of protein (20.28%), sugar (14-15%), mineral (5-7%), vitamins like vitamin C, vitamin B complex, niacin and minerals like Calcium (1450 mg/100 g), phosphorus (570 mg/100 g). Due to the presence of potent antioxidants, sesame seeds are called as 'the seeds of immortality'. India is the largest producer of sesame in the world. It is cultivated on

Patlolla Ruchitha[1]*, Gandreti Ashok[3]

Department of Agronomy, Faculty of Agriculture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj- 211007, Uttar Pradesh, India

Dr. Umesha C.[2]

Assistant Professor, Department of Agronomy,Faculty of Agriculture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj 211007, Uttar Pradesh, India.

Email: ruchithareddy1100@gmail.com
*Corresponding author

19.47 lakh hectares in country with total production of 8.66 lakh tonnes. The average productivity of the crop is 413 kg/ha (Yadav *et al.* 2020).

Sulfur an essential plant nutrient play a key role in the production and productivity of oilseeds. It has a significant influence on quality and development of oilseeds. Which play an important role in plant metabolism system, crucial for the synthesis of essential oil that plays a key role in formation of chlorophyll in plant leaf, increase cold and drought resistance ability in plant. It also increases oil content and pungency in oil. Oil crops are Sulfur (S) loving and thus increasing a number of organic compounds, oil storages, particularly oil glands and vitamin B1. Sulfur is a constituent of three essential amino acids commonly found in plants, namely cysteine, cysteine and methionine, which are essential components of proteins. It can be called as master nutrient for oil seed production (Paul *et al.* 2019).

Zinc being one of the essential micronutrients, plays significant role in various enzymatic and physiological activities of plant body. Zinc plays a key role in some metabolic processes of plants, such as protein synthesis and membrane integrity. It promotes synthesis of growth hormone, seed maturation, starch and chlorophyll synthesis and conversion of sugars to starch pollen formation, integrity of biological membrane and resistance to infection by certain pathogens. Zinc application increases dry matter also regulates water absorption. Foliar application of zinc to crops is an effective way to increase the grain concentration of zinc. (Haritha *et al*. 2022).

MATERIALS AND METHODS

A field experiment was conducted during *zaid* 2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (UP) India. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.694%), The treatments consist of Sulfur 15kg/ha +Zinc 0.3% , Sulfur 15kg/ha +Zinc 0.4% , Sulfur 15kg/ha +Zinc 0.5%, Sulfur 20kg/ha +Zinc 0.3% , Sulfur 20kg/ha +Zinc 0.4%, Sulfur 20kg/ha +Zinc 0.5% , Sulfur 30kg/ha +Zinc 0.3% , Sulfur 30kg/ha +Zinc 0.4% and Sulfur 30 kg/ha +Zinc 0.5% , Control. The experiment was laid out in Randomized Block Design, with 9 treatments replicated thrice. The observations recorded for plant height, number of branches ,plant dry weight, crop growth rate, number of capsules per plant, number of seed per capsule, test weight, relative growth rate, seed yield, stover yield, harvest index. The collected data was subjected to statistical analysis by analysis of variance method (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Pre and post-harvest parameters

Plant height - At 100 DAS, plant height (130.82 cm) was recorded with application of Sulfur 25kg/ha + Zinc 0.5% foliar which is significantly higher over all the treatments and statistically at par with treatment

Table 1. Influence of sulfur and zinc on growth of sesame crop..

Sl. No.	Treatments	Plant height (cm)	Number of branches/plant	. Dry weight (g)	Crop growth rate(g/m^2/day)
1.	Sulfur 15kg/ha + Zinc 0.3% foliar spray	120.34	3.89	12.12	2.61
2	Sulfur 15kg/ha + Zinc 0.4% foliar spray	121.84	3.89	12.22	2.37
3.	Sulfur 15kg/ha + Zinc 0.5% foliar spray	125.32	4.11	12.13	1.09
4.	Sulfur 20kg/ha + Zinc 0.3% foliar spray	123.95	4.22	12.72	2.05
5.	Sulfur 20kg/ha + Zinc 0.4% foliar spray	126.89	4.11	12.75	1.55
6.	Sulfur 20kg/ha + Zinc 0.5% foliar spray	128.63	4.44	13.00	2.01
7.	Sulfur 25kg/ha + Zinc 0.3% foliar spray	124.51	3.67	13.13	2.13
8.	Sulfur 25kg/ha + Zinc 0.4% foliar spray	127.93	4.33	13.31	1.93
9.	Sulfur 25kg/ha + Zinc 0.5% foliar spray	130.82	4.89	13.41	1.92
10.	Control (50 : 40 : 30)	120.49	3.56	11.89	0.94
F-test		S	S	S	S
SEm±		0.91	0.15	0.08	0.33
CD (p=0.05)		2.73	0.46	0.23	0.97

of Sulfur 25kg/ha + Zinc 0.4% foliar spray (128.6cm) as mentioned in Table 1. This increase in plant height might be due to interaction of sulfur with zinc which enhanced the vegetative growth of the plant. These results were supported by the findings of who stated that optimum level of sulfur significantly enhanced the plant height, this significant effect might be due to increase in chlorophyll content which leads to maximum plant growth. Tahir *et al.* (2014). Along with the application of zinc it significantly improves the plant height due to zinc synthesis growth hormones and enlargerment of cell and boosted plant growth. Haritha *et al.* (2022).

Number of branches/plant - At 100 DAS, number of branches (4.89) was recorded with application of Sulfur 25 kg/ha + Zinc 0.5% foliar spray which is significantly higher over all the treatments and statistically at par with treatment of Sulfur 25kg/ha + Zinc 0.4% foliar spray (4.44) as mentioned in Table 1. Branches per plant also increased with increasing sulfur levels and higher branches per plant were recorded in plots where 40 kg/ha sulfur was applied. Higher branches per plant with increased sulfur application levels might be due the fact that higher doses of sulfur enhanced the metabolic and meristematic activities of crop resulting in optimum growth, plant height and branches per plant of sesame. Similar results are also reported by who observed taller plants with higher primary and secondary branches per plant of sesame through higher levels of sulfur application Ahmad *et al.* (2018). Application of zinc it significantly improves the primary and secondary branches due to zinc synthesis growth hormones and enlargerment of cell Haritha *et al*. (2022).

Dry Weight (g) - At 100 DAS, plant dry weight (13.41g/plant) was recorded with application of Sulfur 25kg/ha + Zinc 0.5% foliar spray which is significantly higher over all the treatments and statistically at par with treatment of Sulfur 20 kg/ha + Zinc 0.4% foliar spray (13.31 g/plant) as mentioned in Table 1.The results clearly indicated that an ample dose of sulfur probably played an important role in enhancement of growth attributes by increasing cell division, elongation of meristematic cells and adequate nutrition to the crop. In case of sulfur fertilization, application of 40 kg S per ha recorded the highest plant height (100.8 cm) and dry matter accumulation (2475 g/m^2) at harvest, and leaf area index (1.43) at 60 DAS recorded significantly more values than its lower dose and control Bhavana *et al.* (2022). Along with increasing levels of zinc has overall improvement in vigour and crop growth as it reflected in plant height and dry matter production Yadav *et al.* (2020).

Crop growth rate (g/m^2/day) - During 80-100 DAS, significantly higher plant crop growth rate (2.61 g/m^2/day) was recorded with application of Sulfur 15 kg/ha + Zinc 0.3% foliar spray over all the treatments and statistically at par with treatments of Sulfur 15 kg/ha + Zinc 0.4% foliar spray (2.37 g/m^2/day) of Sulfur 25 kg/ha + Zinc 0.3% foliar spray (2.13 g/m^2/day) and Sulfur 20 kg/ha + Zinc 0.3% foliar spray (2.05 g/m^2/day) and Sulfur 20 kg/ha + Zinc 0.5% foliar spray(2.01 g/m^2/day) and Sulfur 25 kg/ha + Zinc 0.4% foliar spray (1.93 g/m^2/day) as mentioned in Table 1. Plant height at harvest stage increase with increase in sulfur levels. This might be due to more synthesis of amino acids, increase in chlorophyll content in growing region and improving the photosynthetic activity, ultimately enhancing cell division and thereby increased the crop growth rate Murmu *et al.* (2015).

Number of capsules/plants - Treatment with application of Sulfur 25kg/ha + Zinc 0.5% foliar spray was recorded maximum number of pods/plant (28.25) which was significantly superior over all other treatments and statistically at par with treatment of Sulfur 20 kg/ha + Zinc 0.5% foliar spray (27.80). as mentioned in Table 2. Increasing levels of sulfur fertilization up to 30 kg/ha significantly improvement in the number of capsules/plant, seed/capsule and test weight in sesame. All these yield attributes registered maximum values at 45 kg S/ha. The marked improvement in capsules/plant and test weight by applying sulfur could be ascribed to overall improvement in vigour and crop growth as a consequence balanced nutritional environment as discussed above. Supply of sulfur in adequate amount also helps in the development of floral primordial i.e. reproductive parts, which results in the development of capsules and seeds in plants Yadav *et al.* (2020).

Table 2. Influence of sulfur and zinc on yield and yield attributes of sesame crop.

Sl. No.	Treatment	Number of capsules/ plant	Number of seeds/ capsule	Test weight (g)	Seed yield (kg/ha)	Strove yield (kg/ha)	Harvest index (%)
1	Sulfur 15kg/ha + Zinc 0.3% foliar spray	22.80	41.49	2.75	868.32	1706.97	33.76
2	Sulfur 15kg/ha + Zinc 0.4% foliar spray	23.80	42.47	2.75	927.84	1836.51	33.62
3	Sulfur 15kg/ha + Zinc 0.5% foliar spray	25.13	44.07	2.77	1022.40	1858.47	35.47
4	Sulfur 20 kg/ha + Zinc 0.3% foliar spray	24.65	43.59	2.77	991.83	1858.09	34.83
5	Sulfur 20 kg/ha + Zinc 0.4% foliar spray	25.80	45.22	2.78	1082.36	2038.81	34.68
6	Sulfur 20kg/ha + Zinc 0.5% foliar spray	27.80	46.59	2.79	1204.69	1996.48	35.82
7	Sulfur 25kg/ha + Zinc 0.3% foliar spray	25.27	45.20	2.77	1056.02	1996.48	34.70
8	Sulfur 25kg/ha + Zinc 0.4% foliar spray	26.53	45.24	2.78	1112.26	2128.46	35.83
9	Sulfur 25kg/ha + Zinc 0.5% foliar spray	28.25	46.88	2.80	1253.01	2195.21	36.00
10	Control (50:40:30 NPK kg/ha)	21.50	41.20	2.74	810.53	1778.81	34.60
F test		S	S	NS	S	S	S
SEm±		0.25	0.54	0.010	17.60	51.73	0.68
CD (p=0.05)		0.75	1.63	0.032	52.31	153.7	2.02

Zinc increases the number of capsules per plant as it is important essential nutrient it stimulates seed formation and ultimately resulting into higher seed yield Ram *et al.* (2021).

Number of seeds/capsules - Treatment with application of Sulfur 25kg/ha + Zinc 0.5% foliar spray was recorded maximum number of seeds/pods (46.88) which was significantly superior over all other treatments and statistically at par with treatment of Sulfur 20 kg/ha + Zinc 0.5% foliar spray(46.59) as mentioned in Table 2. Results indicates that application of 40 kg sulfur per ha recorded significantly more seeds per capsule (38.33). This may be due to effective translocation of photosynthates from source to sink that resulted in more length of capsules with more number of seeds per capsule Padasalagi *et al.* (2019). The increase in number of capsules due to zinc might be due to adequate supply of zinc during early growth stages is by influencing cell division and elongation in meristematic cell, there by increasing the sink in terms of seeds/capsule Haritha *et al.* (2022).

Test weight - Treatment with application of Sulfur 25 kg/ha + Zinc 0.5% foliar spray was recorded maximum number of test weight (2.80) which was superior over all other treatments and there was no significant difference among the treatments as mentioned in Table 2.

Seed yield (kg/ha) - Treatment with application of Sulfur 25kg/ha + Zinc 0.5% foliar spray was recorded maximum seed yield (1235.01 kg/ha) which was significantly superior over all other treatments and statistically at par with treatment of Sulfur 20 kg/ha + Zinc 0.5% foliar spray (1204.69 kg/ha) as mentioned in Table 2. Sulfur produce maximum seed yield at 40 kg ha^{-1} as compared to control. The high yield may be due to stimulatory effect of sulfur on protein synthesis that further enhanced photosynthesis and yield contributing components which resulted in maximum seed yield Ahmad *et al.* (2018). Zinc is well known for enzyme activation biosynthesis of auxins hormone in various metabolic processes. The positive effect of zinc on seed yield might be due to its requirement in carbohydrate synthesis, photosynthesis and cell elongation Yadav *et al.* (2020).

Straw yield (kg/ha) - Treatment with application of Sulfur 25 kg/ha + Zinc 0.5% foliar spray was recorded maximum straw yield (2195.21 kg/ha) which was significantly superior over all other treatments and statistically at par with treatment of Sulfur 25kg/ha + Zinc 0.4% foliar spray (2128.46 kg/ha) as mentioned in Table 2. The stover yield of sesame increased significantly with increase the level of applied foliar zinc up to 0.75%. The positive effect of zinc on stover yield might have been due to its requirement in carbohydrate synthesis, the pronounced role in photosynthesis and cell elongation Haritha *et al.* (2022). The improvement in straw yield might be due to the fact that sulfur tends to increased growth

Table 3. Influence of sulfur and zinc on economics of sesame crop.

Sl. No.	Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1	Sulfur 15 kg/ha + Zinc 0.3% foliar spray	27069.32	69465.38	42396.07	1.56
2	Sulfur 15 kg/ha + Zinc 0.4% foliar spray	27408.84	74227.43	46818.59	1.70
3	Sulfur 15 kg/ha + Zinc 0.5% foliar spray	27783.4	81791.88	54008.48	1.94
4	Sulfur 20 kg/ha + Zinc 0.3% foliar spray	27817.83	79346.38	51528.55	1.85
5	Sulfur 20 kg/ha + Zinc 0.4% foliar spray	28188.36	86588.88	58400.51	2.07
6	Sulfur 20 kg/ha + Zinc 0.5% foliar spray	28579.07	95445.66	66866.59	2.33
7	Sulfur 25 kg/ha + Zinc 0.3% foliar spray	28507.02	84481.81	55974.79	1.96
8	Sulfur 25 kg/ha + Zinc 0.4% foliar spray	28843.26	88980.95	60137.69	2.08
9	Sulfur 25 kg/ha + Zinc 0.5% foliar spray	29246.01	98800.99	69554.98	2.37
10.	Control (50:40:30 NPK kg/ha)	23486	64842.27	41356.27	1.76

and development in terms of vegetative growth, also activate certain vitamins and co-enzymes. These bio-activities of sulfur might have played important role in improving yield attributes like number of capsules per plant and number of seeds per capsule and there by ultimately increase in seed and stover yield Bhosale *et al.* (2011).

Harvest index (%) - Treatment with application of Sulfur 25kg/ha + Zinc 0.5% foliar spray was recorded maximum harvest index (36.00%) which was significantly superior over all other treatments and statistically at par with treatment of Sulfur 25kg/ha + Zinc 0.4% foliar spray (35.83) as mentioned in Table 2. The increase in stover yield might due to sulfur plays important role in balanced nutrition, photosynthetic process of plant which has a direct bearing on plant growth and development Khan *et al.* (2021).

Economic analysis – Highest Gross returns (98,801 INR/ha), Net returns (69555 INR/ha), Benefit cost ratio (2.37) was observed in treatment-9 with the application of Sulfur 25 kg/ha along with Zinc 0.5% as mentioned in Table 3.

CONCLUSION

It was concluded that with the application of Sulfur 25 kg/ha along with Zinc 0.5% (Treatment-9), has performs positively and improves growth and yield parameters. Maximum seed yield, gross returns, net return and benefit cost ratio were also recorded with the application of Sulfur 25kg/ha along with Zinc 0.5% (Treatment-9). These findings are based on one season therefore, further trials may be require for further conformation.

REFERENCES

Ahmad F, Ahmad J, Nawaz H, Abbas MW, Shah MA, Iqbal S, Mehmood Z, Ali M (2018) Influence of sulphur and potassium levels on yield and yield attribute of sesame (*Sesamum indicum* L.). *Res Agric Livest Fish* 5(2): 147-150.

Bhavana T, Shankar T, Maitra S, Sairam M, Kumar PP (2022) Impact of phosphorus and sulphur levels on growth and productivity of summer sesame. *Crop Res* 57 (3) : 178-184.

Bhosale ND, Dabhi BM, Gaikwad VP, Poonia TC (2011) Response of sesame (*Sesamum indicum* L.) to different levels of potash and sulfur under south Saurashtra region. *Adv Res J Crop Improv* 2(1):121-124.

Gomez KA, Gomez AA (1984) Statistical Procedures for Agricultural Research 2nd ed., Wiley and Sons, Inc. New York, USA.

Haritha G, Singh R, Indu T (2022) Studies on growth and yield of sesame (*Sesamum indicum* L.) as influenced by spacing and foliar application of zinc. *The Pharma Innov J* 11(3): 2366-2369.

Khan SA, Umesha C, Karimunnisa SK (2021) Effect of sulfur levels on growth and yield of different varieties of sesame (*Sesamum indicum* L.). *An Int J* 13(3): 155-158.

Murmu S, Murmu K, Satapathy M (2015) Effect of sulfur fertilization on growth, yield and quality of sesame (*Ses amum indicum* l.) in mid central zone of Odisha. *Int J Bio Res Environ Agric Sci* 1(1): 5-12.

Padasalagi RM, Lalitha BS, Jayadeva HM, Raddy G (2019) Effect of sulphur and boron on growth and yield of sesame (*Sesamum indicum* L.). *J Pharmacog Phytochem* 8 (6) :

1426-1430.

Paul SK, Khatun MM, Sarkar AR (2019) Effect of sulfur on the seed yield and oil content of sesame (*Sesamum indicum* L.). *J Bangladesh Agric Univ* 17(1):33 38.

Ram M, Meena RC, Sundari MM (2021) Enhancing sesame productivity and profitability through zinc and iron application in western Rajasthan. *The Pharma Innov J* 10 (10): 924-928

Tahir M, Ibrahim MA, Tahir S, Ayub A, Tanvee A, Rehman H (2014) Effect of Sulfur Levels on Two Sesame (*Sesamum indicum* L.) Varieties under Climatic Conditions of Pakistan. International *J Plant Soil Sci* 3(3): 281-288, Article no. IJPSS.2014.006.

Yadav P, Yadav SS, Garg K, Athnere Yadav S (2020) Effect of sulphur and zinc fertilization on productivity and economics of sesame (*Sesamum indicum* L.) in semi- arid conditions of Rajasthan. *Int J Chemical Studies* 8(3): 675-679.