Impact of different levels of Sulphur and foliar application of boron on *Zaid* Sunflower

Abstract

The study was conducted during the *Zaid* season of 2022 on Sunflower crop at the crop research farm (CRF) in the Department of Agronomy, SHUATS, Prayagraj (U.P.) India, 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, for evaluating the impact of different levels of Sulphur and foliar application of boron on sunflower crop. The experimental design consisted of 10 treatments, including a control, with 3 levels of Sulphur (40, 45, and 50 kg/ha) and 3 levels of Boron (200 ppm at 30 and 45 days and 100 ppm at 30 and 45 DAS). The experiment was arranged in a Randomized Block Design (RBD) with ten treatments and three replications. The results revealed that application of Sulphur 50 kg/ha in combination with Boron 100 ppm at 30 and 45 DAS showed the highest stem girth (2.96 cm), plant dry weight(50.67g/plant) and the yield attributes namely number of seeds per capitulum (367.86) , Test weight (40.84 g), Seed yield(1.48t/ha) and Stover yield(3.87t/ha) and the highest benefit cost ratio(1.70).

Key words*: Sunflower, Sulphur, Boron, Foliar, Growth, Yield, Zaid.*

INTRODUCTION

The sunflower (Helianthus annuus L.) is a member of the Compositae family that originated in Mexico and Peru and was introduced to India in the 16th century. It is an important oilseed crop with seeds containing approximately 35-40% oil, with some varieties containing up to 50%. Sunflower oil is a rich source of linoleic acid, comprising 64% of its composition, which aids in the removal of cholesterol deposits in the coronary arteries, making it beneficial for heart patients. The crop requires high levels of potassium in addition to nitrogen to improve grain yield and quality. Sunflower has played a significant role in achieving self-sufficiency in edible oil in India and is a crucial element of the "Yellow Revolution" (**Rai, 2002**). Sulphur is essential in increasing the percentage of oil in sunflower seeds and plays an important role in its chemical composition (**Demurin et al., 2001**). "Sulphur is the fourth most important nutrient after N; P and K deficiency is widespread in India" (**Yadav *et al.* 2000; Sakal *et al.* 2001**). "Sunflower requires the same amount of Sulphur or more than phosphorus for high yield and product quality" (**Jamal et al., 2010**). (**Bhagat et al., 2005**) demonstrated "the importance of Sulphur in the biosynthesis of oil in sunflowers and how the application of Sulphur increases the oil content in sunflower seeds. Sulphur is also necessary for the synthesis of certain vitamins, including B vitamins, biotin, and thiamine, as well as the metabolism of carbohydrates, proteins, and oil formation of flavored compounds. Boron plays a crucial role in the synthesis of cell walls, root elongation, glucose metabolism, nucleic acid synthesis, lignification, and tissue differentiation". Sunflower is one of the most sensitive field crops to boron deficiency, and even a slight shift in the margin between sufficiency and deficiency can have a significant impact on productivity. Boron deficiency symptoms typically manifest as stem corkiness, deformed capitulum, poor seed set, and lower seed yield, appearing on the leaves, stems, and reproductive parts**(W. M. Dugger, 1983)**. The present investigation aims to consider the importance of these factors in improving sunflower crop yield and quality.

MATERIALS AND METHODS:

The experiment was conducted during Zaid season from April-June 2022 at the crop research farm (CRF) in the Department of Agronomy, SHUATS, and Prayagraj (U.P.) , 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 . The soil in the experimental field was sandy loam in texture with a slightly alkaline reaction (pH 7.2) and low levels of organic carbon (0.28%), available nitrogen (225 kg/ha) and phosphorus (19.50 kg/ha), but higher levels of potassium (92.00 kg/ha). The experiment was designed in a Randomized Block Design (RBD) with ten treatment combinations and three replications. The experimental area was thoroughly ploughed and harrowed and brought to fine tilth. A total 30 plots were made each of 3.0m x 3.0m size. The different treatments were randomly allocated in each replication. The ten treatment combinations were as follows:

T_1 - Sulphur 40 kg/ha + Boron 200 ppm at 30 DAS(Days after sowing), T_2- Sulphur 40 kg/ha + Boron 200 ppm at 45 DAS, T_3 - Sulphur 40 kg/ha + Boron 100 ppm at 30 and 45 DAS, T_4 - Sulphur 45 kg/ha + Boron 200 ppm at 30 DAS, T_5 - Sulphur 45 kg/ha + Boron 200 ppm at 45 DAS ,T_6 - Sulphur 45 kg/ha +Boron 100 ppm at 30 and 45 DAS, T_7 - Sulphur 50 kg/ha + Boron 200 ppm at 45 DAS, T_8 - Sulphur 50 kg/ha + Boron 200 ppm at 45 DAS, T_9 - Sulphur 50 kg/ha + Boron100 ppm at 30 and 45 DAS ,T_{10} - Control: N:P:K - 60:45:45 (kg/ha). The growth parameters observed at harvest included plant height(cm) , stem girth , plant dry weight, number of seeds per capitulum, test weight, seed yield, Stover yield, and harvest index. *Helianthus annuus* L. Var. Surya was selected for sowing which can be matured around 90-95 days. Line sowing was done manually on 04 April 2022 . Seeds were covered with soil immediately after sowing the seeds. The spacing adopted was (Row to Row 45 cm and Plant to Plant 30 cm) and the seeds were sown at 4-5 cm deep. The ANOVA technique was used for statistically analyzing the data.(R. G. D. Steel and Torrie, 1960).

RESULTS AND DISCUSSION

A. Growth Attributes:

Plant height : At 60 DAS, treatment T_8 (Sulphur 50 kg/ha + Boron 200 ppm at 45 DAS) recorded maximum plant height (150.15 cm) , treatment T_6 (Sulphur 45 kg/ha + Boron 100 ppm at 30 and 45 DAS) was statistically at par with T_8 , with a plant height of (144.18 cm). "Plant height increases with sulphur uptake as it increases cell multiplication, elongation & cell expansion throughout the entire period of crop growth" (**Kumar *et al.* 2011)** "The increase in plant height may be attributed to the appropriate dose of boron, which plays an important role in various enzymatic and biochemical reactions". **(Zahoor *et al.* 2011, Gitte *et al.* 2005)** reported similar results.

Stem girth: At 60 DAS, treatment T_9 (Sulphur 50 kg/ha + Boron 100 ppm at 30 and 45 DAS) recorded the highest Stem girth (2.96 cm), which was significantly greater than all other treatments. However , treatments T_8 (Sulphur 50 kg/ha + Boron 200 ppm at 45 DAS) was found statistically at par with T_9 (Sulphur 50 kg/ha + Boron 100 ppm at 30 and 45 DAS) with Stem girth of (2.74 cm) . "The increase in stem diameter by boron application at sowing time might be the result of efficient carbohydrates and sugar translocation had increased by borate sugar complex formation" (**Silva *et al.* 2011).**

Plant dry weight : At 60 DAS , treatment T_9 (Sulphur 50 kg/ha + Boron 100 ppm at 30 and 45 DAS recorded the highest dry weight (50.67 g/plant), which was significantly greater than all other treatments. However, treatments T_8 (Sulphur 50 kg/ha + Boron 200 ppm at 45 DAS) and T_6 (Sulphur 45 kg/ha + Boron 100 ppm at 30 and 45 DAS) were statistically at par with treatment T_9 (Sulphur 50 kg/ha + Boron 100 ppm at 30 and 45 DAS) with dry weights of (48.33 g/plant) and (47.87 g/plant), respectively. "Sulphur helps in better photosynthesis means more dry matter accumulation as Sulphur is a constituent of succinyl Co-A, which involved in chlorophyll in leaves and their activation at cellular level accelerate photosynthesis. The favorable effect of boron might be attributed to its direct role cell elongation, cell division and biomass accumulation" (**Aravind *et al.* 2018).**

B. Yield Attributes

The application of Sulphur and Boron at different stages of growth resulted in varied effects on the yield components of the crop.

Seeds per capitulum: The highest number of seeds per capitulum (367.86) was recorded with the application of treatment T_9, which involved the use of Sulphur at 50 kg/ha and foliar sprays of Boron at 100 ppm at 30 and 45 DAS. Treatment T_8, which involved Sulphur at 50 kg/ha and foliar spray of Boron at 200 ppm at 45 DAS recorded a seed yield of (351.82), which was not significantly different from that of T_9. The increase in number of seeds per head might be due to increase in translocation of assimilates from source to sink. **(Shivay and Shekawat, 2008).**

Test Weight: "The highest test weight (40.84 g) was recorded with the use of treatment T_9, which involved the use of Sulphur at 50 kg/ha and foliar sprays of Boron at 100 ppm at 30 and 45 DAS. However, treatment T_8, which involved Sulphur at 50 kg/ha and foliar sprays of Boron at 200 ppm at 45 DAS was found to be statistically at par with T_9. Test weight of sunflower was increased due to role of boron in increasing pollen viability and stigmatic receptivity" **(Prasad *et al.* 2015).**

Seed Yield: The highest seed yield (1.48 t/ha) was recorded with treatment T_9, which involved Sulphur at 50 kg/ha and foliar sprays of Boron at 100 ppm at 30 and 45 DAS. However, treatment T_8, which involved Sulphur at 50 kg/ha and foliar sprays of Boron at 200 ppm at 45 DAS and treatment T_7, which involved Sulphur at 50 kg/ha and foliar sprays of Boron at 200 ppm at 30 DAS, were found to be statistically at par with T_9. The increased yield can be attributed to higher dry matter accumulation and better translocation of photosynthates, which led to an increase in yield components **(Sarkar and Mallick , 2009)**.

Stover Yield: "Treatment T_9 also recorded the highest Stover yield (3.87 t/ha). However, treatment T_8, which involved Sulphur at 50 kg/ha and foliar sprays of Boron at 200 ppm at 45 DAS was found to be statistically at par with T_9. The increase in Stover yield can be attributed to the overall improvement in plant organs associated with faster and uniform vegetative growth of the crop with Sulphur application" **(Solanki & Sharma, 2016).**

Harvest Index: The highest harvest index (36.07 %) was recorded in treatment T_6, which involved Sulphur at 45 kg/ha and foliar sprays of Boron at 100 ppm at 30 and 45 DAS. Treatment T_1, which involved Sulphur at 40 kg/ha and foliar sprays of Boron at 200 ppm at 30 DAS was found to be statistically similar to T_6.

CONCLUSION

The results of this one-season experiment suggest that the application of 50 kg/ha Sulphur in combination with 100 ppm foliar sprays of Boron at 30 and 45 DAS (Treatment 9) on sunflower crop during the Zaid season, responded better in terms of growth and yield out of all the other treatments , It significantly enhanced the stem girth , plant dry weight , number of seeds per capitulum , test weight , seed yield , Stover yield and economic yield.

However, it should be noted that these conclusions are based on data from only one season and further confirmation is needed before making recommendations.

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Reference.

Aravind, Surendra Singh, Sharma,P.K. and Ashish, R. 2018. Response of sesame (*Sesamum indicum* L.) to sulphur and boron in upland red soil of vindhyan zone. *Journal of the IndianSociety of Soil Science* **66**(4):432-435.

Bhagat,G.J., Abdul Hamid, Bonde, S.P., Giri, M.D and Mohammad S., 2005. Yield, Quality, Concentration, Uptake and availability of nitrogen, phosphorus, sulphur of sunflower (*Helianthus annuus* L.) as influenced by irrigation and sulphur levels. *Crops Research* **30**(1):30-36.

Demurin, Y, Skoric D, Veresbaranji I & Jocic S (2001). Inheritance of increased oleic acid content in sunflower seed oil. *African Journal of Biotechnology* **23**(2): 87-92.

Gitte, A. N., S. R. Patil and M. A. Tike. 2005. Influence of zinc and boron on biochemical and yield characteristics of sunflower. *Indian Journal of Plant Physiology*. **10**(4): 400-403.

Jamal, A., Yong-Sun, M. and Malik Zainul, A. 2010, Sulphur –a general overview and interaction with nitrogen. *Australian Journal of Crop Science*. **47**(7): 523-529.

Kumar, S., Tewari, S. K. and Singh S. S., 2011, Effect of sources and levels of sulphur and spacing on the growth, yield and quality of spring sunflower (*Helianths annuus*). *Indian Journal of Agronomy*, **56**(3): 242-246.

Prasad, R., Shivay, Y.S., Kumar, D. and Sharma, S.N. 2015. Learning by Doing Exercises in Soil Fertility- *A Practical Manual of Soil Fertility*. Division of Agronomy, *Indian Agricultural Research Institute New Delhi*.

Rai M.2002. Oilseeds in India. *Andhra Pradesh Agriculture Regional Research Journal* pp.13-15.

R. G. D. Steel and Torrie, *Principles and Procedures of Statistics*, McGraw–Hill, New York, NY, USA, 1960.

Sakal, R, Singh, A.P. Choudhary B.C. and Shahi, B. 2001. Sulphur status of Usifluvents and response of crops sulphur application *Fertilizer News* **46**(10): 61-65.

Sarkar, R. K. and Mallik, R. B., 2009, Effect of nitrogen, sulphur and foliar spray of nitrate salts on performance of spring sunflower (*Helianthus annuus* L.). *Indian Journal Agriculture Sciences*,

79(12): 986-990.

Shekhawat, K. and Shivay, Y. S., 2008, Effect of nitrogen sources, sulphur and boron levels on productivity, nutrient uptake and quality of sunflower (*Helianthus annuus* L). *Indian*

Silva, H. R. F., Aquino, L., A., & Batista, C.H. 2011. Residual effect of phosphate fertilizer on sunflower productivity in succession to cotton. *Bioscience Journal*, **25**(5), 786-793.

Solanki, R. L. and Sharma, M. 2016 Effect of phosphorus, sulphur and PSB on growth and yield of mustard in southern Rajasthan. *Annals of Plant and soil Research* **18** (1): 66-69.

W. M. Dugger, "Boron in plant metabolism," in *Encyclopedia of Plant Physiology*, New Series 15 B, pp. 626–650, Springer, Berlin, Germany, 1983.

Yadav, R.L., Dwivedi, B.S., Shukla, A.K. and Kumar, V. 2000. S in balanced fertilization in alluvial soil soils of western Uttar Pradesh. *S in Balanced Fertilization, New Delhi. Pp.27- 41.*

Zahoor, R., Ahmad Basra, S.M., Munir, H., Nadeem, M.A., Yousof, S., & Qusaf, S.H.Y. 2011. Role of Boron in improving Assimilate Partitioning and Achene Yield in Sunflower. *Journal of Agricultural & Social Sciences*, **7**(2), 49-5

Table.1 Effect of Sulphur and boron on growth attributes of Sunflower.

Treatments	Plant height(cm) at 60 DAS	Stem girth (cm) at 60 DAS	Dry Weight(g/plant) at 60 DAS
Sulphur 40 Kg/ha + Boron 200 ppm at 30 DAS	124.5	1.93	35.67
Sulphur 40 Kg/ha + Boron 200 ppm at 45 DAS	133.30	2.08	41.87
Sulphur 40 Kg/ha + Boron 100 ppm at 30 and 45 DAS	135.37	2.29	45.05
Sulphur 45 Kg/ha + Boron 200 ppm at 30 DAS	129.75	2.03	32.63
Sulphur 45 Kg/ha + Boron 200 ppm at 45 DAS	121.74	2.01	35.53
Sulphur 45 Kg/ha + Boron 100 ppm at 30 and 45 DAS	144.18	2.17	47.87
Sulphur 50 Kg/ha + Boron 200 ppm at 30 DAS	136.98	2.25	46.94
Sulphur 50 Kg/ha + Boron 200 ppm at 45 DAS	150.15	2.74	48.33
Sulphur 50 Kg/ha + Boron 100 ppm at 30 and 45 DAS	137.32	2.96	50.67
Control : N:P:K -60:45:45 (kg/ha)	127.87	1.14	33.27
F-Test	S	S	S
S. Em (±)	3.96	0.11	1.02
CD (P=0.05)	11.87	0.33	3.06

Table.2 Effect of Sulphur and Boron on yield attributes and yield of Sunflower.

Treatments	Seeds/Capitulum (No.)	Test weight(g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
Sulphur 40 Kg/ha + Boron 200 ppm at 30 DAS	281.73	33.45	1.13	2.07	35.31
Sulphur 40 Kg/ha + Boron 200 ppm at 45 DAS	295.83	34.24	1.23	2.19	31.98
Sulphur 40 Kg/ha + Boron 100 ppm at 30 and 45 DAS	312.84	35.16	1.18	2.58	32.28
Sulphur 45 Kg/ha + Boron 200 ppm at 30 DAS	282.50	33.67	1.10	2.64	29.41
Sulphur 45 Kg/ha + Boron 200 ppm at 45 D.A.S	281.78	34.09	1.11	2.32	32.36
Sulphur 45 Kg/ha + Boron 100 ppm at 30 and 45 DAS	307.82	35.86	1.27	2.25	36.07
Sulphur 50 Kg/ha + Boron 200 ppm at 30 DAS	316.11	36.66	1.31	2.71	32.58
Sulphur 50 Kg/ha + Boron 200 ppm at 45 DAS	351.82	37.13	1.37	3.07	32.58
Sulphur 50 Kg/ha + Boron 100 ppm at 30 and 45 DAS	367.86	40.84	1.48	3.87	27.66
Control : N:P:K -60:45:45 (kg/ha)	314.54	34.76	1.03	2.17	32.18
F test	S	S	S	S	S
S. Em (±)	5.85	1.28	0.06	0.21	0.86
CD (P = 0.05)	17.53	3.83	0.18	0.65	2.58