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## Response of sulphur and boron on growth, yield and economics of sunflower (*Helianthus annuus* L.)

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### Abstract

A field Experiment was conducted during *kharif* 2019 at Central Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), available N (238 kg/ha), available P (32.10 kg/ha) and available K (189 kg/ha). The treatment consists of 2 levels of Sulphur (30 kg/ha) and (50 kg/ha) and 2 application methods of Boron as soil application (1 kg/ha) and as foliar application (0.2% boron spray) at ray floret stage, whose effect was observed on sunflower. There were 9 treatments each replicated thrice. The experiment was laid out in Randomized Block Design. The results showed that growth parameters *viz.* Plant height (145.69 cm) at 60 DAS, Number of leaves per plant (23.20) at 60 DAS, were recorded significantly higher in (50 kg/ha Sulphur + 1 kg/ha Boron). Maximum stem girth (3.06 cm) at 60 DAS was recorded in (50 kg/ha Sulphur + 0.2% spray Boron). The Yield parameters *viz.* Number of filled seeds per capitulum (367.86), Number of unfilled seeds per capitulum (16.37), test weight (40.52 g), seed yield (1476.71 kg/ha), Economics of treatments *viz.* Gross returns (149257 ₹/ha), Net returns (94021 ₹/ha) and BC ratio (2.70) were recorded were recorded significantly higher with application of (50 kg/ha Sulphur + 0.2% Boron spray).

**Keywords:** Sunflower, kharif, sulphur, boron, growth, yield attributes, economics

### Introduction

Oilseed production ranks second in importance next to food production. With increasing demographic pressure shortage of edible oils has become a chronic economic and dietary problem in India. To increase the production of existing oilseeds and to bridge the gap between demand and supply, several attempts were made in the country during recent past through horizontal and vertical expansion including introduction of new oilseed crops for enhancing the oilseed production.

Sunflower (*Helianthus annuus* L.) belongs to family Compositae originated in Mexico and Peru, introduced into India in the 16<sup>th</sup> century. Globally, sunflower ranks second to soybean among annual field crops grown for edible Oil. The Quantity of sunflower oil represents about 15 per cent of the total world production of major vegetable oils. It has established as an efficient oilseed crop under adverse climatic conditions, as an intercrop and option as a catch crop in multiple cropping systems. Sunflower is one of the most important oilseed crops; its oil is considered as premium because of its high polyunsaturated fatty acid (PUFA) content with high level of linoleic acid and absence of linolenic acid. Sunflower oil is rich source of (64%) of linoleic acid. Its contribution towards attaining self-sufficiency in edible oil as well as to "Yellow revolution" in the country is noteworthy (Mangala Rai, 2002) [4].

Sulphur is an essential plant nutrient for crop production. In oil seeds sulphur plays a vital role in the development of seed and improving quality (Naser *et al.*, 2012) [8]. Sulphur is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium (Tandon and messick, 2002) 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) [7]. Sulphur is best known for its role in the synthesis of proteins, oils and vitamins. It performs many physiological functions like synthesis of cysteine, methionine, chlorophyll and oil content of oilseed crops. It is also responsible for synthesis of certain vitamins (B, biotin, thiamine) metabolism of carbohydrates, proteins and oil formation of flavored compounds.

Sulphur application has many advantages for sunflower regarding growth parameters; yield and yield quality.

Sunflower is one of the most sensitive crop to B deficiency. One of the main reasons for low productivity of sunflower is poor seed setting and high per cent of chaffy seeds in the centre of the capitulum. 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) <sup>[1]</sup>. Boron is an essential element for sunflower, playing many important roles like flowering, pollen germination, fruiting processes and seed setting. (Mirche *et al.*, 2016) <sup>[6]</sup>.

### Materials and Methods

A field experiment was conducted during *kharif* 2019 at Central Crop Research Farm, Department of Agronomy, SHUATS, Allahabad, (U.P.). Which is located at 25° 39' 42''N latitude, 81°67'56'' E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna river by the side of Prayagraj - Rewa road about 12 km from the city. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.58%), medium in available N (238 kg/ha), high in available P (32.10 kg/ ha) and low in available K (189 kg /ha). The environmental conditions prevailed during experimental period were favorable for normal growth and development of sunflower crop. The experiment was laid out in Randomized Block Design. Treatment consisted of 2 levels of Sulphur *viz.* S<sub>1</sub> (30 Kg S/ha), S<sub>2</sub> (50 Kg S/ha) and 2 levels of Boron B<sub>1</sub> (1 Kg B/ha), B<sub>2</sub> (0.2% Spray B/ha) There were 9 treatments each replicated thrice. It was sown on 30<sup>th</sup> June 2019 with seed rate of 5-5.5 Kg/ha at spacing 45\*30 cms. The nutrient sources were Urea, DAP and Murate of Potash (MOP) to fulfill the requirement of N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and S. The recommended dose of 80 kg N, 60 kg P & 40 kg K<sub>2</sub>O, 40 kg S and 1 kg B per ha was applied according to the treatment details through Urea, DAP, MOP. Whole of nitrogen, phosphorus, potash, sulphur and boron applied as basal at the time of sowing. 0.2% of boron Spraying is done at ray floret stage. Weeds were kept under control by manual weeding when needed. Thinning was done after 15 days after sowing to maintain proper plant spacing.

The biometric observations were recorded at various stages of crop growth on different characteristics *viz.*, plant height, number of functional leaves, and Stem girth on five plants randomly selected from each net plot.

Post harvest studies include number of filled seeds per capitulum, number of unfilled seeds per capitulum, 1000 seed weight (g) and seed yield kg/ha were also calculated.

**Plant height (cm):** The average height of plants was recorded at an interval of 15 DAS. The height of plant was measured from the base of the plant up to the tip. Height of the plants was recorded at 15,30,45,60 days after sowing and five plants were randomly selected from each plot which was tagged for observations.

**Number of leaves per plant:** From the five-tagged plants of each plot, numbers of leaves at different growth stages were recorded at 15, 30, 45 and 60 DAS and the average number of leaves/plant was calculated for each observation.

**Stem girth (cm):** From the five-tagged plants of each plot, stem girth of sunflower plant at different growth stages were recorded at 15, 30, 45 and 60 DAS and the average stem girth

of sunflower plant was calculated with the help of vernier caliper for each observation.

**Number of filled seeds/capitulum:** Number of seeds per capitulum was counted from five plants harvested from 1m<sup>2</sup> area from each plot and an average was taken.

**Number of unfilled seeds/capitulum:** Number of unfilled seeds per capitulum was counted from five plants harvested from 1m<sup>2</sup> area from each plot and an average was taken.

**Test weight (g):** A random sample of 1000 seeds was taken from the harvested bulk and was weighed.

**Seed yield (kg/ha):** Seed yield from the harvest area (1.0 m<sup>2</sup>) were dried in sun, cleaned and weighed separately from each plot for calculating the seed yield in kg/ha.

**Statistical analysis:** the data recorded during the course of investigation was subjected to statistical analysis by "Analysis of variance technique". The significant and non-significant treatment effects were judged with the help of 'F' (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level. Statistical analysis was performed for randomized block design (Gomez *et al.*, 1983). The data generated for one season and analysed statistically.

## Results and Discussion

### 1. Growth and Development

The growth parameters like Plant height, No. of leaves, Stem girth, significantly affected by the application of sulphur and boron. Sunflower crop fertilized with T<sub>8</sub> (50 Kg S/ha along with 1 Kg B/ha) significantly resulted in higher plant height (145.69 cm) The total number of functional leaves were found significantly higher in T<sub>9</sub> (50 kg/ha sulphur + 0.2% spray boron) (23.20) The maximum stem girth was recorded in T<sub>9</sub> (50 kg/ha sulphur + 0.2% boron spray) (3.06 cm) which was significantly higher. The increase in growth attributes may be due to better uptake and translocation of plant nutrients to the growing plants, adequate supply of sulphur and boron resulted in higher production of photosynthates and their translocation from the source to sink. However, it plays important role in various enzymatic and other biochemical reactions, which ultimately procured to increase the growth and growth attributes. Similar kind of results were reported by Mirche *et al.*, (2016) <sup>[6]</sup>, Satish kumar *et al.*, (2011) <sup>[11]</sup>.

### 2. Yield and Yield attributes.

Yield and yield attributing characters of sunflower *viz.* Number of filled seeds, number of unfilled seeds, 1000 seed weight and seed yield were influenced significantly due to application of sulphur and boron. There was an increase in mean number of filled seeds per capitulum T<sub>9</sub> (50 kg/ha S + 0.2% B spray) recorded significantly highest number of filled seeds per capitulum (367.86). The increase in number of seeds per head might be due to increase in translocation of assimilates from source to sink as reported by (Shivay and Shekawat, 2008) <sup>[12]</sup>. The number of unfilled seeds per capitulum decreased significantly corresponding to increase in sulphur and boron application significantly lowest number of unfilled seeds per capitulum recorded in T<sub>9</sub> (50 kg/ha S + 0.2% B spray) (16.37). Whereas highest number of unfilled seeds were recorded in T<sub>1</sub>, which is considered as Control plot. Boron application increases seed yield of sunflower

owing to increase in seed filling and thus decreasing the number of unfilled seeds (Prasad 2015). The highest 1000 seed weight was found in treatment T<sub>9</sub> (50 kg/ha S + 0.2% B spray) (40.52 g) which was significantly superior over rest of all the treatments. Application of sulphur and boron significantly influenced seed yield, T<sub>9</sub> (50 kg/ha S + 0.2% B spray) (1476.71 kg/ha) was found significantly higher. Sarkar and Mallick (2009) [10], also observed that sulphur is known to play vital role in formation of amino acids. Higher dry matter accumulation and better translocation of photo-synthates led to increase in yield components, which in turn resulted in increase in seed yield. It might be due to the balanced fertilizer application of (N, P and K along with adequate

amount of Sulphur and boron to the crop. These findings were in confirmative with those reported by Mirche *et al.*, (2016) [6], Tamak *et al.*, (1997) [13].

### 3. Economics

The highest gross returns (Rs 1,49,257) Net Returns (Rs 94,021) and maximum Benefit-cost ratio (2.70) was recorded in T<sub>9</sub> (50 kg/ha Sulphur + 0.2% Boron Spray). The combined application of Sulphur and Boron along with N, P and K. to the crop increases the grain yield, stover yield and Oil content of Sunflower. Which was superior over rest of all the treatments. These results were in line with results of Bhosale *et al* (2011) [2].

**Table 1:** Effect on Sulphur and Boron on Growth Parameters of Sunflower (60 DAS).

Treatments	Plant height (cm)	No. of Leaves/plant	Stem girth (cm)
T <sub>1</sub> - Control (RDF)	127.87	20.07	1.93
T <sub>2</sub> - 30 kg S/ha	133.30	20.80	2.08
T <sub>3</sub> - 50 kg S/ha	135.37	22.03	2.29
T <sub>4</sub> - 1 kg B/ha	129.75	21.27	2.03
T <sub>5</sub> - 0.2% boron spray	121.74	20.33	2.01
T <sub>6</sub> - 30 kg S/ha + 1 kg B/ha	144.18	20.70	2.17
T <sub>7</sub> - 30 Kg S/ha + 0.2% B spray	136.98	20.93	2.25
T <sub>8</sub> - 50 Kg S/ha + 1 Kg B/ha	145.69	23.20	2.74
T <sub>9</sub> - 50 Kg S/ha + 0.2% B spray	137.32	23.13	3.06
F-test	S	S	S
S.Em (+)	3.96	0.50	0.11
CD (P=0.05)	11.87	1.51	0.33

**Table 2:** Effect of Nitrogen and Sulphur Levels on Yield Attributes and yield

Treatments	No. of filled seeds/ Capitulum	No. of unfilled seeds/ capitulum	Test weight (g)	Seed yield (Kg/ha)
T <sub>1</sub> - Control (RDF)	281.73	39.42	34.24	1035.01
T <sub>2</sub> - 30 kg S/ha	295.83	19.89	35.16	1232.30
T <sub>3</sub> - 50 kg S/ha	312.84	20.44	35.67	1267.73
T <sub>4</sub> - 1 kg B/ha	282.50	31.05	34.09	1101.71
T <sub>5</sub> - 0.2% boron spray	281.78	18.26	35.86	1077.16
T <sub>6</sub> - 30 kg S/ha + 1kg B/ha	307.82	25.16	36.66	1319.74
T <sub>7</sub> - 30 Kg S/ha + 0.2% B spray	316.11	23.53	37.13	1414.72
T <sub>8</sub> - 50 Kg S/ha + 1 Kg B/ha	351.82	17.91	37.84	1337.74
T <sub>9</sub> - 50 Kg S/ha + 0.2% B spray	367.86	16.37	40.52	1476.71
F-test	S	S	S	S
S.Em±	5.85	0.42	0.28	25.68
CD (P = 0.05)	17.53	1.26	0.83	77.00

**Table 3:** Effect of Nitrogen and Sulphur Levels on Economics.

Treatments	Cost of production (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
T <sub>1</sub> - Control (RDF)	4490	111.117	66.147	2.47
T <sub>2</sub> - 30 kg S/ha	48120	126.295	78.175	2.62
T <sub>3</sub> - 50 kg S/ha	50220	126.129	75.909	2.51
T <sub>4</sub> - 1 kg B/ha	47070	111.333	64.263	2.36
T <sub>5</sub> - 0.2% boron spray	49986	108.845	58.858	2.17
T <sub>6</sub> - 30 kg S/ha + 1 kg B/ha	50220	133.329	83.109	2.65
T <sub>7</sub> - 30 Kg S/ha + 0.2% B spray	53136	143.010	89.874	2.69
T <sub>8</sub> - 50 Kg S/ha + 1 Kg B/ha	52320	135.213	82.893	2.58
T <sub>9</sub> - 50 Kg S/ha + 0.2% B spray	55236	149.257	94.021	2.70

### Conclusion

In the light of the above study, it may be concluded that application of Sulphur and Boron in adequate amount to crop is a fitting practice for augmenting higher Sunflower yields for farmers. There was an increase in seed yield of sunflower by 18% over the control. Application of 50 kg/ha sulphur + 1 kg/ha boron has influenced the Growth attributes of Sunflower. However, yield attributes and maximum Net

returns (94021 ₹/ha), BC ratio (2.70) was recorded higher with 50 kg/ha sulphur + 0.2% B spray. Since the findings were recorded are based on the research done in one season it may be repeated for further confirmation.

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