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Influence of Sulphur and Boron on Yield and Economics of Sunflower (*Helianthus annuus* L.)

G. Rahul[1*], Rajesh Singh[2] and Ekta Singh[3]
[1]*M.Sc. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.*
[2]*Assistant Professor, Department of Agronomy, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.*
[3]*Ph.D. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.*

(Corresponding author: G. Rahul)*
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ABSTRACT: A field trial was laid out during *Zaid* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of trial 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 two levels of sulphur soil application and four levels of boron with a control. The trial was laid out in randomized block design with nine treatments each replicated thrice. It is concluded that application of 40 kg/ha Sulphur + 1.5 kg/ha Boron recorded considerably greater grain yield (1429.28 kg/ha), gross return (83,988.16 ₹/ha), net return (56,258.92 ₹/ha) and benefit cost ratio (2.16). These findings are based on one season; therefore, further trail may be required for further confirmation. The oil and protein contents of sunflower and mustard were significantly and synergistically improved by the application of both sulphur and boron.

Keywords: Sunflower, zaid, Sulphur, boron, yield and economics.

INTRODUCTION

Oil consumption has been increased due to increasing population and capitation consumption recently. Certainly, one of the most attentions is to cultivate oil seeds, such as sunflower, because of its importance in human nutrition. Development of oil seeds quality and quantity has formed a substantial part of farming in different counties (Weiss, 2000).

In the agricultural economy of India, oilseeds are important next only to food grains in terms of acreage, production and value. India is the largest producer of oilseeds in the world in terms of output. Among the oilseed crops, sunflower (*Helianthus annuus* L.) is an all season crop. Holds great promise as an oilseed crop because of its short period, photo-in-sensitivity and wide adaptability to different agro-climatic regions and soil types. Sunflower seed covers about 48-53 percent edible oil. Sunflower oil is a rich source of linoleic acid which is good for heart patients. The oil is also used for developed hydrogenated oil. Sulphur shortage is observed mainly due to high crop yield and consequently higher rate of S removal by crops, and lesser use of S comprising fertilizers (Messick, 2003). S is an essential plant nutrient for crop production. For oil crop producers, S fertilizer is especially significant because oil crop require more S than cereal grains. S is best known for its role in the formation of amino acids methionine (21% S) and cysteine (27% S); synthesis of proteins and chlorophyll oil content of the seeds and nutritious quality of forages (Jamal *et al.,* 2005). Asad *et al*., (2002) reported that B necessity of sunflower during reproductive evolution is higher than during vegetative growth. Hence the present study was carried out to evaluate the response of sulphur and boron levels on yield and economics sunflower production. Sulphur aids in the synthesis of sulphur containing aminoacids such as cystein, methionine and chlorophyll, vitamins B, biotin and thiamine. It is also involved in the metabolism of carbohydrates, oil content, protein content and in addition on growth and metabolism, es- pecially by its profound effect on protolytic enzymes Najar *et al.,* (2011). Application of sulphur at 40 kg ha^{-1} gave maximum plant height, leaf area index and dry matter production in sunflower Bhagat *et al*., (2003). Application of 50kg sulphur ha^{-1} in addition to 0.2% foliar spray gave significant increase in capitulum diameter (15.57 cm) over no application (12.45 cm) Indu and Singh, (2020). Sulphur application at 40 kg ha^{-1} recorded maximum seed yield (2178 and 2278 kg ha^{-1}) and stalk yield (4422 and 4483 kg ha^{-1}) than other levels and control in both crops Kalaiyarasan *et al*., (2016)

MATERIALS AND METHODS

A Field trial was laid during *Zaid* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of trial 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 two levels sulphur, four levels of boron soil application. The experiment was laid out in randomized block design with nine treatments each replicated thrice.

RESULTS AND DISCUSSION

Yield attributes

Diameter of capitulam (cm). The considerably greater capitulam diameter was observed in 40 kg/ha sulphur + 1.5 kg/ha boron (14.86 cm). Which was statistically at par with the application of 40 kg/ha sulphur + 1.0 kg/ha boron (14.69 cm) and 40 kg/ha sulphur + 0.5 kg/ha boron (14.51 cm). This is due to the role of boron in cell division, sugar transport and hormone advance **(Khalifa, 2005)**.

Number of seeds per capitulam. The considerably greater number of seeds per capitulam was observed in 40 kg/ha sulphur + 1.5 kg/ha boron (333.43). Which was statistically at par with the application of 40 kg/ha sulphur + 1.0 kg/ha boron (331.65) and 40 kg/ha sulphur + 0.5 kg/ha boron (325.46). Sulphur is known to play a vital role in the creation of amino acids, had favourable effect on yield qualities due to proper portioning of photosynthetic from source to sink. These findings are in conformity with reports of Singh and Agarwal (2001). Boron levels considerably influenced the yield attributes in crop. Application of boron 1.5 kg B kg/ha significantly influenced the yield attributes over other levels. This might be due to the role of boron in cell elongation, photosynthesis, translocation of sugars and transpiration. These results are in harmony with those obtained by Renukadevi *et al.,* (2003).

Table 1: Influence of sulphur and boron applications on yield attributes of sunflower.

Treatment	Capitulum diameter (cm)	Number of seeds/ capitulum	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
T_1 : Control	12.28	277.13	34.35	1223.80	2248.05	54.43
T_2 : 20 kg/ha S + 0 kg/ha B	12.88	279.91	34.23	1321.19	2308.19	57.22
T_3 : 20 kg/ha S + 0.5 kg/ha B	13.41	287.32	34.34	1337.16	2335.22	57.26
T_4 : 20 kg/ha S + 1.0 kg/ha B	13.43	294.29	34.41	1360.94	2354.23	57.81
T_5 : 20 kg/ha S + 1.5 kg/ha B	13.42	301.01	34.58	1386.26	2389.81	58.00
T_6 : 40 kg/ha S + 0 kg/ha B	14.11	311.67	34.62	1405.54	2425.52	57.94
T_7 : 40 kg/ha S + 0.5 kg/ha B	14.51	325.46	34.71	1418.13	2443.15	58.04
T_8 : 40 kg/ha S + 1.0 kg/ha B	14.69	331.65	34.71	1420.41	2462.42	57.68
T_9 : 40 kg/ha S + 1.5 kg/ha B	14.89	333.43	34.87	1429.28	2476.33	57.71
sEm (±)	0.24	3.38	0.41	6.12	6.92	0.29
CD (p=0.05)	0.71	10.12	-	18.35	20.73	-

Test weight (g). The greater test weight was observed in 40 kg/ha sulphur + 1.5 kg/ha boron (34.67 g). And lowest was observed in 20 kg/ha sulphur + 0 kg/ha boron (34.23 g). There was no substantial difference among the treatments.

Seed yield (kg/ha). The considerably greater seed yield was observed in 40 kg/ha sulphur + 1.5 kg/ha boron (1429.28 kg/ha). Which was statistically at par with 40 kg/ha sulphur + 1.0 kg/ha boron (1420.41 kg/ha) and 40 kg/ha sulphur + 0.5 kg/ha boron (1418.13 kg/ha). This increase in seed yield of spring sunflower might be due to significant increase in yield attributes *viz* capitalism's diameter, number of seeds per capitulam and 1000-seed weight with S application. Seed yield enhanced due to B application was probably because of a good balance between photosynthesis and respiration. Since the final yield depends upon the translocation of photosynthates from the source to sink (Shivay and Shekhawat, 2009).

Stalk yield (kg/ha). The considerably greater stalk yield was observed in 40 kg/ha sulphur + 1.5 kg/ha boron (2476.33 kg/ha). Which was statistically at par with the application of 40 kg/ha sulphur + 1.0 kg/ha boron (2462.42 kg/ha). The interactions between sulphur and boron levels were found significant in crop. The higher seed yield was registered under the treatment combination of (40 S kg/ha with 1.5 B kg/ha). This might be due to availability of sulphur, boron and other nutrients at both vegetative and reproductive stages. These findings were earlier reported by Raja *et al.,* (2007).

Harvest Index (HI). The harvest index (HI) of sunflower remained unaffected considerably due to S levels and also B levels. However, following the trend up to now, absolute control plot produced significantly the lowest HI.

DISCUSSION

Sulphur and boron application resulted in significance increase in growth individualities such as plant height, number of leaves per plant, dry weight CGR and RGR, where as in yield attributes significantly effected on capitulam diameter and number of seeds per capitulam. Obviously these have jointly contributed and increased the yield potential of the crop as reflected by the higher seed yield. Such a response to increasing levels of 'S' might be ascribed to adequate supply of nutrients re-sulted in high production of photosynthates and their translocation to sink Shivay and Shekhawat (2009). A greater amount of dry matter accumulation was observed due to boron application since it is an essential element for growth and development of crops. Akcam and Demiray (2004) also reported that the boron application increased root and shoot length due to increase in Indole acetic acid (IAA) content, a growth promoter hormone. Seed yield enhanced due to B application was probably because of a good balance between photosynthesis and respiration. Since the final yield depends upon the translocation of photosynthates from the source to sink, B is supposed to play an important role here. Boron maintains assembly and mechanical properties of cell walls; it maintains structural and functional integrity of cell walls. Like potassium, boron is also involved in some aspects of flowering and fruiting processes, pollen germination, cell division, nitrogen metabolism, carbohydrate metabolism, active salt absorption, hormone movement and action, water metabolism and the water relations in plants. They both serve in acting as a buffer and are necessary in the maintenance of conducting tissues and to exert a regulatory effect on other elements. It has been shown that an optimal level of boron increases permeability in the cell membrane (Ujwala, 2011). The effect of different levels of boron (0.5, 1.0, 1.5 and 2.0 kg ha-1) as soil application and two levels of foliar spray (0.2% and 0.3%). The highest seed yield was recorded for the soil application of B @ 2.0 kg/ha. The yield increase in sunflower was 3.6 to 15.8 per cent over the control studied by Renukadevi *et al.,* (2002). Boron is an essential element for sunflower, playing many important roles like flowering, pollen germination, fruiting processes and seed setting. (Mirche *et al.,* 2016) Micronutrients have been reported to play a major role in increasing seed setting percentage in sunflower owing to their influence on growth and yield components (Anjaiah Theerthala, 2018).

ECONOMICS

Cost of cultivation (₹/ha). The maximum cost of cultivation was found in with the application of 40 kg/ha sulphur + 1.5 kg/ha boron (27,729.24 ₹/ha). And lowest was observed in control treatment (23,594.24 ₹/ha)

Gross return (₹/ha). The maximum gross return was found in with the application of 40 kg/ha sulphur + 1.5 kg/ha boron (83,988.16 ₹/ha). And lowest was observed in control treatment (72,040.24 ₹/ha).

Net return (₹/ha). The maximum net return was found in with the application of 40 kg/ha sulphur + 1.5 kg/ha boron (56,258.92 ₹/ha). And lowest was observed in control treatment (48,446.00 ₹/ha).

B:C ratio. Higher B:C ratio was found in with the application of 40 kg/ha sulphur + 1.5 kg/ha boron (2.16). And lowest was observed in control treatment (1.92). Similarly greater gross income, net returns and benefit cost ratio over with 1 kg/ha of boron application control in sunflower recorded reported by Binh *et al.,* (2017); Kalaiyarasan *et al.,* (2020).

Table 2: Influence of sulphur and boron applications on economics of sunflower.

Treatments	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T_1 : Control	23,594.24	48,446.00	72,040.24	1.92
T_2 : 20 kg/ha S + 0 kg/ha B	25,594.24	52,057.79	77,752.03	2.00
T_3 : 20 kg/ha S + 0.5 kg/ha B	25,639.24	53,052.62	78,691.86	2.05
T_4 : 20 kg/ha S + 1.0 kg/ha B	25,684.24	54,406.88	80,081.12	2.00
T_5 : 20 kg/ha S + 1.5 kg/ha B	25,729.24	55,853.16	81,581.40	2.01
T_6 : 40 kg/ha S + 0 kg/ha B	27,594.24	55,121.59	82,715.83	2.01
T_7 : 40 kg/ha S + 0.5 kg/ha B	27,639.24	55,817.70	83,456.94	2.06
T_8 : 40 kg/ha S + 1.0 kg/ha B	27,684.24	55,906.88	83,591.12	2.11
T_9 : 40 kg/ha S + 1.5 kg/ha B	27,729.24	56,258.92	83,988.16	2.16

CONCLUSION

It is concluded that application of 40 kg/ha sulphur + 1.5 kg/ha boron noted considerably greater seed yield (1429.28 kg/ha), gross return (83,988.16 ₹/ha), net return (56,258.92 ₹/ha) and benefit cost ratio (2.16). These findings are based on one season; therefore, further trail may be required for further confirmation.

Conflict of Interest. None.

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